7 Perioperative Management of Patients with Retroperitoneal Tumors

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In addition to the inaccessibility of the retroperitoneal region, retroperitoneal tumors (RPTs) present no or non-specific symptoms until they have grown to a substantial size and invaded many adjacent organs. As a result, the removal of RPTs is quite complex. A good clinical outcome depends on not only superb surgical technique but also comprehensively perioperative management. There are very few reports on the perioperative management for patients with RPTs in international literatures, and in-depth understanding of its importance is required for surgeons. The perioperative management of RPTs involves multidisciplinary knowledge on circulation, respiration, digestion, urinary system, nerves, and blood vessels, due to the prolonged operation time, more blood loss, frequent blood transfusion, major surgical trauma, and multiple organ resection; thus, only a multidisciplinary team with comprehensive knowledge can help patients smoothly pass through the perioperative period.

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1 Preoperative Preparation of Retroperitoneal Tumor

1.1 Assessment of the Difficulty of Surgery

Emphasis should be laid on the comprehensive and accurate imaging, such as ultrasound, CT, and MRI. If necessary, intravenous pyelogram (IVP) or digital selective angiography (DSA) is performed. The images should clearly provide accurate and reliable information on the disease, including tumor size, location, as well as relations with surrounding organs and blood vessels, thus helping surgeons predict the resectability of RPTs. Since there are several intestinal canals located anterior to RPTs, ultrasound can't exhibit obvious advantage in the diagnosis. Moreover, the relationship between the tumor and retroperitoneal blood vessels is difficult to be displayed with ultrasound due to the deep location of the tumor. Rich blood supply indicated by ultrasound often suggests great difficulty in tumor resection. CT scan can display the tumor size, shape, boundaries, density, necrosis, cystic degeneration, and relation with adjacent organ and tissues. After injection of contrast media, CT can better disclose the degree of tumor blood supply, so it is of great importance to the assessment of relationship between the tumor and major blood vessels. CT scan is the most important tool for assessing resectability. Significant displacement or invasiveness $\geq 1/2$ of abdominal

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aorta and other blood vessel, or inferior vena cava stenosis (to the extent of being invisible on image), suggests the extreme difficulty of surgery and the possibility of vascular resection and even transplantation. MRI offers abundant information, but it has limitations in abdominal examination due to the effects of gastrointestinal gas. For this reason, MRI is primarily used to understand the relationship between RPTs and major retroperitoneal blood vessels. Due to the special nature of imaging principle, many surgeons are not skilled in reading abdominal MR images. It is encouraged to conduct MDT discussions with radiologists before surgery, so that surgeons may accurately predict the difficulty of resectability. Before surgery, gastrointestinal barium contrast is used to detect compression and displacement of gastrointestinal tract, and multiple displacements with stenosis suggest the high difficulty of surgery.

1.2 Prediction of Postoperative Prognosis

Clinically, the prediction of prognosis is vital for RPT patients. If a patient who has received a surgical excision wouldn't be expected to survive for more than 1 year, the surgery may be meaningless. A major factor that determines clinical outcome is the tumor's biological behavior, i.e., malignant degree, which can be indirectly reflected by its growth rate. In our hospital, some patients who underwent R1 resection had experienced relapse 3 months later, with tumors occupying the whole abdominal cavity. In these patients, the resectability rate was extremely low, and postoperative prognosis was dismal.

1.3 Prediction of Patients' Tolerance to Surgery

Before removal of RPTs, an overall analysis must be performed on the patient's cardiopulmonary, hepatic and renal, and coagulation function, as well as nutritional status, in order to comprehensively assess the patient's tolerance to such major surgery. For patients who are expected to undergo the resection of one kidney, clinicians must confirm whether their contralateral kidney function is normal using renogram, IVP, or other reliable methods. If serum albumin is <30 mg/ml, the incidence of intestinal fistula, infection, and other postoperative complications would be high. The elderly patients with poor cardiopulmonary function generally cannot survive this type of surgery.

1.4 Preparation for Intestinal Cleansing

Preoperative intestinal preparation is essential to complex RPT surgery, since up to 29.8% of patients who undergo the resection of RPTs may receive combined gastrointestinal surgery. Preoperative intestinal obstruction is common, especially in those who experience a relapse following resection of RPTs. As abdominal wound is extensive, the incidence of postoperative intestinal adhesions is high. The residual stool left in the intestine should be completely removed when performing secondary operation. Patients without preoperative gastrointestinal obstruction can be given laxatives to empty gastrointestinal contents and parenteral antibiotics for anti-inflammation. Intestinal preparation of patients with gastrointestinal obstruction is mainly performed by cleansing enema.

1.5 Improvement of Nutritional Status

As patients with RPTs often present with malnutrition and gastrointestinal obstruction before surgery, supportive enteral nutrition should be administered while monitoring indicators such as serum albumin, prealbumin, and hemoglobin. If these patients cannot take food by mouth, total parenteral nutrition (TPN) support is required to raise albumin to more than 30 mg/ml. In addition to big three macronutrients (carbohydrate, protein, and fat), sufficient dose of vitamins and trace elements is also needed, especially vitamin

K. For patients with anemia, a small amount of red blood cells should be infused successively to improve oxygen metabolism.

1.6 Sufficient Reserves in Blood Bank

Due to a lot of uncertainties during surgery of RPTs, it is difficult to predict the amount of blood loss before operation. Large surgical wounds and long operation duration increase the risk of accidental injuries to major blood vessels during surgery. On the one hand, a large tumor itself can facilitate the growth through the feeding vessels, making it difficult to stop bleeding due to very thin walls of blood vessels. Thus, available source of blood supply for patients must be guaranteed before surgery. Generally, the amount of blood reserve should be three times the expected transfusion amount to ensure enough reserve blood supply once unexpected bleeding occurs. In addition to sufficient RBCs, plenty of plasma will be needed, which can provide coagulating substances if coagulation disorder occurs following infusion of a large number of RBCs.

1.7 Preparation of Vascular Devices and Vascular Repair Materials

As RPT surgery often involves injury and repair of major blood vessels, clinicians should prepare vascular devices, various types of vascular sutures, and artificial blood vessel materials required for repairing vascular defects before surgery, especially when preoperative imaging findings suggest a close relationship between the tumor and major retroperitoneal blood vessels.

1.8 Selective Embolization

Digital subtraction angiography (DSA) is used to assess blood supply to RTPs and identify blood source, which plays an important role in demonstrating cellular origin of the tumor and richness of blood supply, as well as predicting benign vs. malignant predisposition. Angiography is also of diagnostic value for compression and displacement of blood vessels, wrapping and infiltration of blood vessel walls, vascular stenosis, and intraluminal thrombosis. In addition, angiography is essential to help guide repair of vascular damage and reduce or control blood loss during resection of RPTs. Patients who have hypervascular primary RPTs are advised to receive preoperative embolization. Selective embolization, that causes tumor ischemia or reduces blood supply, is conducive to the management of blood vessels during surgery. This strategy can significantly reduce intraoperative blood loss, increase operational safety, and improve rate of complete resection. Generally, the surgery should be performed within 1–3 days after embolization. If the interval is more than 3 days, the revascularization will increase inflammation, thus leading to heavier wound bleeding. That may explain why long interval will adversely affect the surgery. Patients with large hypervascular RPTs following effective embolization will present a certain degree of heat absorption, resulting in tumor shrinkage (presenting with gray surface) and tension reduction intraoperatively.

1.9 Preparation of Special Case

Functional pheochromocytoma is a special type of RPTs, which is mostly located adjacent to abdominal aorta and inferior vena cava, with rich blood supply. The resection on functional pheochromocytoma is very risky due to sharp fluctuations in blood pressure. Catecholamine metabolites should be determined preoperatively. If the levels of catecholamine metabolites are elevated, the preparation for surgery will be conducted as the same as that for pheochromocytoma. The preoperative preparations of retroperitoneal paraganglioma with functional properties similar to pheochromocytoma are described in relevant sections herein.

2 Intraoperative Management and Surgical Strategy

2.1 Surgical Approach and Intraoperative Exposure

For RPTs located deeply in abdominal cavity, the surgery is usually complicated and requires a longer period of time, and the surgical approach varies from the tumor location. The first principle is that the surgical incision should be large enough to achieve adequate exposure for good visualization of the operative field. A midline longitudinal incision can be used as the main surgical incision in most cases of RPTs, with transverse incision as an auxiliary incision when appropriate. The midline longitudinal incision with high flexibility can be supplemented by different auxiliary incisions during surgery if necessary. Surgeons may rapidly open and close abdomen via midline abdominal incision, thus shortening operation duration, minimizing incision bleeding, and reducing postoperative wound complications. The second principle is that surgeons should try to access retroperitoneal space without intermesenteric dissection. In general, peritoneal incision should be made via paracolic gutter, or the access into the retroperitoneal space is made by cutting gastrocolic ligament, diaphragm, and spleen ligament or flipping colon, duodenum, head and tails of the pancreas, or other organs, thus creating large enough surgical fields in order to prevent damages to the abdominal and mesenteric arteries.

2.2 Adhesion Separation Technology in Retroperitoneal Tumor Surgery

The separation of adhesions should be performed during the surgery of RPTs, especially in those with large and recurrent tumors. The most common adhesion occurs between the tumor and gastrointestinal tract and its mesentery. Liposarcoma is one of RPTs that most frequently generate adhesion. After repeated surgeries, the gap between the bowel and the tumor almost disappears in patients with intra-abdominal multiple tumors; therefore, the separation of adhesions will be a key step of the surgery. If it is difficult to separate the adhesion between the bowel and the tumor, combined removal of partial bowel can be performed; keep in mind that more than 1 m of the small intestine should be retained in order to avoid postoperative short bowel syndrome. After the separation of extensive abdominal adhesions, the entire digestive tract should be repeatedly checked for cracks, which should not be missed, and any crack must be repaired immediately. Adhesions are separated usually by sharp dissection and rarely by blunt dissection (only for loose space). If any adhesion between tumor and blood vessels occurs, traveling route of the blood vessels should be identified prior to sharp separation outside of the vessel wall.

2.3 En Bloc vs. Piecemeal Resection

The principle for surgery of RPTs is to strive for a complete and en bloc resection of the tumor, together with involved tissues and organs adjacent to the tumor, namely, R0 resection. R0 resection, representing the highest level of surgery, is a pivotal step in reducing postoperative recurrence. Alternatively, piecemeal resection should be selected if it is hard to perform R0 complete resection when a large tumor seriously affects the visualization of surgical field and exposure or the identification of major blood vessels and adjacent organs. The residual tumor should not be removed until most of the tumor body has been resected and the boundaries with major blood vessels and adjacent structures have been clearly identified. During the surgery, surgeons may predict the extent of tumor blood supply and estimate the controllable degree of bleeding after oncotomy base on their own experience. Considering the difficulty in stopping bleeding, en bloc resection rather than piecemeal resection should be performed.

2.4 Combined Organ Resection and Palliative Resection

The purpose of surgery for RPTs should emphasize complete resection of the tumor, leaving no evidence of residual tumor around the margin under the microscope. Retroperitoneal tumor frequently invades adjacent organs, so a combined resection of involved organs should be performed in order to achieve R0 resection. Organs that usually require combined resection include the colon, kidney, small intestine, pancreatic body and tail, ureter, and bladder. In our hospital, 132 out of 687 cases of primary RPTs underwent the combined organ resection (19%), including colorectal (12.8%), kidney (10.6%), and small bowel resection (7.4%). Other organs resected during RPT surgery include suprarenal gland, ureter, partial stomach, duodenum, head of pancreas, spleen, uterus, and adnexa. No matter combined resection is performed on organs or blood vessels, the possibility of reconstruction and the incidence of complications after reconstruction must be taken into account. If it is very risky, combined resection should be given up. If a tumor cannot be completely resected, a palliative resection will be performed for the following purposes: (a) firstly reducing the tumor burden and prolonging the patient's survival time and (b) removing the tumor compression, relieving the patient's symptoms, and improving the patient's quality of life. Due to high-grade malignancy and rapid growth speed, pathological remission of RPTs cannot be achieved even with palliative resection, so it might be wise to give up surgery.

2.5 Prevention and Treatment of Bleeding During Surgery

As a large amount of blood loss frequently occurs during surgery of RPTs, effective prevention and control of bleeding are the keys to successful operation. Surgeons and anesthesiologists must strengthen their skills and knowledge compared to those who perform conventional surgery and work together to deal with emergencies. Normally, in order to avoid failure of transfusion via lower extremity caused by intraoperative blockage of the inferior vena cava or iliac vein, two rapid infusion passages that doesn't pass through lower limbs should be established. In emergencies, multichannel, pressurized, and intravenous bolus of blood transfusion should be implemented. The backup person should be ready to respond to emergencies (Feng et al. 2015; Mishra and Joshi 2015).

3 Postoperative Management

During the surgery of RPTs that requires longer operative time, with higher incidence of combined organ resection and major surgical trauma, patients may experience bleeding, shock, and other severe complications. Therefore, the postoperative management is an important link to clinical outcome during the perioperative period (Flynn et al. 2007).

3.1 Strict Monitoring of Vital Signs

Patients with RPTs who have experienced major surgical trauma and large blood loss definitely need high volume of liquid and blood transfusion. As the blood loss cannot be accurately estimated, the usual volume of blood transfusion is far from equivalent to that of blood loss. Meanwhile the larger surgical wound increases the risk of persistent bleeding and exudates postoperatively. As a result, strict monitoring of vital signs and maintenance of blood volume balance are the most important tasks in the first 24 h after surgery. Central venous pressure is of significance to determine blood volume and to guide fluid infusion, while dynamic changes in hemoglobin concentration and hematocrit are critical indicators for objectively estimating the volume of bleeding and re-bleeding as well as guiding postoperative blood transfusion.

3.2 Observation and Interpretation of Quantitative and Qualitative Changes in Intraperitoneal Drainage

A heavy blood loss may occur during surgery of RPTs. The excessive consumption of coagulation factors during the operation leads to significant decline in postoperative coagulation function. Moreover, large surgical wounds may cause continuous bleeding postoperatively. Therefore, close observation of changes in volume and nature of peritoneal drainage is vital to discover postoperative bleeding. Based on our years of experience, in the absence of bleeding of major blood vessels, with the estimated amount of bleeding of less than 100 ml/h, conservative treatment may be considered, while dynamic changes in the patient's condition should be closely observed. Two large accesses for liquid and blood transfusion should be kept available after operation. Hemostatic treatment includes expansion of blood volume with fluid replacement. If hemoglobin and hematocrit decrease by 20% as compared with preoperative levels, supplementation of physical ingredients should be preferred to maintain the plasma colloid osmotic pressure. Appropriate blood coagulant drugs, vasoactive drugs, and coagulation factors may be used to improve blood coagulation function. Patients with heavy bleeding, especially those with severe liver impairment, will significantly benefit from fibrinogen. Patients with rapid bleeding postoperatively may show little response to short-term hemostatic transfusion therapy and thus experience a progressive decline in hemoglobin. Patients with decreased and unstable blood pressure should undergo an exploratory surgery timely to stop bleeding.

3.3 Maintenance of Balance Between Water and Electrolyte

During RPT surgery, infusion of large volume of liquid and blood may be needed, and it is difficult to accurately determine the amount of supplementation. On the one hand, the amount of blood loss may be too large to be accurately estimated. On the other hand, large surgical wounds and long-term intraperitoneal exposure may lead to more water evaporates which are not apparent fluid loss and often ignored by surgeons. In addition, patients with RPTs usually undergo intestinal preparation before surgery, so they are already in the dehydrated state. The above factors should be fully considered when fluid is supplemented intraoperatively and postoperatively. To maintain the balance between water and electrolyte, it is necessary to monitor the patient's vital signs, central venous pressure, and biochemistry parameters. The amount of fluid replacement is adjusted to maintain the balance between intake and output, and vital signs are kept stable intraoperatively and postoperatively. Since blood volume expansion during the surgery can result in hemodilution and water retention, diuretics should be administered appropriately based on stable vital signs to remove excessive water, especially in patients who present lower leg swelling before surgery.

3.4 Strengthening of Nutritional Support

The resection of RPTs is a major surgery, requiring excellent postoperative nutritional support, especially in patients who undergo intestinal resection or repair during the surgery. More importantly, the level of serum albumin in these patients must be maintained at above 35 mg/ml to avoid large amounts of exudates in the operative field, reduce tissue edema, and prevent intestinal leakage and infection postoperatively.

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