Cholecystectomy, porta hepatis stripping, and omental bursectomy

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Abstract: As ovarian cancer commonly involves the visceral organs without boundary, more aggressive procedures are adopted during cytoreductive surgery. One of the most difficult aspect of the operation involves the procedure for the gall bladder, porta hepatis, and omental bursa. As the upper abdominal surgical field is not familiar to the gynecologic surgeon, and the vital organs or vessels are densely positioned, these procedures can be challenging for achieving the optimal cytoreductive surgery. The surgical approaches for advanced ovarian cancer that are required in the upper abdomen have evolved with the progress in surgical techniques. This article will discuss the surgical approach by focusing on cholecystectomy, porta hepatis debulking, and omental bursectomy, as well as the regional anatomy in patients with advanced ovarian cancer.

Keywords: Cholecystectomy; porta hepatis; lesser sac; advanced ovarian cancer; cytoreductive surgery

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Introduction

Most ovarian cancer patients are diagnosed at an advanced stage, with more than 60% of them presenting with upper abdominal metastatic disease (1). Upper abdominal disease is related with an increased risk of suboptimal residual disease; moreover, the surgical complexity is higher than that for other parts of the abdomen (2). Although previous studies have reported the feasibility of radical resection of upper abdominal disease and the associated long-term patient survival, lesions in certain anatomical regions including the gallbladder, porta hepatis and omental bursa are still considered major obstacles to achieving optimal residual disease (3,4).

The porta hepatis is a particularly difficult area for achieving complete cytoreduction in patients with ovarian cancer (5). As the field is not familiar to the gynecologic surgeon and includes complicated structures such as the hepatic artery, portal vein and common bile duct, it can pose a challenge for optimal cytoreduction. One of the most challenging peritonectomy procedures is lesser omentectomy with stripping of the omental bursa. Vital structures including major vessels and organs are densely positioned, and mistakes during the procedure can lead to lethal hemorrhage or damage to adjacent major organs. Therefore, thorough knowledge of the adjacent anatomical structure is imperative for safe lesion dissection (6-9). In this review, we will discuss the surgical approach of each procedure, focusing on the related anatomy for safe operation.

Regional anatomy

Misinterpretation of the normal anatomy and anatomical variations contributes to major postoperative complications, including massive bleeding and major organ damage. Knowledge of the basic anatomy, including major vessels

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and adjacent anatomical structures, is critical for safe surgical procedures.

Gallbladder

The gallbladder is located in the fossa located at the junction of the right and left liver. Although the liver and gallbladder must be retracted during an open surgical approach, the natural position of the gall bladder is anterior to the proximal part of the duodenum, with its neck and cystic duct immediately superior to the duodenum. On the surface, the visceral peritoneum is continuous with Glisson's capsule, which surround the fundus of the gallbladder and binds its body and neck to the liver. The hepatic surface of the gallbladder is attached to the liver by connective tissue from the fibrous capsule of the liver. The gallbladder is divided into the fundus, body, infundibulum, and neck. As the neck of the gall bladder joins the cystic duct, it can make a sigmoid-shaped curve or an abnormal sacculation (Hartmann pouch), which is related to the formation of gallstones. This pouch varies in size, and a wide pouch may occlude the cystic duct within Calot's triangle, which is surrounded by the common hepatic duct medially, cystic duct inferiorly, and inferior surface of the liver superiorly (10).

The blood supply to the gall bladder and cystic duct is from the cystic artery, which commonly stems from the right hepatic artery in Calot's triangle. However, variations in the origin and course of the cystic artery occur in approximately 20% of patients (11), and a double cystic artery has been reported in 15% of patients (9). The cystic artery typically runs superior to the cystic duct and posterior to the common hepatic duct. Venous drainage of the fundus and body of the gallbladder is directly through the liver. Veins from the neck and cystic duct flow via the cystic vein through the portal venous system or directly into the liver. The lymphatic drainage of the gallbladder is to the hepatic lymph nodes, often through cystic lymph nodes located near Calot's triangle. Efferent lymphatic vessels from these nodes pass to the celiac lymph nodes.

The cystic duct connects the gallbladder to the common hepatic duct to form the common bile duct and is inarguably one of the most important structures to identify during cholecystectomy. The size of the cystic duct varies from 1 to 5 cm in length and from 3 to 7 mm in width; an exceptionally short (<2 cm) cystic duct may be a challenge due to the possible risk of damage to the biliary system (9).

Porta hepatis

The porta hepatis is the entrance and exit for several important vessels and nerves. It includes three important structures, the portal vein, proper hepatic artery, and hepatic bile duct. From anterior to posterior, these structures are located in the order of the duct, artery, and vein. The hepatoduodenal ligament is the peritoneal portion of the lesser omentum connecting the porta hepatis and superior part of the duodenum. The hepatoduodenal ligament contains the three main structures, namely—the extrahepatic bile duct, proper hepatic artery, and portal vein—which are collectively known as the portal triad, wrapped in a serous covering. In the hepatoduodenal ligament, the proper hepatic artery runs left of the bile duct while the portal vein runs posterior to the common bile duct and proper hepatic artery. As the hepatoduodenal ligament provides a route for peritoneal carcinomatosis, it should be removed when metastatic lesions are visualized (6,8).

Omental bursa

The omental bursa or lesser sac is a potential hollow peritoneal space posterior to the lesser omentum. As the lesser sac is a peritoneal space, all its boundaries are lined by the peritoneum. The anterior boundary of the lesser sac is primarily composed of the hepatogastric ligament (lesser omentum) and posterior wall of the stomach. The gastrosplenic and splenorenal (or lienorenal) ligaments are located on the left lateral side. The epiploic foramen (of Winslow) is the only natural window on the right side and communicates with the peritoneal cavity. Posteriorly, the peritoneum covers the diaphragm (crus of the right hemidiaphragm) and pancreas. The lesser omentum is the continuous double layers of the visceral peritoneum. Between the two layers of the lesser omentum, bordering on the right free margin, is the hepatic artery proper. Attached to the lesser curvature of the stomach are the right and left gastric arteries, and the gastric vein (7).

Procedures

Cholecystectomy

Typically, a generous midline incision commonly used for the cytoreductive surgery allows adequate surgical exposure of the gallbladder. Good visualization of the gallbladder,

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Calot's triangle, and porta hepatis, including the bile ducts is important for the safety of the procedure. Before dissection, a surgeon should perform careful manual palpation and visual inspection for incidental pathological findings or anatomical abnormalities.

Once the structures around the surgical field are adequately identified, a surgeon can grasp the fundus of the gallbladder using a Kelly clamp and manipulate to facilitate best visualization. Traditionally, procedures in open cholecystectomy utilize a retrograde or "top-down" approach. By contrast, dissection starts from the identification of the cystic artery and cystic duct in the antegrade or "bottom-up" approach. The top-down approach starts with the mobilization of the gallbladder from the liver. As the cystic duct is the last remaining structure of the dissection, this technique may minimize the risk of injury to the portal structures. The fibro-areolar tissue between the gallbladder and liver can be separated by an electrocautery device. The dissection plane is typically avascular, and bleeding from the liver bed is commonly managed with electrocautery. The argon plasma coagulator can be applied to the liver bed or surrounding metastatic lesions for bleeding control and tumor elimination.

Variants of the origination and course of the cystic artery are common. Consequently, recognition of the anatomy of the cystic artery is essential and dissection of the cystic pedicle containing the cystic artery and duct is crucial. If possible, the cystic artery can be ligated close to the gallbladder wall to avoid hemorrhage or hepatobiliary complication. The cystic duct can be palpated and milked at this stage to identify the structure clearly. The cystic duct can also be ligated close to the gallbladder; it is not necessary to perform dissection at the junction of the cystic and common duct. In case of severe inflammation or obliteration of tissue planes, some tissue can remain attached to the cystic duct. If the cystic duct is large or accompanied by inflammation, stapling devices also can be utilized. In general, the cystic duct is ligated using absorbable sutures, and the cystic artery can be ligated either with ties or clips.

Cholecystectomy is one of the most common procedures performed in hepatic-biliary surgery. Nevertheless, complications including bleeding or bile duct injury remain a concern even for experienced surgeons. In situations of excessive bleeding in the region of Calot's triangle, additional clipping or electrocauterization can worsen the hemorrhage. The key to avoiding such complications lies in paying attention to the anatomic structure during meticulous dissection. As the peritoneum splits on the right border of the hepatic duct, any anomalous duct and artery can be best visualized in this plane by lifting the anterior layer of the peritoneum in the region of Calot's triangle. Another key to safe procedures includes the clear delineation of the cystic duct and artery joining the gallbladder neck before ligation and transection. Moreover, since undue cephalad traction on the gallbladder may lead to misidentification of the common bile duct as the cystic duct during ligation, it must be ensured not to make excessive traction on the gallbladder (12,13). Postoperatively, bile duct injury should be suspected when patients present with fever, jaundice, and/or bilious ascites. Percutaneous catheter drainage of the bilious ascites or endoscopic retrograde cholangiopancreatography (ERCP) may define the type of injury and allow stent placement.

Porta hepatis debulking

Before dissection, a surgeon can evaluate the tumor nodules around the porta hepatis by placing the palpating finger into the foramen of Winslow and the thumb anteriorly. Ovarian cancer may sometimes involve the falciform and round ligaments of the liver. For complete cytoreduction, surgeons should also inspect these ligaments and the peritoneal surfaces within the umbilical fissure and remove these structures if tumor invasion is confirmed.

The cancerous tissue coating the hepatoduodenal ligament can be bluntly stripped using Russian forceps and sharply dissected from the gallbladder bed or peritoneal attachment of the liver surface toward the duodenum by using an electrosurgical device. During the stripping, special care should be taken to avoid injury to the left hepatic artery, which is usually the most superficial of the portal structures. For the dissection, the peritoneum is grasped using Russian forceps, and a blunt and sharp dissection technique can be applied aptly.

Then, the peritoneum of the anterior hepatoduodenal ligament is stripped from the structure. Although the anterior part of the hepatoduodenal ligament is commonly involved in tumors, when the tumor spreads to the posterior hepatoduodenal ligament, circumferential dissection around the hepatoduodenal ligament is required. The peritoneal stripping procedure can be extended medially, laterally, and posteriorly to complete the circumferential dissection. By connecting the dissection from each side of the porta hepatis, circumferential dissection is achieved. Sharp and blunt dissection should be properly applied for this procedure.

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Tumor nodules may be located between liver segments 4 and 5. These tumor nodules can be dissected and electroevaporated. Care should be taken not to damage the vasculature present in this fissure. Electrosurgery using a Bovie unit and blunt dissection using Russian forceps can efficiently remove the tumors on top of the vascular structure. Although this approach can be sequenced as described earlier, surgeons can change the order of each procedure based on tumor location and ease of the dissection planes (14,15).

A few studies reported the results of porta hepatis surgery in advanced ovarian cancer. All the studies state a high feasibility rate of porta hepatis procedures, resulting in a complete resection rate of over 90%. Morbidity specifically related to the procedures was identified in 3 patients out of 77 (3.8%). There was no long term morbidity reported (14,16,17). However, as the traumatic injury to the porta hepatis can cause exsanguinating hemorrhage during the surgery, the tumor resection should always be attempted once the around major structures have been clearly identified and protected.

Omental bursectomy

As a part of lesser omentectomy, the hepatoduodenal ligament is removed as described earlier. The hepatogastric ligament can then be separated from the fissure defined by the ligamentum venosum. Special care is required to avoid damaging the common hepatic artery located on the right margin of the lesser omentum. For safety, a surgeon can palpate the hepatic artery before dividing the peritoneum. Care should be taken to avoid accessory left hepatic artery injury that may arise from the left gastric artery and through the hepatogastric ligament. If the artery is included in the tumor or if the vessel obscures the clear exposure of the omental bursa, the artery can be ligated and resected as part of the hepatogastric ligament. The lesser omentum containing the tumor is then dissected from the liver and lesser curvature of the stomach. Traction on the lesser omental specimen should be maintained during the procedure and removed from the arcade made by the right and left gastric arteries.

A Deaver retractor is positioned beneath the caudate lobe of the liver to expose the entire floor of the omental bursa. Russian forceps can be used for blunt dissection of the peritoneum from the superior recess of the omental bursa, the crus of the right hemidiaphragm, and beneath the portal vein. Remnant tumors can then be removed by electroevaporation from the shelf of the liver parenchyma beneath the portal vein and joining the right and left sides of the caudate lobe. Special caution is needed while stripping the floor of the omental bursa to remain superficial to the right phrenic artery (18).

The left hepatic artery is known to be the most frequently injured vessel. The left hepatic or left inferior phrenic vein can be inadvertently traumatized by irregular and unpredictable diaphragmatic contractions stimulated by electrocauterization near the crus of the right hemidiaphragm. Therefore, in-depth knowledge of the omental bursa (or lesser sac) is imperative for adequate dissection of these organs.

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