

# Glisson's Pedicle Approach and Liver Round Ligament Approach in Anatomical Hepatectomy

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## 12.1 Glisson's Pedicle Approach in Liver Resection

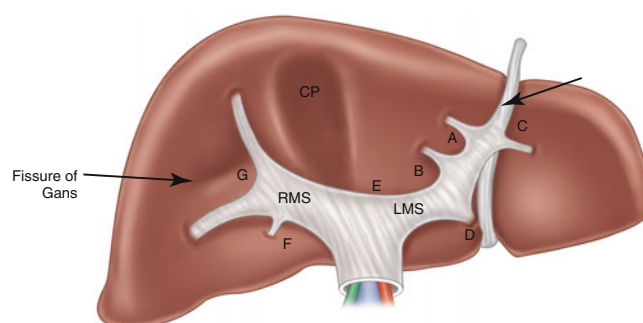
### 12.1.1 Anatomy

The hepatic artery, portal vein, and bile ducts (the portal triad) in the ligamentum hepatoduodenale are encased in a membrane and branch, and they constitute Glisson's system. This system consists of extrahepatic and intrahepatic portions. The portal triad encased in the connective tissue and peritoneum, up to the porta hepatis, constitutes the extrahepatic portion of Glisson's system, whereas the portion that extends into the liver is considered intrahepatic. The ligamentum hepatoduodenale is the main stem of Glisson's system and gives rise to two primary branches at the porta hepatis. The left primary branch of Glisson's pedicle (including the left branch of the portal vein, the left hepatic artery, and the left hepatic duct) runs in the left hilar plate and turns upward in the fissure toward the ligamentum teres hepatis after giving rise to branches leading to the II segment at the left-most part of the left hilar plate. The left primary branch of Glisson's pedicle gives off branches to the III segment at the left side of the base of the fissure for the ligamentum teres hepatis and branches to the IV segment at the right side of the base of the fissure for the ligamentum teres hepatis; it then continues with the ligamentum teres hepatis. The main stem of the right primary branch of the Glisson's pedicle is short and occasionally even absent, and it quickly divides into two secondary branches (Fig. 12.1). Based on this anatomical foundation, Professor Takasaki (Tokyo Women Medical University) divided the liver into three sections: the right segment, middle segment, and left segment, which

correspond, respectively, to the right posterior lobe, right anterior lobe, and left lobe in Couinaud's hepatic segments [1]. By extrahepatic dissection of Glisson's pedicle, we can address the structure in Glisson's pedicle without opening Glisson's sheath, thus avoiding complex operations and potential damage to the hepatic portal. This procedure is called Glisson's pedicle transection hepatectomy. After development and promotion by Machado and others, this technology has been available for hepatic segmentectomy, hepatic lobectomy, hemihepatectomy, and extensive hepatectomy and shows its unique advantages [2, 3].

**Advantages** This technique addresses hepatic ducts without opening Glisson's sheath, saves time, and avoids potential damage to the hepatic portal.

**Disadvantage** This technique requires adept operative skills and solid hepatic anatomy, and it may cause duct injury when there is variation in the hepatic portal.



**Fig. 12.1** Blocking the inflow of the corresponding hepatic lobes or hepatic segments. A: The basis of the round ligament, right side; B: inferior margin of the quadrate lobe, near the left end of the hilar plate; C: the basis of the round ligament, left side; D: superior margin of the quadrate lobe, near the left end of the hilar plate; E: inferior margin of the quadrate lobe, near the capsule bed; F: inferior margin of Glisson's pedicle near the portal vein branches, right side; G: fissure of Ganz. LMS left branch of Glisson's pedicle, RMS right branches of Glisson's pedicle, CP cystic plate, the arrows indicate the round ligament

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## 12.1.2 Techniques

Take the right costal margin incision along the midline directly up to the xiphoid. Confirm that there are no intrahepatic metastases or intra-abdominal metastases. Cut the falciform ligament and the round ligament, and reserve the stump of the round ligament for traction. Dissect the coronary ligament until the conjunctive region of the suprahepatic inferior vena cava, hepatic vein, and inferior vena cava is exposed. Cut off the left side of the deltoid ligament and completely dissociate the left liver. Locate the tumor and confirm the relationship between the cancer and the intrahepatic ducts with intraoperative ultrasound.

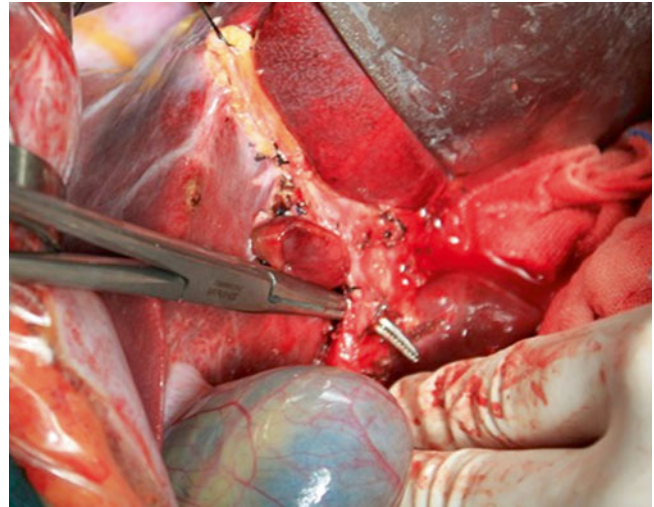
### 12.1.2.1 Hepatic Left Lateral Lobectomy

**Control the Inflow of Left Lateral Lobe** Blood into the left lateral lobe (including the S2 and S3) is supported by the left Glisson's pedicle branches along the left side of the fissure of the round ligament. A small incision on the left side is the basis for the fissure of the round ligament (Fig. 12.1); then, make an incision on the front of the left venous ligament and left Glisson's pedicle branch confluence (Fig. 12.1). Use long curved forceps for blunt dissection from site C to site D until the curved forceps pierce site D. Then, a tourniquet can surround the left Glisson's pedicle branches with the curved forceps traction until the branches are broken off.

**Parenchymal Transection** Resect the liver at the diaphragmatic surface along the left border of the falciform ligament, at the visceral surface along the left border of the round ligament, and toward the Arantius ligament follows an order of a superior-inferior movement and then an inferior-superior movement. Because the inflow of the left lateral lobe and bile duct has been amputated, the hepatectomy can be performed more quickly. After exposing the left hepatic vein trunk, amputate it, and reinforce the stump with 5/0 polydioxanone suture (PDS) wire. Remove the entire specimen, staunch the bleeding, place the drainage tube, and close the abdomen.

### 12.1.2.2 Left Hemihepatectomy

**Control the Inflow of the Left Liver** Dissect the left Glisson's branches at the left side of the hilar plate, which will avoid injury to the blood vessels and bile ducts if there is anatomical variation of the hepatic portal. Using the confluence of the left Arantius ligament and left Glisson's pedicle branches as a guide, safely and quickly dissect the left Glisson's pedicle branches. Make a small incision at the inferior border of the fissure of the round ligament, and dissect



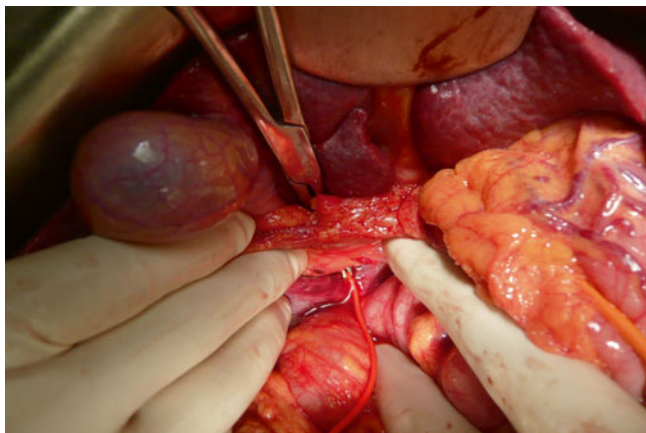
**Fig. 12.2** Isolating the left Glisson's branch at the end of left hilar plate

the front confluence of the left Arantius ligament and left Glisson's branch (Fig. 12.1) to expose the back of left Glisson's pedicle branch. Then, use long curved forceps for blunt dissection from site B to site D, encircle the left Glisson's branch with a tourniquet and amputate the left branch (Fig. 12.2).

**Parenchymal Transection** After occlusion of the left hepatic inflow, a significant ischemic line appears on the liver surface; the hepatectomy starts from this line. Make an incision along the left hepatic vein following an order of a superior-inferior movement and then an inferior-superior movement. Intraoperative ultrasound can help locate the middle hepatic vein when necessary. After exposing the left hepatic vein trunk, amputate it, and reinforce the stump with 5/0 PDS wire. When the tumor affects the caudate lobe and the caudate lobe must be resected, resect the liver along the line as described until arriving in the front of the inferior vena cava. Then, pull the caudate lobe and left liver to the left, expose the front and left side of the retrohepatic inferior vena cava, and ligate the short hepatic vein from inferior to superior. After the back of left hepatic vein is completely exposed, ligate and suture it. Remove the entire specimen, staunch the bleeding, place a drainage tube, and close the abdomen.

### 12.1.2.3 Right Hemihepatectomy

**Control the Inflow of the Right Liver** Make a small incision on the right side of the confluence of the caudate lobe, gallbladder bed, and far right side of the hilar plate (Fig. 12.1), up to the level of the hepatoduodenal ligament. Expose the connective tissue at the inferior border of the hilar plate.



**Fig. 12.3** Isolating the right Glisson's pedicle trunk in the right hilar plate

Reveal the caudate branch after careful dissection. Dissect, ligate, and suture this branch; blunt dissection can occur from this branch to incision E until the entire right Glisson's pedicle trunk is dissected. Amputate the trunk, and suture the ends (Fig. 12.3).

**Parenchymal Transection** After right hepatic inflow is occluded, a significant ischemic line appears on the liver surface. The hepatectomy starts from this line, along the right side of middle hepatic vein following an order of a superior-inferior movement and then an inferior-superior movement. Intraoperative ultrasound can help locate the middle hepatic vein when necessary. After exposing the right hepatic vein trunk, amputate it, and reinforce the stump with 5/0 PDS wire. Remove the entire specimen, staunch the bleeding, place a drainage tube, and close the abdomen.

#### 12.1.2.4 Right Anterior Lobe Resection

The incision is made as a right hemihepatectomy. Then, use curved forceps for blunt dissection along the right Glisson's pedicle and pierce the fissure of Ganz. The fissure of Ganz is the boundary of the right anterior and right posterior branches, which is obvious in 70 % of patients. Therefore, we can use the fissure of Ganz as an anatomical marker for dissecting the right anterior Glisson's pedicle branch and the right posterior Glisson's pedicle branch.

S4 will be cut off when performing a middle hepatectomy or right extensive hepatectomy. The round ligament is a guide when blocking the inflow of S4. The S4 branches come from the left Glisson's pedicle branch (the left portal vein continuation of the round ligament). During dissection of these branches, a small incision is made on the right side at the base of the fissure for the round ligament (Fig. 12.1), and another incision is made at the inferior border of the quadrate

lobe near the fissure for the round ligament (Fig. 12.1). Use a right-angle clamp for blunt dissection between A and B, and place a tourniquet around the left Glisson's sheath until the left branch is amputated. Resect the liver at the diaphragmatic surface along the right border of the falciform ligament at the visceral surface along the left border of the round ligament.

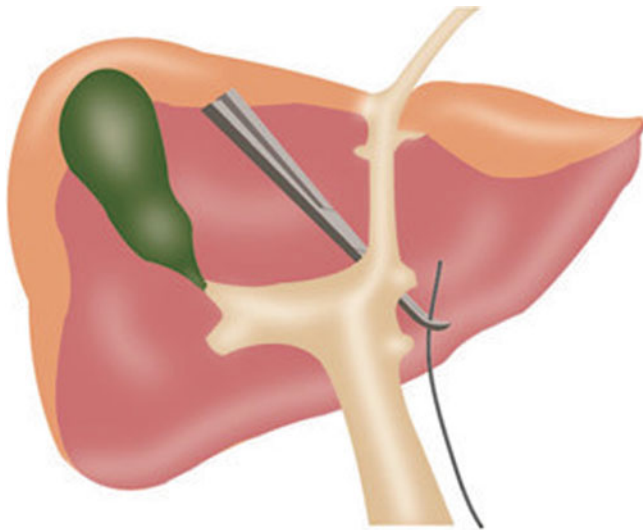
## 12.2 The round Ligament Approach in Hepatectomy

Traditional hepatectomy techniques often start from the hepatoduodenal ligament until the corresponding artery, portal vein, and bile duct are dissected. As we introduced earlier, the round ligament approach starts from the round ligament. First, the fissure of the round ligament is dissected, and the left end of hilar plate is found and isolated. Ligate the structure in the hilar plate. Then, we lower the porta hepatis, which allows complete separation of the hilar plate and hepatic parenchyma so that we can safely and quickly transect hepatic parenchyma. The round ligament approach is applicable for extensive hepatectomy, left hepatectomy, and middle hepatectomy, etc.

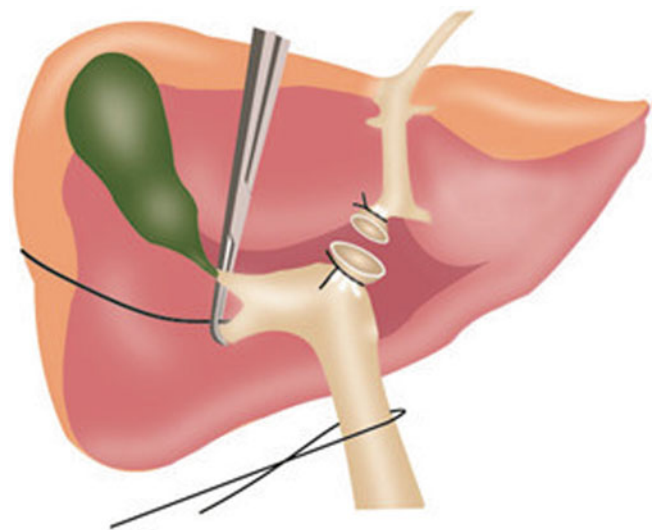
### 12.2.1 Anatomy

The left primary branch of Glisson's pedicle, including the left branch of portal vein, the left hepatic artery, and the left hepatic duct, runs in the left hilar plate and turns upward in the fissure for the ligamentum teres hepatis after giving off branches to segment II at the left-most part of the left hilar plate. The left primary branch of Glisson's pedicle gives off branches to segment III at the left side of the base of the fissure for the ligamentum teres hepatis and branches to segment IV at the right side of the base of the fissure for the ligamentum teres hepatis. Then, it continues with the ligamentum teres hepatis. We can use the ligamentum teres hepatis as a landmark to confirm Glisson's pedicle of some hepatic lobes and hepatic segments and then separate and ligate it out of the liver to selectively block hepatic blood flow. Moreover, we can also use the fissure of the ligamentum teres hepatis and the falciform ligament as a landmark to limit the disconnection of the hepatic parenchyma.

**Advantages** (1) Using the left approach, dissect the back of the porta hepatis, which can create space for liver parenchyma transection and avoid damaging the retained bile ducts during parenchyma transection. (2) For the patients with hilar adhesions caused by hilar surgery, injury, etc., the left approach is better than the anterior approach.



**Fig. 12.4** The left main sheath is divided at the left end of the hilar plate



**Fig. 12.5** The hilar plate is lowered along the base of segment IV, and a long curved clamp is introduced from the incision left to the cystic plate toward the right edge of the gallbladder bed and penetrates the parenchyma between the anterior and posterior section pedicles to isolate the right anterior section pedicle

## 12.2.2 Techniques

### 12.2.2.1 Extensive Left Hepatectomy

**Control Inflow of the Liver with the Round Ligament Approach** Dissect the ligamentum teres hepatis and find the left end of the hilar plate. Dissect the hilar plate; isolate the left branch of portal vein, left hepatic duct, and left hepatic artery; amputate and suture them one by one (Fig. 12.4). Lower the right side of the hilar plate until it reaches the left side of the gallbladder plate. On the left side of the gallbladder plate, dissect the right anterior Glisson's pedicle branch as described above: amputate and suture them or clamp them first. Address them after Glisson's pedicle has been fully revealed. Pull the hilar plate, which has been stripped from the liver parenchyma to the right side during hepatectomy, inside to create enough space for the surgery and to prevent accidental injury to the bile ducts in the hilar plate (Fig. 12.5).

**Parenchymal Transection** Because the tumor volume tends to be larger when the patient needs extensive hepatectomy, dissecting around the liver using the traditional surgical approach may cause tumor hematogenous spread, rupture, and even uncontrolled bleeding, which are caused by tumor oppression and liver rotation. Therefore, the anterior approach is a better choice for larger tumors, especially for those that are adhered to the posterior peritoneum or diaphragm. After right hepatic inflow is occluded, the liver parenchymal transection can occur along the hepatic ischemic line, which is between the right anterior branch and the right posterior branch of portal vein. Intraoperative ultrasound can help liver parenchymal transection when necessary. The surgeon should pay attention to protect the right

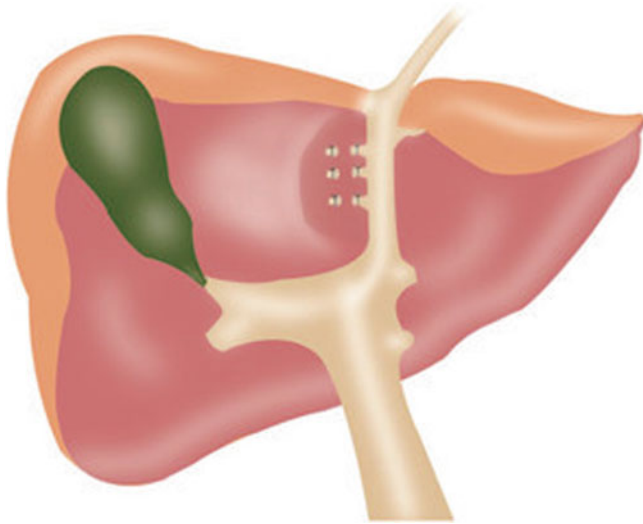


**Fig. 12.6** The raw surface of the remnant liver after left hepatic trisectionectomy

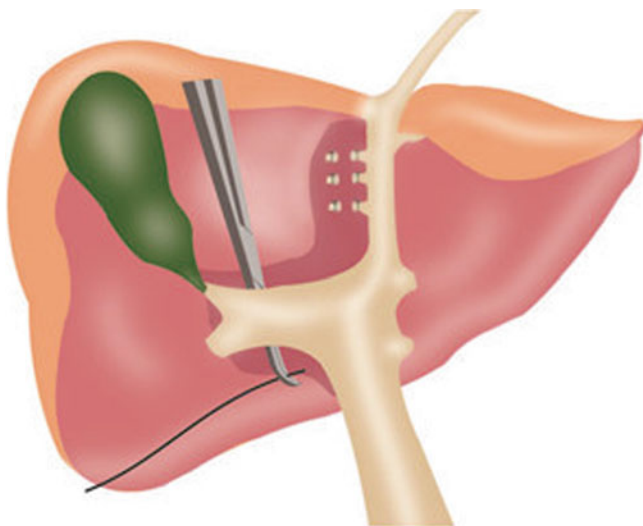
hepatic vein; injuring this vein can cause massive intraoperative blood loss and residual liver dysfunction. The raw surface should be a plane of the exposed right hepatic vein after surgery (Fig. 12.6).

### 12.2.2.2 Right Extensive Hepatectomy

Right extensive hepatectomy can also follow the liver round ligament approach. Dissect and ligate Glisson's pedicle, dominating over segment IV in the fissure for the round ligament (Fig. 12.7), from here to the superior border along the right side, descending along the porta hepatis to the left side of the gallbladder plate. Dissect the right Glisson's pedicle trunk as described above; then, amputate and suture the ends



**Fig. 12.7** The Glisson's pedicles to segment IV are divided along the fissure for the round ligament

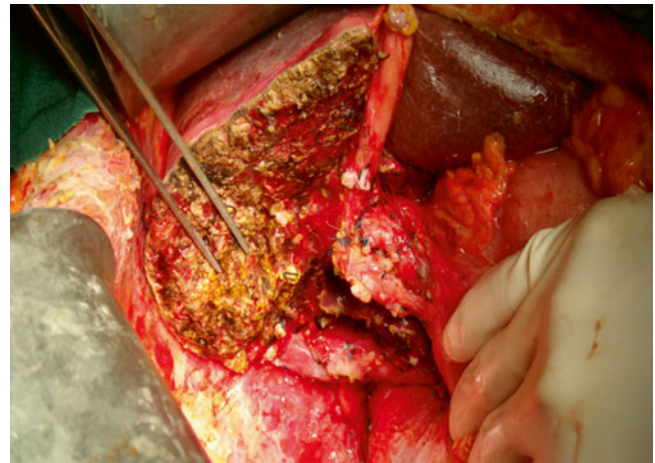


**Fig. 12.8** The hilar plate is lowered along the base of the caudate lobe and the right Glisson pedicles of segment I is dissected and ligated, after that, the right main sheath is isolated

(Fig. 12.8). Pull the hilar plate to the left during the hepatectomy, and dissect the liver parenchyma along the fissure for the round ligament. The raw surface is the fully exposed right side of the round ligament (Fig. 12.9).

The left approach is also applicable for left liver resection and mesohepatectomy. In conclusion, the main advantages of the left approach are as follows:

1. The left approach provides convenience for dissection along the porta hepatis. When separating the liver tissue,



**Fig. 12.9** The raw surface of the remnant liver after right hepatic trisectionectomy

we can separate the porta hepatis from the liver tissue of the operating area, avoiding accidental damage from liver resection.

2. When there is adhesion on the porta hepatis, especially those that were caused by previous hilar surgeries, it is usually difficult to separate the porta hepatis from the anterior and is better to take the left approach to reduce intraoperative bleeding and operative injury.

Although the two surgical methods described above are excellent for the liver resection of most patients, relative contraindications exist. These techniques should not be used in patients with anatomic variation in the porta hepatis to avoid portal damage. If the tumor is invading the porta hepatis, the Glisson's pedicle approach is usually difficult and may cause tumor rupture; in this case, the traditional method of gradually dissecting porta hepatis is considered better. However, for experienced liver surgeons who are familiar with liver anatomy, the Glisson's pedicle approach and round ligament approach have become important methods of hepatectomy and are applied to tricky surgeries, including triple liver resection and mesohepatectomy, and make these surgeries simple and safe.

## References

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2. Machado MA, Herman P, Machado MC. Anatomical resection of left liver segments. *Arch Surg.* 2004;139:1346–9.
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