Tumorectomy

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24.1 Introduction

Surgical treatment of colorectal liver metastases (CRLM) and hepatocellular carcinoma (HCC) is moving toward a parenchyma-sparing approach. The observation that surgical margin width is not definitively correlated with CRLM recurrence rate has encouraged favoring limited nonanatomic liver resections over major hepatectomies [1–3]. The optimal width of resection margin is unclear, with no clear minimum established. Pawlik and colleagues observed that the width of a negative margin did not affect survival, recurrence risk, or site of recurrence [4]. They concluded that a predicted margin width of <1 cm should not be used as exclusion to resection. A recent meta-analysis showed that a resection margin >1 cm is desirable, but disease-free survival is only slightly affected by a subcentimeter margin [5]. Emphasis on obtaining an R0 resection rather than striving for a minimal margin width was confirmed in the 2006 American Hepato-Pancreato-Biliary Association/Society for Surgery of the Alimentary Tract/Society of Surgical Oncology (AHPBA/SSAT/SSO) Consensus Statement [6]. This approach has the advantage of reducing morbidity without changes in long-term results and offers the possibility of repeated hepatectomies in case of liver metastasis recurrence [7–9]. This trend has been improved by progresses in intraoperative ultrasound (US), which reduces the need for major hepatectomies even in demanding situations such as tumor invasion of the hepatic veins [10].

The concept of parenchymal preservation might be different in cases of HCC. Impaired liver function secondary to the underlying cirrhosis requires a

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balance between oncologic issues and parenchyma preservation. HCC spreads along portal veins and can give rise to satellite nodules up to 2 cm. Therefore, anatomic resection of parenchyma involved by the tumor, along with its feeding portal branch, is considered the gold standard treatment for HCC, and anatomic segmentectomy can be considered the more parenchymal-preserving oncologically effective procedure [11, 12]. However, in case of reduced liver function evaluated by indocyanine green clearance (IGC) or Model for End-Stage Liver Disease (MELD) score, subsegmentectomies can be applied, particularly in cases of superficial nodules not amenable to a percutaneous approach. This type of resection has been applied via the laparoscopic approach in patients with HCC on cirrhotic liver who are awaiting liver transplantation to control the tumor during the waiting period and to facilitate operative procedures at the time of transplantation [13]. In this chapter, we discuss the technique of nonanatomic resections, which can be applied for CRLM and HCC on cirrhosis. These considerations can be extended to endocrine tumors and noncolorectal, nonendocrine (NCRNNE) liver metastases [14].

24.2 Factors Affecting Surgical Strategy

Even though nonanatomic resections are commonly performed, even in low-volume centers, tumorectomies may present challenges that can hamper oncologic efficacy and patient safety. There are no standard techniques for tumorectomies as there are for anatomic resections, and there are no anatomic landmarks on the liver surface to drive the resection. Frequently, curved or angulated resection lines are required, and the nodule can be in close relation to a major liver vessel. Therefore, confidence with intraoperative US is imperative when approaching liver resection with a parenchymal-preserving attempt. As major portal pedicles are not usually dissected and ligated during a tumorectomy as they are in anatomic major hepatectomies, and the availability of a system for inflow occlusion (Pringle maneuver) is prudential in most cases, particularly if nodules are located in the right lobe, and are essential when dissection close to a major vascular structure is planned. Tumor proximity to the main vascular structure represents a possible limiting factor to carrying out a safe tumorectomy due to the risk of bleeding and biliary fistula, and in these situations, laparoscopy should be carefully evaluated.

- Position of the tumor is the primary consideration in surgical strategy for laparoscopic tumorectomy. Resections in the posterolateral segments are difficult due to inadequate exposure, poor operative field, and difficulty with parenchymal dissection. In studies investigating the laparoscopic approach to posterolateral liver malignancies, major resection is the prevalent procedure, in contrast to minor resections performed for lesions in the anterior segments [15]. This discrepancy can be ascribed to the rigid laparoscopic tools. In fact, segmentectomies and subsegmentectomies of the posterosuperior segments require curved or angulated section lines and

are demanding procedures considering small degrees of freedom allowed by the instruments [15].

- Distance of the lesion from the liver surface is crucial due to the lack of tactile sensation in laparoscopic and – even more so – in robot-assisted surgery. For deeply located lesions, laparoscopic US is mandatory for locating the tumor and achieving a clear margin resection. In the second instance, lesion dimensions and echogenicity may contribute to hampering a margin-free tumorectomy or even tumor identification. Careful US exploration in an attempt to correlate intraoperative findings with preoperative images can help identify even small isoechoic lesions. An iPad (Apple Computer Inc., CA, USA) enveloped into a sterile plastic bag can be used to intraoperatively view preoperative images. Using the application OsiriX, an open-source Digital Imaging and Communications in Medicine (DICOM) viewer, it is possible to watch in real time the preoperative computed tomography (CT) and magnetic resonance (MR) images, scrolling through them while performing the laparoscopic US liver exploration.

24.3 Technical Details

For a safe laparoscopic tumorectomy, patient positioning and trocar placement should be individualized according to tumor location. Pneumoperitoneum induction with the Veress needle can help tailor trocar position, thus limiting the use of a periumbilical port to cases in which it is really necessary, as for tumor located in segments 4b and 5 and in the left lobe, and to avoid injury to a recannulated umbilical vein, which might be quite dangerous in cirrhotic patients. Nonanatomic liver resection of peripheric, superficial lesions located in anterior segments (3, 4b, 5, 6) is generally feasible and can be done with minimal morbidity and mortality rates. Pedicle clamping is optional or can be applied only in case of bleeding, and liver division can be performed with all the available transection devices; in these cases, using a cutting stapler can facilitate resection and markedly reduced operative time. Generally, three to four trocars disposed at the level of the umbilical line are adequate.

For lesions located in the posterolateral sector (upper segment 6; segments 7 and 8), the patient is rotated on the left flank to facilitate liver mobilization and inferior vena cava dissection, when necessary. The camera port and the left-sided trocars should be placed as close as possible to the right costal margin, whereas the right trocar can be inserted in the intercostal space between the 10th and 11th ribs along the scapular line. At this level, the risk of accidentally injuring the lung is very low, and direct access is provided to the posterolateral segments, as previously shown by Gumbs and Gayet in laparoscopic surgery and by our group for the robot-assisted approach [16, 17]. Due to the higher risk of bleeding, intermittent pedicle clamping is advisable when approaching posterolateral segments [17, 18].

Careful US exploration with demarcation on the Glisson capsule of the right hepatic vein can avoid major bleeding during parenchymal transection. For deeply located lesions or when the tumor is close to a major vessel, even in those located in anterior segments, the "corkscrew" technique can be useful: After identifying the lesion by inspection and intraoperative US, Glisson's capsule is marked with electrocautery 1- to 2-cm away from the tumor margin. According to tumor location, the marked area is anchored by stitches, with caution taken to prevent the needle from entering the tumor. The suture is held together by metallic clips, and upward traction is performed, facilitating parenchymal transection and accurate identification of vascular and biliary structures. Parenchymal transection is performed with the monopolar shears for the first liver layer (1 cm from the Glisson capsule) and then with the Kelly-clamp crushing technique or an ultrasonic dissector. Whenever necessary, metallic clips or stitches are applied to achieve vascular and biliary control. Control of the surgical margin should be always verified by intraoperative US during parenchymal transection [19]. Generally, small specimens can be extracted using an EndoBag through any port site; otherwise, enlarging the umbilical port or, rarely, a Pfannenstiel incision, could be necessary.

24.4 Robot-Assisted Nonanatomic Resections

Robot assistance is particularly useful for performing parenchymal-preserving resections, especially in the posterolateral segments and when the tumor is in contact with a portal branch or hepatic veins and when both are close to the tumor mass (Fig. 24.1) [17]. In fact, EndoWrist instruments allow fine movements and complex transection planes, reducing discomfort coming from the use of rigid tools. Principles of patient and trocar positions in conventional laparoscopic surgery are applicable also for the robot-assisted approach. For liver surgery, the robot is docked over the patient's head.

All liver resections should be guided by US performed by the on-table surgeon. The console surgeon can view the US screen in picture-in-picture modality, directing the dissection plane, which appears as an echogenic line between the cut surfaces. The parenchyma is usually transected with the Harmonic scalpel for straight-line resections. The Kelly-clamp crushing technique with the EndoWrist bipolar Precise forceps (Intuitive Surgical Systems, Sunnyvale, CA, USA) is preferred for curved and angulated section lines and tumor dissection close to a major liver vessel. Hemostasis of small vessels is obtained with monopolar or bipolar cautery. To secure larger vessels on the transection line, we use Hem-o-lok® clips or ligatures with Vicryl® or Prolene®. The hepatic veins are usually divided with the laparoscopic linear stapler or sutured with Prolene®. Biliostasis is assessed by observation and bile leaks controlled with sutures, as in open surgery.

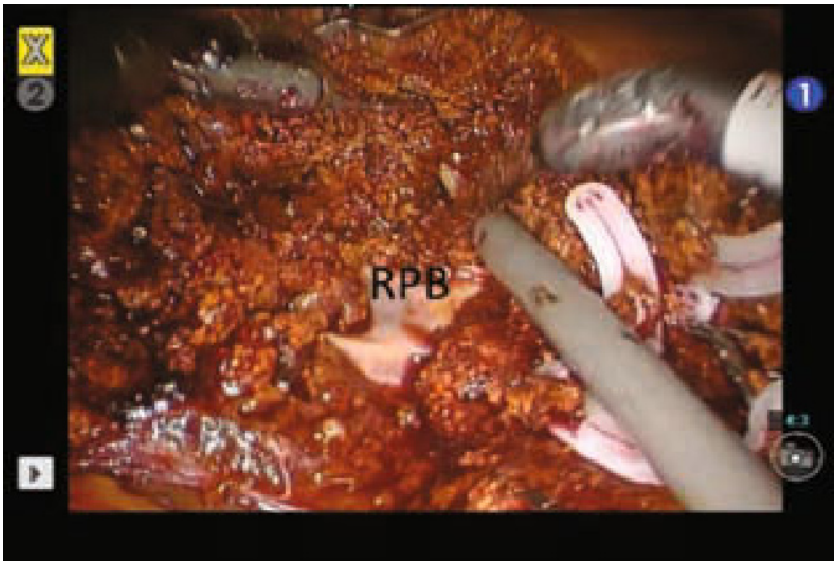

Fig. 24.1 Right portal branch (RPB): final field after tumorectomy of a colorectal liver metastasis close to the RPB

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