

Technical Note

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[Gennaro Mazzealla](#)*, [Diego Coletta](#), [Giovanni Tortorelli](#), Raffaello Mancini, Pasquale Perri, Andrea Oddi

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Technical Note

Robotic Approach for Regional Lymphadenectomy and Liver Bisegmentectomy in Gallbladder Cancer

Gennaro Mazzearella ^{1,2}, Diego Coletta ¹, Giovanni Tortorelli ¹, Raffaello Mancini ¹, Pasquale Perri ¹ and Andrea Oddi ¹

¹ General and Hepato-Pancreato-Biliary Surgery, IRCSS Regina Elena National Cancer Institute, Rome, Italy

² Department of Surgery, Sapienza University of Rome, Rome, Italy

* Correspondence: gennaromazzearella226@gmail.com; Tel.: +39 3395890259

Abstract: Gallbladder cancer (GBC) is an aggressive malignancy with poor prognosis. Due to the generally asymptomatic course of the disease in its early stages, patients are most often diagnosed incidentally (iGBC), following cholecystectomy for presumed benign disease. Thorough staging to predict oncologic and technical resectability is mandatory. Robotic surgery has emerged as a promising approach for the treatment of complex hepatic malignancies, and it can be performed in almost all types of liver resections. However, due to limited data, the minimally invasive approach in GBC remains controversial. Positive regional lymph nodes (LNs) and therefore the quality of lymphadenectomy have been proven to be significant predictors of survival after surgery. This study aims to report our approach for regional lymphadenectomy and robotic liver resection (RLR) in patients with GBC or iGBC diagnosed after laparoscopic cholecystectomy (LC), focusing on precision surgery, adequacy of regional lymphadenectomy and outcomes.

Keywords: gallbladder cancer; lymphadenectomy; robotic surgery; robotic liver resection; bisegmentectomy; precision surgery

1. Introduction

Gallbladder cancer (GBC) is the fifth most common gastrointestinal cancer and the most common cancer of the biliary tract, accounting for 165,000 annual tumour-related deaths worldwide [1]. The likelihood of being affected is four times greater for women than men and the main risk factors for GBC development are cholelithiasis, polyps and gallbladder adenomyoma [2]. GBC is an aggressive malignancy with poor prognosis. Due to the generally asymptomatic course of the disease in its early stages, patients are most often diagnosed incidentally (iGBC), following cholecystectomy for presumed benign disease. Just 25% of these will have prospectively radical surgery, and only 16% of them will survive longer than 5 years [3,4]. Careful staging to predict oncologic and technical resectability is mandatory. Status of portal lymph nodes (LNs), peritoneal implants and vascular invasion are the most faithful parameters to define resectability.

Robotic surgery has emerged as a promising approach for the treatment of complex hepatic malignancies. In 2018, an multinational consensus statement on robotic hepatectomy gave recommendations for robotic liver resection (RLR), introducing to the standardization of these surgical procedures [5]. This approach can be employed in nearly all liver resections, including minor hepatectomy, major hepatectomy, donor hepatectomy and complex liver resections [6–10]. In 2023, the international consensus statement on RLR updated recommendations and provided guidance to further standardize robotic hepatectomy and to improve the outcomes in RLR clinical practice [11]. In the majority of currently available studies, RLR is associated with less intraoperative blood loss, shorter postoperative hospital stay, fewer overall complications and less postoperative pain, compared to open liver resection (OLR) and laparoscopic liver resection (LLR) [11].

However, due to limited data, the minimally invasive approach in GBC remains controversial. Positive regional LNs and therefore the quality of lymphadenectomy have been proven to be essential predictors of survival after surgery.

This descriptive study aims to report our surgical approach for regional lymphadenectomy and RLR in patients with GBC, focusing on **precision surgery**, adequacy of regional lymphadenectomy and outcomes.

2. Description of Surgical Techniques

We describe our current surgical strategy in the case of an iGBC referred to our center after undergoing LC for gallbladder (GB) stones, with negative cystic duct margin. It shows a robotic minimally invasive radical resection of segments 4b and 5 with regional lymphadenectomy, using the Da Vinci Xi Surgical System.

Patient Positioning and Port Placement

The patient is placed in a supine and 30° reverse Trendelenburg position. Robotic surgery is performed with the da Vinci Xi robotic platform (Intuitive Surgical Inc., Sunnyvale, CA) using a five-trocar technique. Pneumoperitoneum is created using a Veress needle via percutaneous puncture at the Palmer point. Standard port placement is used with the Xi System docked from the right side of the patient. An assistant port is placed in the right flank (**Figure 1**). The camera is inserted through arm 2 and targeting is also performed from arm 2. The surgeon sits at the robotic console while the assistant surgeon stands on the left-side of the patient.

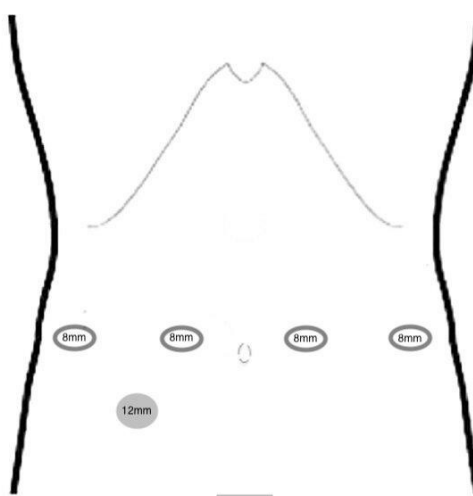


Figure 1. Robotic port placement for RLR.

Robotic Instrumentation

Standard robotic instruments used: fenestrated bipolar forceps at arm 1, camera at arm 2, monopolar curved scissors and SynchroSeal (Da Vinci Energy by Intuitive) at arm 3, Cadiere forceps at arm 4.

Lymphadenectomy and Hilar Dissection

The abdominal cavity is first inspected for any unknown peritoneal implants. At this time, adhesions from the previous surgery are divided. After a complete Kocher maneuver, intercavo-aortic (station 16), retropancreatic (station 13) and common hepatic artery (station 8) lymphadenectomy is performed. The hepatic hilum is then carefully dissected, to expose the proper hepatic artery (station 12a), the left and right hepatic arteries, the common bile duct (station 12b) and the portal vein (station 12p). The vascular elements are then suspended on tapes for indirect traction

and an extensive hilar lymphadenectomy is performed (**Figure 2-3**). At this time, a Foley catheter is placed as usual around the hepatic pedicle as a precaution in case of a Pringle maneuver.

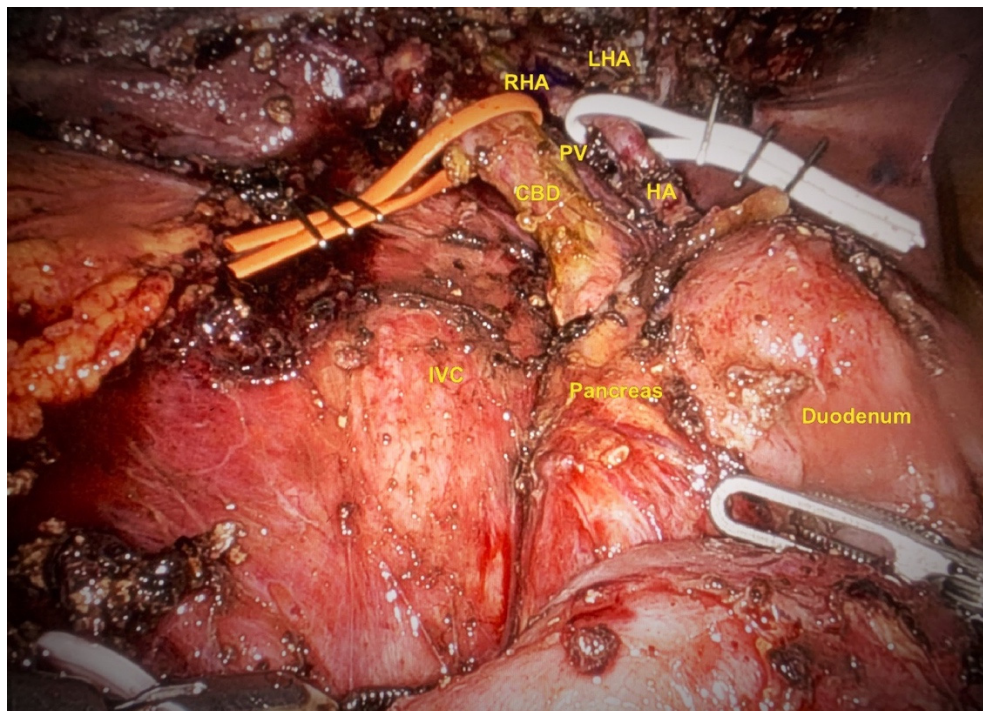


Figure 2. Surgical field during robotic lymphadenectomy after Kocher maneuver. IVC inferior vena cava; CBD common bile duct; PV portal vein; HA hepatic artery; RHA right hepatic artery; LHA left hepatic artery.

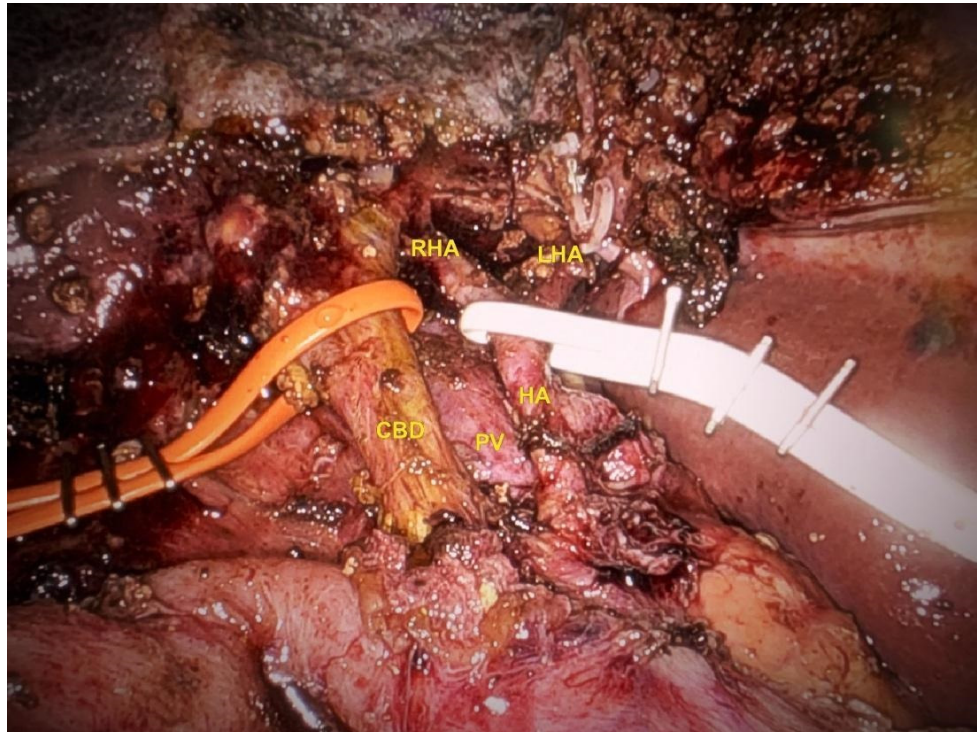


Figure 3. Robotic hilar lymphadenectomy. CBD common bile duct; PV portal vein; HA hepatic artery; RHA right hepatic artery; LHA left hepatic artery.

Hepatic Bisegmentectomy (S4b + S5)

Intraoperative ultrasound is performed by inserting the ultrasound probe through the 12 mm assistant port. After identifying the glissonian pedicles for segments 4b and 5 the surgical resection

margins are marked on the hepatic surface. The liver parenchyma is then transected using robotic fenestrated bipolar forceps and monopolar curved scissors or SynchroSeal. The glissonian elements for segments 4b and 5 are accessed via the intrahepatic approach and divided between hemoloks. In this case, a single Pringle maneuver is performed throughout the procedure with a total clamping time of 12 minutes (**Figure 4**). The liver's raw surface is checked for bleeding and bile leakage. Haemostatic dressings are put on and the peritoneal cavity is drained with a 19-F tube. The surgical specimen is removed through a Pfannenstiel incision, after being wrapped in a plastic bag to minimize the risk of intra-abdominal seeding and recurrence at the port sites. The scar from the umbilical port site used for the extraction of the GB during the previous cholecystectomy, is finally removed.



Figure 4. Robotic liver bisegmentectomy of S4b-S5.

3. Results

From 2023, 4 patients with GBC or iGBC after LC were treated with the same robotic approach to regional lymphadenectomy and liver bisegmentectomy, using the Da Vinci Xi Surgical System (**Table 1**). The mean operation time was 339 minutes. Estimated blood loss was < 200 ml and no transfusions were required. The postoperative course was uneventful, no postoperative bleeding or biliary fistulas were observed. The mean length of stay was 10 days. No 30 days-mortality was reported. No residual disease was found in the final pathology examination of either the liver specimen or excised scar tissue from the port site. Mean LNs retrieved are 9.5 (range 6 – 12). However, in 1 case, 1 of 12 removed LNs (station 12p) contained a 2 mm subcapsular metastasis. After surgery, the patient started adjuvant chemotherapy with gemcitabine, which is still ongoing. No evidence of disease was seen at the first CT follow-up at 4 months.

4. Discussion

The diagnosis of Stage II (T2) GBC is often made incidentally following LC and necessitates re-resection for adequate treatment and staging. Due to the high propensity of GBCs to spread through the lymphatic system, achieving an adequate lymphadenectomy is essential to improve the outcome of these patients. Effective LN dissection and a higher number of retrieved LNs are indeed associated

with better survival, even in node-negative patients [12–16]. LN metastasis is therefore a critical prognostic factor for patient survival after curative resection. Although the 8th edition of the AJCC Cancer Staging Manual recommends at least 6 LNs to be harvested [17], most studies report a median yield of approximately two or three LNs, demonstrating the need for improvement in this area [4].

To achieve this goal, it is often necessary to extend the dissection beyond the portal nodes [4]. The gallbladder's regional LNs are classified into three distinct groups: first-level nodes, second-level nodes, and more distant nodes (**Figure 5**). The first-echelon nodes are situated on either the cystic duct (CD) or common bile duct (CBD), while the second-echelon nodes are situated posterosuperior to the head of the pancreas or around the portal vein/hepatic arteries [18].

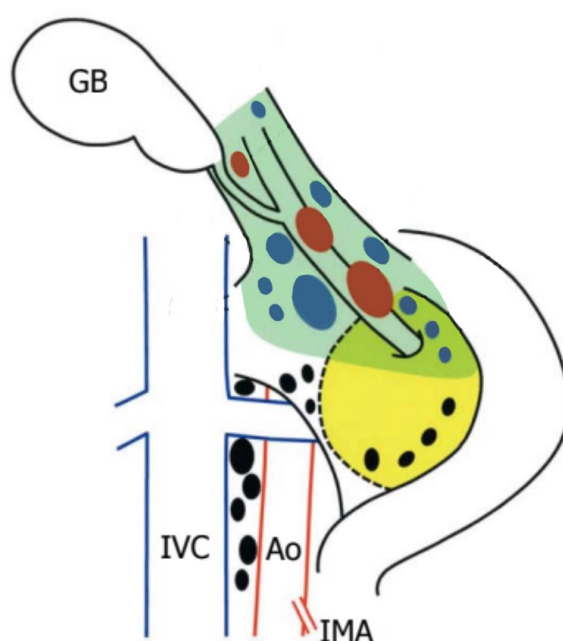


Figure 5. Topographical distribution of the regional lymph nodes of the gallbladder, shown after a Kocher maneuver. GB gallbladder; IVC inferior vena cava; AO aorta; IMA, inferior mesenteric artery.

The second-echelon nodes are a challenge to dissect thoroughly, even for experienced hepatobiliary surgeons. In particular, removal of the posterior superior pancreaticoduodenal, retroportal and right celiac nodes requires meticulous technique.

We believe these cases of GBCs were an excellent indication for the use of the robotic system to significantly improve the quality of lymphadenectomy. The superior three-dimensional magnified vision provided by the robotic platform, along with the extreme flexibility of the tremor-filtered robotic arms, allows the surgeon to operate with extreme precision and skill in even the most delicate and complex surgical fields.

Indeed, in the described study, surgical steps such as dissection of the hepatic hilum, axial (aortocaval/celiac) lymphadenectomy, and intraparenchymal access and division of the glissonian pedicle benefited greatly from the utilization of the robotic platform. The exceptional stability of the system, combined with the well-known characteristics of the robotic platform (superior image rendering, increased dexterity, multiple degrees of freedom and high performance instruments) translated into great confidence in the surgeon's manipulation of even the smallest anatomical structures.

As a result, in the described case the total LN harvest was 12, with 1 single GBC metastasis identified among the retrieved nodes, specifically located along the bile duct (station 12b).

There are a few tricks that we believe can be used to make the lymphadenectomy easier to perform. First, a complete Kocher maneuver: this not only provides direct access to the aortocaval and retropancreatic LNs, but also provides a better view of the retroportal space, which facilitates its subsequent dissection (**Figure 5**). The easy orientation and much closer view of the surgical field provided by the robotic platform allows for gentle dissection and retraction of even the most delicate retroperitoneal structures, minimizing the risk of inadvertent injury.

When approaching the hepatic pedicle, anatomical landmarks such as the CD (or cystic stump in the case of previous cholecystectomy) and the large LN located on the anterior aspect of the common hepatic artery (station 8), should not be overlooked as they are critical for the proper identification and preparation. Therefore, we believe it is imperative to correctly identify these structures at the beginning of the dissection. Once the hepatic pedicle elements are identified, they should be immediately encircled with rubber bands and any direct manipulation of these fragile structures by the robotic arms should be avoided.

Up to 26% of patients with GBC will present with axial (aortocaval/celiac) nodal invasion that would not benefit them from radical surgery. As stated in the 2015 Expert Consensus on Gallbladder Cancer, it is important to assess the status of these lymphatic stations prior to any further surgical steps [4]. Therefore, after the exploration of the abdominal cavity, dissection of aortocaval and coeliac LNs should be the first step of surgery.

For tumours confined to the GB (T1b–2), cholecystectomy with radical exeresis of adjacent liver parenchyma is recommended. In these cases, the common hepatic duct (CHD)/ CBD resection should be added if gross or microscopic implication of the CD is demonstrated on intraoperative evaluation. For patients with T3 or T4 cancers, the extention of primary exeresis is still controversial; therefore, radical resection of locally advanced GBCs should be reserved just for medically suit patients following pluridisciplinary debate [4].

Minimally invasive surgery provides superior perioperative outcomes in terms of hospital stay, pain control, and cosmesis. According to an international multicenter study of different surgical approaches to GBC by Ielpo et al. [1], the robotic approach was associated with multiple advantages, including a higher number of retrieved LNs, minor Pringle maneuver times, lower valued intraoperative blood loss, and shorter hospital stay when compared to both open and laparoscopic approaches.

However, minimally invasive surgery is not yet routinely used for the treatment of GBC. As elsewhere in oncology, strict adherence to the basic principles of cancer surgery is essential for the safe implementation of robotic surgery in this setting.

The technical challenges to be met when using a minimally invasive approach are 1) appropriate portal and aortocaval lymph node sampling; 2) R0 liver transection margins, and, in the more advanced stages, (3) CHD/ CBD resection or reconstruction [4].

In conclusion, the quality of lymphadenectomy is an important predictor of survival after surgery for GBC. The robotic approach has been shown to be technically safe and feasible when performed in centers with adequate experience in minimally invasive surgery. It can provide adequate lymph node recovery and good oncologic radicality, offering better short-term results and at least non-inferior long-term outcomes.

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Abbreviations

GBC	gallbladder cancer;
iGBC	incidentally gallbladder cancer;
RLR	robotic liver resection;
OLR	open liver resection;
LLR	laparoscopic liver resection;
LN	lymph nodes;
LC	laparoscopic cholecystectomy;
CBD	common bile duct;
CHD	common hepatic duct.

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