

Case Report

Laparoscopic Resection of a Large Mucinous Cystic Neoplasm of the Liver: A Case Report

Yuto Aoki¹, Yukio Oshiro¹, Ryo Ga¹,
Mampeï Kawashima¹, Chikako Hasegawa², Youichi Kawano³,
Junji Ueda³, Yoshiharu Nakamura¹ and Hiroshi Yoshida³

¹Department of Gastroenterological Surgery, Nippon Medical School Chiba Hokusoh Hospital, Chiba, Japan

²Department of Pathology, Nippon Medical School Chiba Hokusoh Hospital, Chiba, Japan

³Department of Gastroenterological Surgery, Nippon Medical School, Tokyo, Japan

Mucinous cystic neoplasms of the liver (MCNs-L) are rare cystic tumors characterized by multilocular cysts lined with a mucin-producing epithelium and supported by ovarian-like stroma. These tumors account for <5% of all cystic liver lesions and carry a potential risk of malignant transformation, necessitating early diagnosis and surgical resection. This report describes the successful laparoscopic partial liver resection of segments 4 and 5 for a large MCN-L in a woman in her 40s who presented with upper abdominal discomfort. Imaging studies revealed a multilocular cystic lesion measuring 11.9 × 8.5 × 13.0 cm in segments 4 and 5 of the liver. The primary challenges were the size of the lesion and the need to prevent cystic content spillage during surgery. Using meticulous techniques, including the use of a retrieval bag and controlled aspiration, we successfully excised the tumor laparoscopically and without contamination. Pathological analysis confirmed a diagnosis of mucinous cystic adenoma with no evidence of malignancy. The patient recovered uneventfully and was discharged on postoperative day 7. This case highlights the feasibility and safety of a laparoscopic approach for large MCNs-L. Furthermore, it underscores the importance of preoperative planning, precise surgical techniques, and measures to prevent cystic content dissemination. Minimally invasive surgery offers significant benefits, including reduced recovery time and improved cosmetic outcomes, and can be effectively applied to large hepatic cystic lesions by experienced surgical teams.

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Introduction

Mucinous cystic neoplasms of the liver (MCNs-L) are rare cystic tumors that are distinct from intraductal papillary neoplasms of the bile ducts (IPNB), as classified in the revised 2010 World Health Organization (WHO) classification. They are considered the hepatic counterpart of pancreatic MCNs. MCNs-L are characterized by multilocular cysts lined with mucin-producing epithelium and

supported by ovarian-type stroma. MCNs-L account for <5% of all cystic liver lesions¹ and may undergo malignant transformation if left untreated. Therefore, early diagnosis and complete surgical resection are essential for optimal patient outcomes.

Differentiating MCNs-L from simple hepatic cysts based on imaging findings can be challenging. Anderson et al.² identified several imaging features that help distin-

Correspondence to Yuto Aoki, yutoaoki@nms.ac.jp

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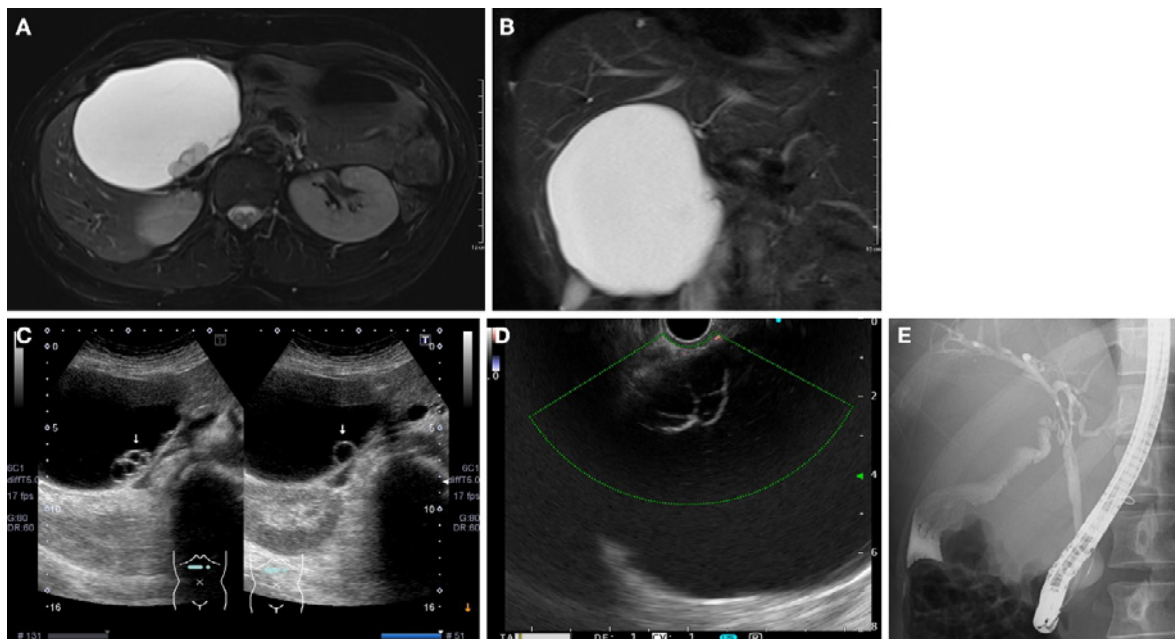


Figure 1 Imaging findings at initial presentation

(A) Axial T2-weighted magnetic resonance imaging (MRI) showing a cystic lesion located in segments 4 and 5 of the liver, suggestive of a mucinous cystic neoplasm of the liver (MCN-L).

(B) Coronal T2-weighted MRI indicating the lesion's maximum diameter of 11.1 cm.

(C) Abdominal ultrasonography image showing a multilocular cystic lesion.

(D) Endoscopic ultrasonography (EUS) revealing multilocular cystic components within the lesion.

(E) Endoscopic retrograde cholangiopancreatography (ERCP) showing no communication between the cystic lesion and biliary system.

guish MCNs-L from simple hepatic cysts, including thick septations or nodularity, upstream biliary dilatation, thin septations, internal hemorrhage, perfusional changes, and the presence of fewer than three coexisting liver cysts. Magnetic resonance imaging (MRI) has been found to be superior to computed tomography (CT) in detecting these features, particularly for visualizing thin septations and internal hemorrhage or proteinaceous debris².

Laparoscopic liver resection (LLR) has recently gained popularity due to its minimally invasive approach, which offers cosmetic benefits and expedited recovery, making it particularly advantageous for benign and low-grade tumors. However, laparotomy is sometimes preferred for larger MCNs-L due to the risk of peritoneal dissemination resulting from intraperitoneal contamination of the cyst contents^{3,4}. Herein, we present a case in which a large MCN-L was successfully excised laparoscopically without contamination of the abdominal cavity.

Case Report

A previously healthy woman in her 40s presented to a local physician with upper abdominal discomfort. Abdominal ultrasonography revealed a cystic lesion in the liver, prompting referral to our hospital for further evaluation.

ation.

Initially, a simple hepatic cyst was suspected, and further imaging, including magnetic resonance cholangiopancreatography (MRCP) and abdominal ultrasonography, was performed. The examination identified a large cyst measuring 10.4 × 7.8 × 11.1 cm located in segments (Sg) 4 and 5 of the liver, with a multilocular cyst within it. Consequently, the possibility of a cystic tumor, such as an MCN-L, was considered (**Figure 1A–1C**).

Further investigations included endoscopic ultrasonography (EUS), which identified a 3-cm multifocal lesion within the large cyst. However, the cyst interior exhibited low signal intensity without significant solid components (**Figure 1D**). Endoscopic retrograde cholangiopancreatography (ERCP) demonstrated no evidence of biliary communication between the cyst and the biliary system (**Figure 1E**). Based on these imaging findings, MCN-L was strongly suspected. Given the size and nature of the lesion, surgical resection was recommended.

No significant abnormalities were detected in the blood or biochemical tests, including common tumor markers for adenocarcinoma and ovarian cancer, such as CEA, CA19-9, CA125, and HE4 (**Table 1**). Contrast-enhanced computed tomography (CT) performed 3

Table 1 Findings from Blood and Biochemical Analyses

Variable	Result	Unit
WBC	3,100	/ μ L
RBC	4.24	10^6 / μ L
Hb	12.7	g/dL
Ht	38.6	%
Plt	248	10^3 / μ L
TP	7.6	g/dL
Alb	4.3	g/dL
T-Bil	0.5	mg/dL
D-Bil	0.2	mg/dL
AST	21	U/L
ALT	38	U/L
ALP	112	U/L
GGT	131	U/L
CRP	0.23	mg/dL
PT%	96.9	%
PT-INR	1.01	
APTT	34.3	sec.
D dimer	0.9	μ g/mL
CEA	1.0	ng/mL
CA19-9	22.4	U/mL
DUPAN-2	137	U/mL
CA125	23.0	U/mL
HE4	44.8	pmol/L
ICG _{R15}	3.6	%
K _{ICG}	0.221	

WBC, white blood cells; RBC, red blood cells; Hb, hemoglobin; Ht, hematocrit; Plt, platelet; TP, total protein; Alb, albumin; T-Bil, total bilirubin; D-Bil, direct bilirubin; AST, aspartate aminotransferase; ALT, alanine transaminase; ALP, alkaline phosphatase; GGT, gamma-glutamyl transferase; CRP, C-reactive protein; PT%, prothrombin time percentage; PT-INR, prothrombin time-international normalized ratio; APTT, activated partial thromboplastin time; CEA, carcinoembryonic antigen; CA, cancer antigen; DUPAN-2, Duke pancreatic mono-clonal antigen type 2; HE4, human epididymis protein 4; ICG_{R15}, indocyanine green retention at 15 min; K_{ICG}, indocyanine green elimination rate.

weeks before surgery showed an increase in the size of the cystic lesion to $11.9 \times 8.5 \times 13.0$ cm (**Figure 2**). Mild upstream biliary dilatation was observed, and the cyst contained thin septations, consistent with the characteristic imaging features of MCN-L. To minimize the risk of intraoperative spillage of cystic contents into the abdominal cavity, open liver resection was initially considered. However, the patient strongly preferred laparoscopic resection.

Two months after the initial visit, laparoscopic partial

liver resection of Sg 4 and 5 was successfully performed (**Figure 3**). Five ports were placed, and the hepatoduodenal ligament was taped in preparation for the Pringle maneuver. The hepatic circumflex was dissected and pulled to the patient's left side, and hepatic parenchymal dissection was performed with blood inflow controlled using the Pringle maneuver. The liver was dissected from the left side of the tumor along the cyst wall. The inflowing Glisson capsule (G4) was clipped and separated. The right side of the cystic tumor was then dissected along the cyst wall. The lesion was in contact with the hepatic vein (V5), which was dissected and preserved. The branch of G5 was clipped and dissected as appropriate. The bifurcation between V5 and V4 was reached, and V4 was dissected. The remaining cephalic hepatic parenchyma was dissected along the cyst wall to complete the hepatic dissection. The gallbladder was also resected due to its isolation during hepatic resection. The resected cystic tumor was placed in a retrieval bag. A 4-cm mini-laparotomy wound was created at the umbilicus, and a suction tube was affixed to the cystic tumor within the retrieval bag immediately below the wound. To ensure a secure and leak-proof connection between the suction tube and the cyst wall, we used surgical glue (DERMA-BOND™ ADVANCED™, Ethicon Inc., Somerville, NJ, USA) to affix the tube to the surface of the cyst. This technique enabled controlled aspiration of cystic fluid in a closed system within the retrieval bag, thereby minimizing the risk of spillage into the abdominal cavity. The cyst was punctured through the tube to prevent leakage of cystic fluid into the abdominal cavity. The cystic fluid appeared light brown and turbid, and a sample was sent for cytological examination. The specimen was removed while still in the retrieval bag after ensuring sufficient atrophy of the cyst. The operative time was 323 min, and intraoperative blood loss was 140 mL.

The patient had an uneventful postoperative course with no complications and was discharged on postoperative day 7.

Pathological examination of the resected specimen (**Figure 4**) revealed a multilocular cystic lesion visible macroscopically. A histological analysis identified an ovarian-like stroma beneath the cyst wall epithelium. Immunohistochemical analysis of the stroma showed positivity for estrogen receptor (ER) and progesterone receptor (PgR). No evidence of malignancy was observed, and the lesion was diagnosed as a mucinous cystadenoma. Cytological analysis of the cystic fluid revealed no malignant findings. At the 1-month follow-up, the patient re-

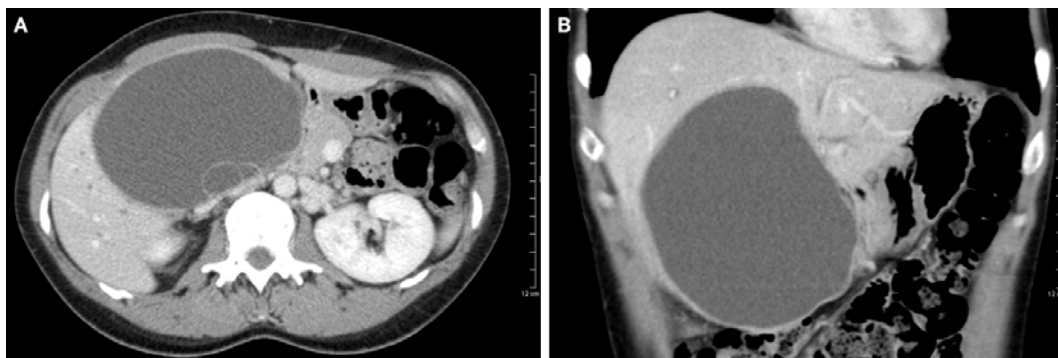


Figure 2 Preoperative contrast-enhanced computed tomography (CT) findings
Contrast-enhanced CT images obtained 3 weeks prior to surgery show a cystic lesion in segments 4 and 5 of the liver, measuring $11.9 \times 8.5 \times 13.0$ cm, indicating growth compared with the initial imaging. The intrahepatic bile ducts were slightly dilated.
(A) Axial view; (B) Coronal view.

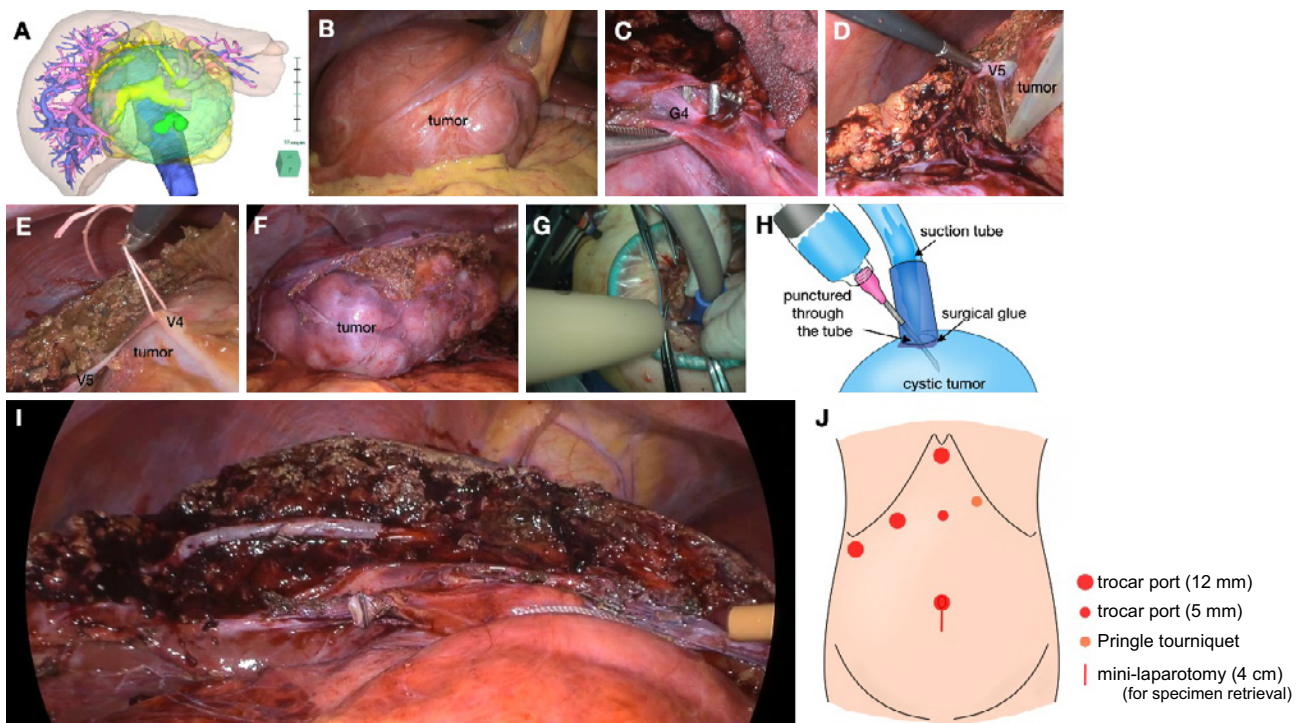


Figure 3 Intraoperative findings

- (A) Preoperative 3D simulation: cystic tumor (light blue) with a multilocular cyst (green) located in liver segments 4 and 5.
- (B) Laparoscopic view of the liver prior to resection showing the large cystic tumor in segments 4 and 5.
- (C) Intraoperative view of the Glisson capsule (G4) encircled in preparation for clipping and transection.
- (D) Tumor dissection from the hepatic vein (V5).
- (E) Identification and encirclement of the bifurcation between hepatic veins V4 and V5.
- (F) Completion of liver parenchymal transection without cyst rupture.
- (G) Aspiration of the cystic contents using a suction tube glued to the cyst wall with surgical adhesive (DERMABOND™ ADVANCED™, Ethicon Inc., Somerville, NJ, USA), which was performed within a retrieval bag to prevent spillage into the abdominal cavity.
- (H) Schematic representation of this technique.
- (I) Post-resection view of the liver showing the transection plane.
- (J) Schematic illustration of port placement.

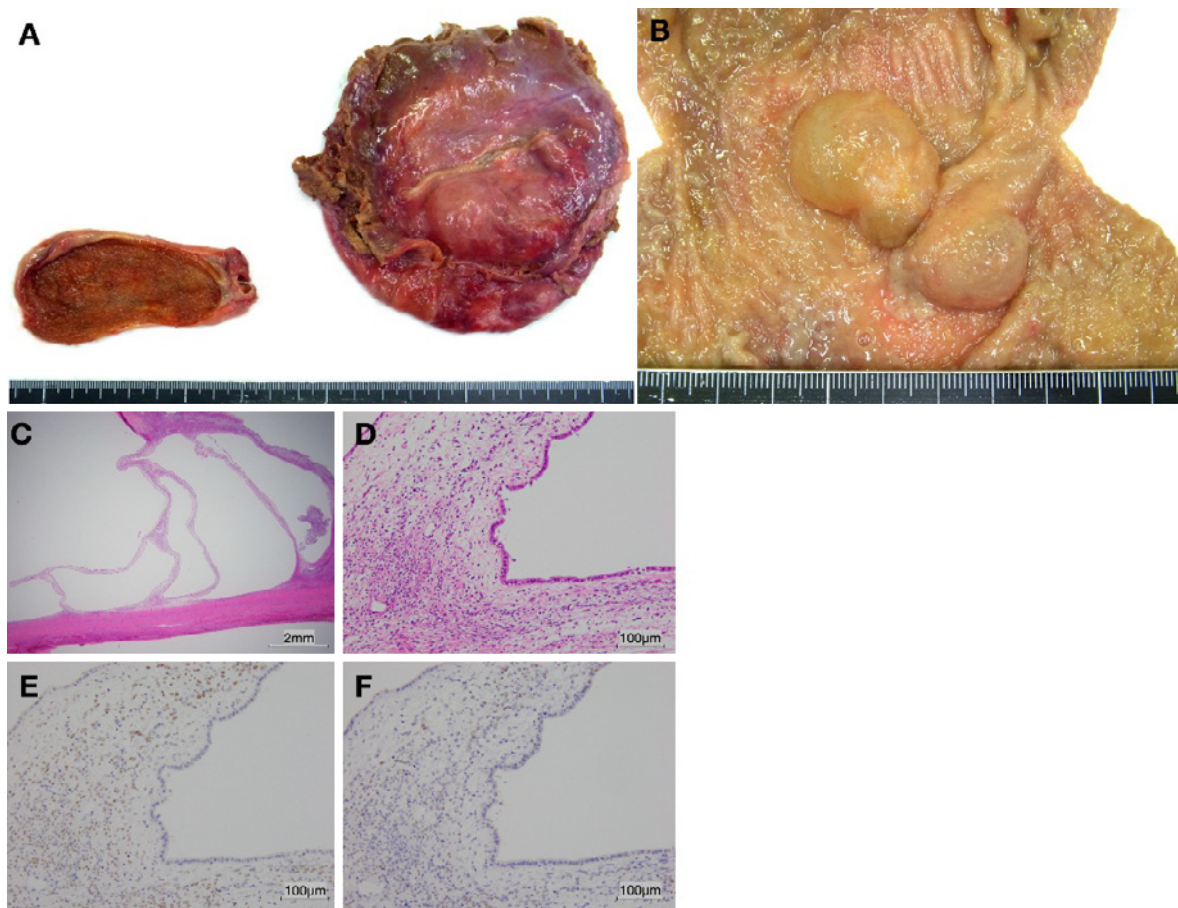


Figure 4 Pathological findings of the resected specimen

(A) Gross appearance of the resected specimen, showing a large cystic lesion.

(B) Internal view of the cyst revealing a multilocular structure with intracystic cyst formation.

(C) Hematoxylin and eosin (HE) staining showing an ovarian-like stroma beneath the epithelial lining (original magnification $\times 12.5$).

(D) Hematoxylin and eosin (HE) staining showing an ovarian-like stroma beneath the epithelial lining (original magnification $\times 200$).

(E) Immunohistochemical staining for estrogen receptor (ER), demonstrating positivity in the ovarian-like stroma (original magnification $\times 200$).

(F) Immunohistochemical staining for progesterone receptor (PgR), also demonstrating positivity in the ovarian-like stroma (original magnification $\times 200$).

Microscopic findings confirmed a diagnosis of mucinous cystadenoma.

ported feeling well, with no complaints or complications.

The patient provided informed consent at admission for the use of her clinical information for research and educational purposes.

Discussion

This case highlights the efficacy of a minimally invasive laparoscopic approach for managing a large MCN-L, emphasizing its feasibility even in complex cases. The surgical team successfully excised a substantial lesion without cystic content spillage, demonstrating that laparoscopic resection is a safe alternative to laparotomy for large MCNs-L, provided meticulous precautions are taken. An

additional advantage of laparoscopic surgery is the reduced risk of surgical site infection (SSI) compared with open surgery, which is particularly beneficial for hepatobiliary and pancreatic procedures where the SSI risk is inherently high⁵.

Previous studies have described puncturing and draining large MCNs-L before hepatic parenchymal dissection to reduce cyst size and facilitate resection^{6,7}. In previously reported cases, various techniques were used to aspirate the cyst contents prior to resection. Kumagai et al.⁶ performed aspiration using a metallic needle based on intraoperative photographs; however, no specific methods for sealing the puncture site were described. In contrast,

Asai et al.⁷ employed a SAND balloon catheter (Hakko Co., Ltd., Japan), which features two inflatable balloons to sandwich the cyst wall, thereby minimizing fluid leakage during aspiration. They also reported that the puncture site was sutured after aspiration to prevent spillage⁷. However, this technique carries the risk of peritoneal dissemination and potential complications, particularly when malignancy cannot be preoperatively excluded. In our case, we opted to avoid aspiration prior to parenchymal transection due to concerns regarding potential intraperitoneal dissemination. Instead, we performed controlled aspiration within a retrieval bag after complete dissection of the cyst, using a suction tube glued to the cyst wall to maintain a closed system. This technique ensured safe decompression and retrieval without contamination of the peritoneal cavity. To mitigate this risk, we prioritized the intact removal of the cyst, employing a retrieval bag and controlled aspiration of the cystic fluid under a sealed wound. This technique aligns with the oncological principles of en bloc resection, minimizing the possibility of intraoperative spillage. Kogo et al.⁸ reported a similar technique for laparoscopic resection of a large cystic lymphangioma, demonstrating its safety and effectiveness in preventing contamination.

Although specific data on the incidence of intraoperative rupture in MCNs-L are scarce, studies on pancreatic MCNs (MCN-P), which share histological similarities, have reported such events. Ohtsuka et al.⁹ documented intraoperative rupture in two out of 11 cases of MCN-P >45 mm, highlighting the potential risk associated with large cystic lesions. Therefore, similar caution should be exercised during the surgical management of large MCNs-L to prevent rupture and potential peritoneal dissemination.

To prevent intraoperative rupture, we made every effort to handle the cyst with meticulous care, avoiding any maneuvers that might place stress on the cyst wall. Fortunately, the cyst wall appeared to be thick and robust on preoperative imaging and intraoperative inspection, enabling en bloc resection through gentle and deliberate laparoscopic techniques. Had the cyst wall appeared thin or fragile, we would have considered preoperative aspiration of the cyst contents, as suggested in previous reports^{6,7}. In the unlikely event of intraoperative rupture, our contingency plan included immediate suction of the leaked contents, followed by thorough irrigation of the peritoneal cavity with saline. However, we recognize that rupture carries a risk of intraperitoneal dissemination of tumor cells and should be avoided

whenever possible.

Preoperative imaging confirmed the presence of a large MCN-L without solid components or biliary communication, guiding the decision for surgical intervention. Despite the tumor's proximity to Glisson's capsule and hepatic veins, its low-grade nature and lack of invasive features enabled a minimally invasive approach. Furumaya et al.¹⁰ reported no recurrence in patients undergoing minor liver resections for MCNs-L, suggesting that extensive resection is not always necessary, particularly when complete excision can be achieved laparoscopically. Given the caudal liver location of the tumor and the expertise of the surgical team in laparoscopic liver surgery, complete resection was technically feasible while preserving hepatic function.

A literature review^{6,7,11–14} revealed varying approaches to MCN-L management, with hemi-hepatectomy being frequently performed for larger lesions due to concerns regarding complete resection. However, partial liver resection has also been documented as a viable option in select cases, particularly when the possibility of preoperative malignancy is excluded^{7,13}. While some reports recommended puncturing and draining the cyst contents before hepatic dissection^{6,7}, our approach demonstrated that intact removal is feasible. When meticulous techniques are applied, contamination can be effectively prevented. This underscores the importance of tailoring the surgical strategy to each patient, balancing oncological safety with the advantages of a minimally invasive approach.

In conclusion, this case highlights the potential of laparoscopic surgery as a safe and effective approach for treating large hepatic cystic lesions. Early diagnosis and complete surgical resection remain the cornerstones of MCN-L treatment, while advances in laparoscopic techniques continue to expand the scope of minimally invasive surgery, offering significant benefits for recovery and cosmetic outcomes. This case contributes to the growing evidence supporting the laparoscopic management of large MCNs-L and emphasizes the importance of careful preoperative planning and skilled surgical execution.

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the manuscript.

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