



doi:10.7659/j.issn.1005-6947.2024.07.003
http://dx.doi.org/10.7659/j.issn.1005-6947.2024.07.003
China Journal of General Surgery, 2024, 33(7):1043-1050.

· 专题研究 ·

穿刺正染 ICG 荧光导航腹腔镜解剖性肝VII段切除术 1 例报告 (附视频)

王峥, 尤楠, 贺永刚, 艾麦提·牙森, 郑璐

(中国人民解放军陆军军医大学第二附属医院 肝胆外科, 重庆 400037)

摘要

背景与目的: 腹腔镜解剖性肝切除术已成为肝后叶VII段(S7)占位性病变的主要手术方式。然而, 受限于S7肝蒂复杂解剖结构, 在肝表面可有缺血线, 而在肝实质内缺乏有效引导。鉴于此, 笔者团队采用吲哚菁绿(ICG)荧光穿刺正染技术实施腹腔镜解剖性肝S7切除术。本文对此做一汇报。

方法: 回顾性分析中国人民解放军陆军军医大学第二附属医院肝胆外科采用ICG荧光穿刺正染技术行腹腔镜解剖性肝S7切除术的1例患者临床资料。

结果: 按照术前三维重建模拟成功获得肝S7 ICG荧光染色区域后采取足侧入路方式行解剖性肝S7切除, 术中循荧光边界及右肝静脉断肝, 过程中先后离断S7门静脉(P7)及右肝静脉S7各属支。患者术后恢复良好, 术后1个月复查腹部超声见肝S7已切除, 未见肿瘤复发征象。

结论: ICG荧光穿刺正染技术对腹腔镜解剖性肝S7切除术起到良好的辅助指引作用, 可提高手术安全性和保证肿瘤R₀切缘。

关键词

肝切除术; 腹腔镜; 吲哚花青绿
中图分类号: R657.3

A case report on laparoscopic anatomical liver segment VII resection with ICG fluorescence-guided puncture positive staining (with video)

WANG Zheng, YOU Nan, HE Yonggang, AIMAITI·Yasen, ZHENG Lu

(Department of Hepatobiliary Surgery, the Second Affiliated Hospital of Army Medical University, PLA, Chongqing 400037, China)

Abstract

Background and Aims: Laparoscopic anatomical liver resection has become the main surgical approach for space-occupying lesions located in segment VII (S7) of the posterior lobe of the liver. However, due to the complex anatomical structure of the S7 hepatic pedicle, there may be ischemic lines on the liver surface, but a lack of effective guidance within the liver parenchyma. Given this, our team

基金项目: 重庆市科卫联合医学科研项目面上基金资助项目(2023MSXM004); 中国人民解放军陆军军医大学科技创新能力提升专项基金资助项目(2022XJS20); 中国人民解放军陆军军医大学第二附属医院青年博士人才孵化计划基金资助项目(2022YQB031)。

收稿日期: 2024-01-08; **修订日期:** 2024-02-26。

作者简介: 王峥, 中国人民解放军陆军军医大学第二附属医院主治医师, 主要从事肝胆疾病临床方面的研究。

通信作者: 郑璐, Email: zhengl@tmmu.edu.cn

adopted indocyanine green (ICG) fluorescence-guided puncture positive staining technique for laparoscopic anatomical liver S7 resection. This paper reports on this technique.

Methods: The clinical data of one patient who underwent laparoscopic anatomical liver S7 resection using the ICG fluorescence-guided puncture positive staining technique in the Department of Hepatobiliary Surgery, Second Affiliated Hospital of Army Medical University were retrospectively analyzed.

Results: Following successful preoperative 3D reconstruction simulation to obtain the ICG fluorescent staining region of liver S7, an anatomical liver S7 resection was performed using a caudal approach. During surgery, the liver was transected along the fluorescent boundary and the right hepatic vein, with sequential division of the S7 portal vein (P7) and tributaries of the right hepatic vein from S7. The patient recovered well after surgery, and one month later, an abdominal ultrasound review showed that liver S7 had been resected with no signs of tumor recurrence.

Conclusion: The ICG fluorescence-guided puncture positive staining technique provides excellent assistance in laparoscopic anatomical liver S7 resection, improving surgical safety and ensuring R₀ resection margins.

Key words Hepatectomy; Laparoscopes; Indocyanine Green

CLC number: R657.3

肝VII段(segment 7, S7)位于肝脏右后叶上段,受右侧肋弓的阻挡,在行腹腔镜解剖性切除过程中,术者视野受限,手术操作器械到达术区路径长,操作角度、灵活度受到极大限制,被认为是难度较大的手术^[1]。目前解剖性肝S7切除的主要入路为经肝蒂入路^[2],即优先解剖出肝S7肝蒂并阻断,然后根据肝表面缺血线划定S7预切线。但肝S7肝蒂走行于右半肝背侧肝实质深部,操作空间小,暴露困难,解剖难度大,同时该入路虽然在肝表面可有缺血线,而在肝实质内缺乏有效引导,如何解决这一问题是精确完成解剖性肝S7切除术的关键^[3-4]。随着技术发展和理念更新,吲哚菁绿(indocyanine green, ICG)荧光成像技术使得腹腔镜解剖性肝切除的全路径可视化导航成为可能^[5-6]。笔者应用ICG荧光穿刺正染技术进行腹腔镜解剖性肝S7切除术1例,取得良好的效果,现报告如下。

1 资料与方法

1.1 一般资料

患者男,53岁。因“体检发现肝脏占位10 d”入院。患者既往有乙型病毒性肝炎病史。体检:

皮肤巩膜无黄染,浅表淋巴结未触及肿大,未见肝掌及蜘蛛痣;腹平坦,无压痛、反跳痛及肌紧张,全腹未扪及异常包块。实验室检查:天门冬氨酸氨基转移酶(aspartate transaminase, AST) 41.5 U/L,丙氨酸氨基转移酶(alanine aminotransferase, ALT) 43.0 U/L,总胆红素(total bilirubin, TBIL) 18.1 μmol/L,乙型肝炎病毒表面抗原(hepatitis B virus surface antigen, HBsAg) (+),乙型肝炎病毒脱氧核糖核酸(hepatitis B virus deoxyribonucleic acid, HBV-DNA) <20 U/mL;肿瘤标志物:甲胎蛋白(alpha-fetoprotein, AFP) 77.2 ng/mL;肝功能Child-Pugh分级A级,营养风险筛查2002(Nutritional Risk Screening, NRS2002)评分3,体力状态评分美国东部肿瘤协作组(Eastern Cooperative Oncology Group, ECOG)评分0,患者术前10 d肝脏储备功能检查结果显示:ICG 15 min滞留率(ICG-R15)为3.2%,血常规、肾功能未见明显异常。肝胆胰脾核磁共振成像(magnetic resonance imaging, MRI)平扫加增强(普美显)提示:肝右后叶结节,大小约3.9 cm×2.1 cm,增强扫描动脉期不均匀强化,静脉期及延迟期强化减低,肝胆期呈低信号,诊断考虑原发性肝癌(图1)。

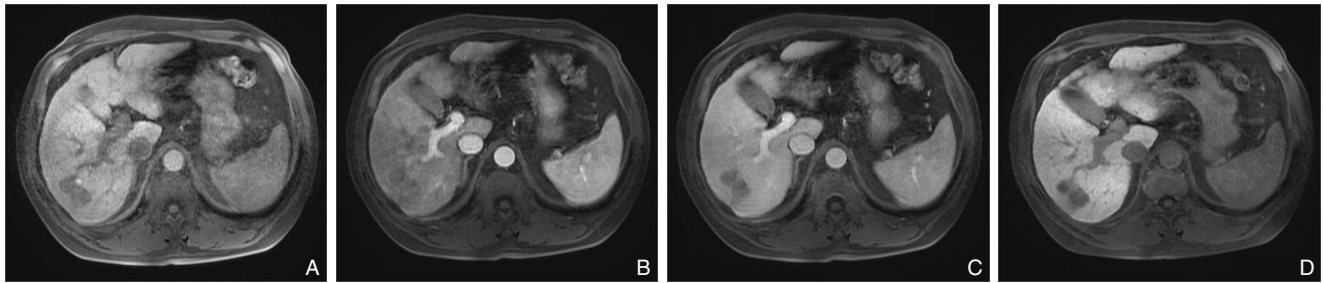


图1 术前MRI影像资料 A: 肝右后叶结节, 增强扫描动脉期不均匀强化; B: 门静脉期强化减低; C: 延迟期强化减低; D: 肝胆期呈低信号

Figure 1 Preoperative MRI imaging data A: Nodular mass in the right posterior hepatic lobe, with uneven enhancement in the arterial phase on contrast-enhanced scan; B: Reduced enhancement in the portal venous phase; C: Decreased enhancement in the delayed phase; D: Low signal in the hepatobiliary phase

1.2 手术规划

三维重建更清楚判断肿瘤位于肝S7, 门静脉及肝静脉无变异, 门静脉右后支发出属支(P7)供应S7, 出肝血流为右肝静脉属支, S7体积391.72 mL, 切除肝S7后剩余肝体积占标准肝体积85% (图2A-C)。术前对穿刺染色进行了模拟, 病变位于肝S7, 术中在超声引导下向肝S7门静脉穿刺并

注射浓度为0.005 mg/mL ICG 4 mL, 待10~20 s后S7荧光染色显影完成正染后行手术切除^[7] (图2D)。术中按照术前模拟采用超声引导穿刺P7 ICG荧光正染技术对肝S7进行染色, 取得肝S7 ICG荧光染色成功后, 采取足侧入路方式行肝S7切除。术中需处理门静脉右后支发出的P7及右肝静脉的S7属支。

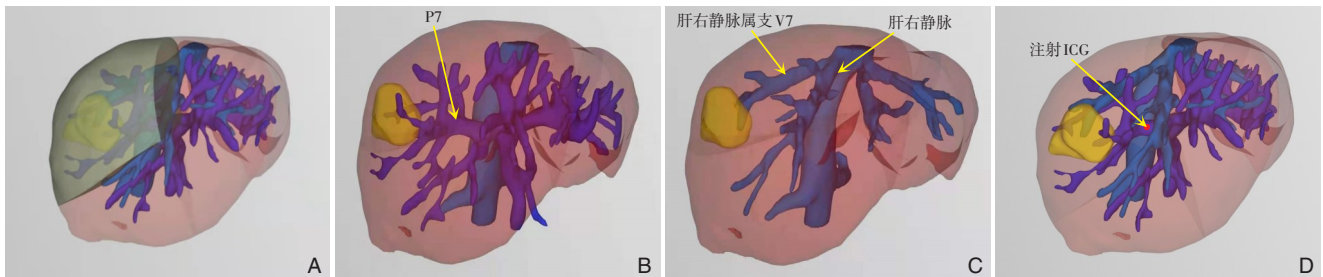


图2 术前三维重建影像资料 A: 肿瘤位于肝S7; B: 门静脉右后支发出P7供应S7; C: 出肝血流为右肝静脉属支; D: 术前规划显示向S7门静脉进行穿刺并注射ICG的位置

Figure 2 Preoperative 3D reconstruction imaging data A: The tumor mass located in the liver S7; B: The right posterior branch of the portal vein gives off P7 to supply S7; C: The outflow from the liver is a tributary of the right hepatic vein; D: Preoperative planning shows the location for puncturing and injecting ICG into the S7 portal vein

1.3 手术方法

患者取仰卧分腿位, 右侧垫高30°, 全麻成功后, 根据患者体型, 建立观察孔于肚脐右侧约2.5 cm, 主刀操作孔分别位于右侧腋前线肋缘下3 cm及右侧腋中线第11、12肋间, 助手操作孔分别位于剑突下及剑突下6 cm处 (图3A)。手术步骤如下: 进入腹腔后首先进行腹腔探查, 离断肝周韧带、肝圆韧带、右冠状韧带, 在第一肝门预置阻断带, 离断肝肾韧带、右侧三角韧带, 将右肝完全游离至下腔静脉旁 (图3B); 采用术中超声定位肿瘤及肝S7位置, 超声引导下成功穿刺P7后 (图3C), 缓慢注射浓度为0.005 mg/mL ICG 4 mL; 在荧光腹

腔镜下可见S7逐渐染色, 再次术中超声确定肿瘤位于肝S7染色范围内, 根据ICG荧光染色边界标记预切线 (图3D); 利用阻断带, 将肝右后叶向左牵引翻转, 在腹腔镜视野正中显露肝S7, 荧光模式下用超声刀沿荧光边界由足侧向头侧、由浅入深依次离断肝包膜、肝实质 (图3E); 解剖血管, 根据肝静脉位置及走行确认右肝静脉 (图3F), 离断右肝静脉S7的细小分支, 沿右肝静脉主干右侧和荧光边界离断肝实质; 在肝实质内找到P7穿刺部位, 完全游离出肝蒂G7 (图3G), 用血管直线切割闭合器离断G7; 沿右肝静脉主干右侧及荧光边界向头侧继续离断肝实质并处理右肝静脉属支;

在右肝静脉头侧游离出1支粗大右肝静脉属支V7(图3H),用血管切割闭合器离断V7,超声刀离断后侧肝组织后完整切除肝S7(图3I);将切除的肝组织及肿瘤放入标本袋,检查肝脏切缘无胆汁

漏及活动性出血后,扩大剑突下穿刺孔,将标本袋取出,于肝断面放置止血材料,右侧膈下放置引流管后关腹,手术结束(视频1)。

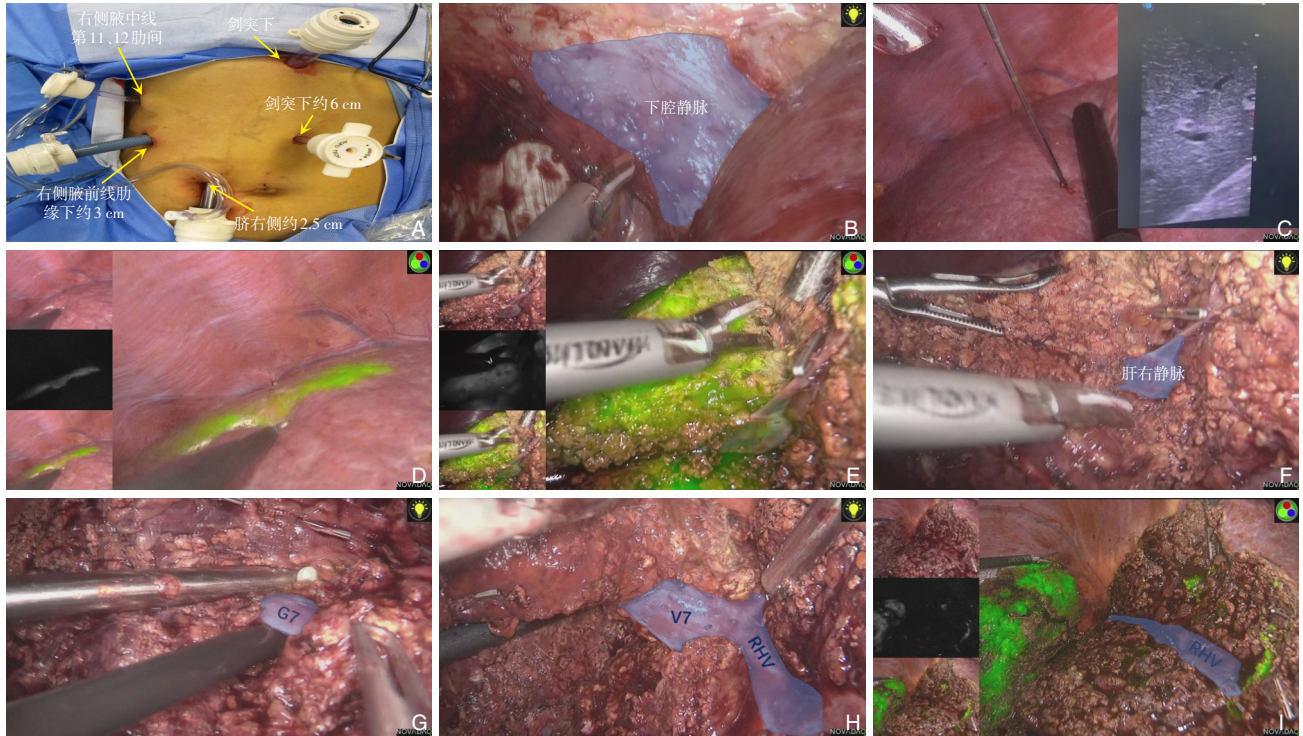


图3 穿刺正染ICG荧光导航腹腔镜解剖性肝S7切除术过程 A: Trocar布局; B: 右肝完全游离至下腔静脉旁; C: 超声引导下穿刺P7; D: 根据ICG荧光染色边界标记预切线; E: 沿荧光染色界面断肝; F: 肝右静脉; G: 肝S7肝蒂G7; H: 右肝静脉属支V7; I: 完整切除肝S7

Figure 3 Surgical process of laparoscopic anatomical liver S7 resection under the guidance of ICG fluorescence positive staining A: Trocar layout; B: Complete dissociation of the right liver to the inferior vena cava; C: Ultrasound guided puncture of P7; D: Marking pre-resection line based on ICG fluorescence staining boundaries; E: Liver transection along the fluorescence-stained interface; F: Right hepatic vein; G: Liver pedicle G7 in the liver S7; H: Hepatic vein tributary V7; I: Complete resection of liver S7



视频1 穿刺正染ICG荧光导航腹腔镜解剖性肝S7切除术
Video 1 Laparoscopic anatomical liver S7 resection with ICG fluorescence-guided puncture positive staining

扫描至移动设备观看手术视频:



<http://www.zp wz.net/zgptwkzz/article/html/pw240010>

2 结果

患者手术过程顺利,术中出血量约200 mL,手术时间250 min,术中无输血。术后病理学检查结果显示:“肝右后叶肿物”,符合中分化肝细胞性肝癌,切缘阴性(图4)。患者术后第1天复查肝功示:ALT 472.5 U/L、AST 416.2 U/L、TBIL 16.8 $\mu\text{mol/L}$ 、白蛋白(albumin, ALB) 32.6 g/L;术后第3天肝功示:ALT 220.5 U/L、AST 88.7 U/L、TBIL 26.6 $\mu\text{mol/L}$ 、ALB 37.4 g/L;术后第7天肝功恢复至正常。患者术后第1天进流质饮食,第3天拔出腹腔引流管,术后未发生胆汁漏、肝衰竭等并发症,术后恢复良好并第7天顺利出院。术后随访1个月复查肝功、肿瘤标志物AFP正常,腹部超声提示肝S7已切除并未见肿瘤复发征象。

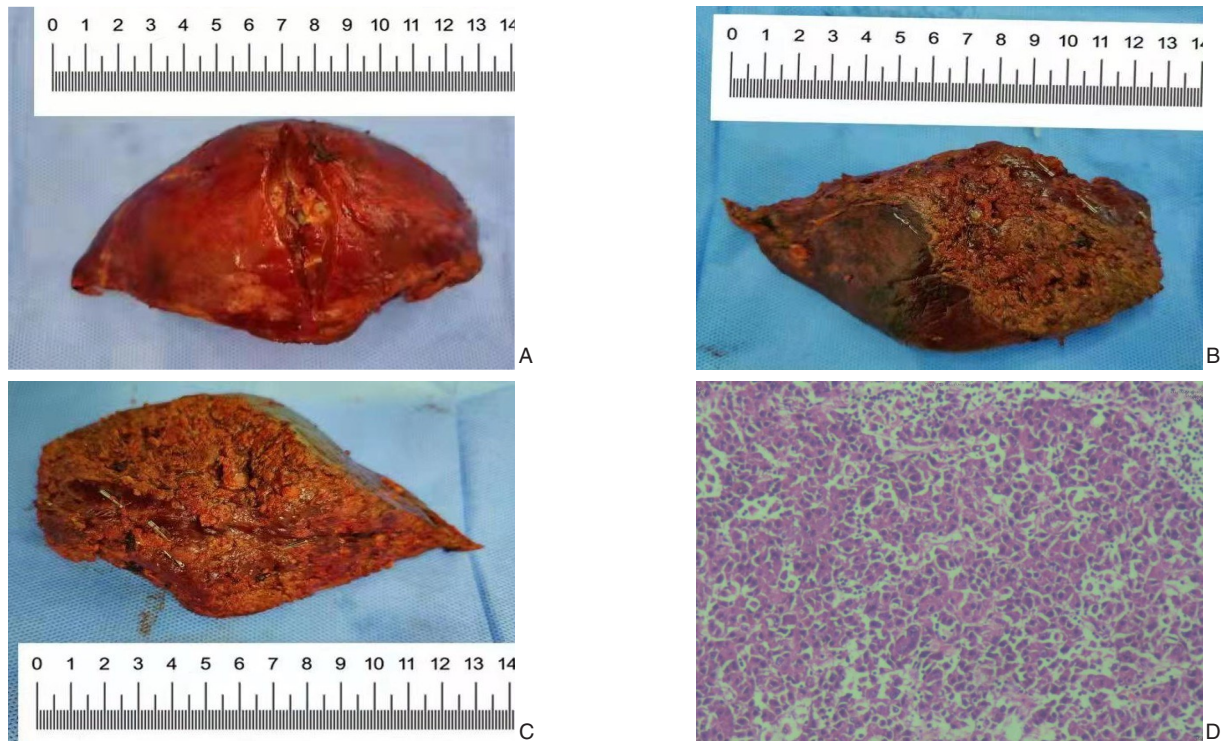


图4 术后标本及病理图片 A: 手术标本整体观; B-C: 手术标本剖面观; D: 肝右后叶肿瘤符合中分化肝细胞性肝癌, 切缘阴性

Figure 4 Postoperative specimens and pathological images A: Overall view of surgical specimen; B-C: Section view of surgical specimen; D: Tumor mass in the right posterior hepatic lobe corresponded to moderately differentiated hepatocellular carcinoma, negative margin of incision

3 讨论

2008年, ICG荧光成像技术在肝脏手术中应用被首次报道^[8], 在解剖性肝切除术中展现出广阔的应用前景。有研究^[9-10]报道, ICG荧光成像技术不仅可准确显示各肝段在肝脏表面的界限, 而且肝实质内也有明显的荧光界限, 有利于精准把握解剖性肝切除目标肝段的肝断面。Takemura等^[11]指出, ICG荧光实时成像技术可明确肿瘤三维边界及肝脏解剖性分段, 避免腹腔镜二维视觉的误差, 提高R₀切除率, 进而降低术后复发及转移, 这与一项纳入15篇文献的Meta分析^[12]结果一致。目前ICG荧光染色导航腹腔镜肝S7解剖性切除术报道较少, 原因在于肝S7位置深在、解剖复杂、视野暴露困难以及对术者手术技术要求较高。笔者现总结荧光染色导航下腹腔镜肝S7解剖性切除术经验如下。

3.1 三维可视化技术的术前充分评估

肝脏三维重建技术可以通过旋转、放大等多种技术手段, 充分了解肝内脉管结构, 避免肝内

重要脉管结构的损伤, 目前该项技术已广泛用于腹腔镜肝脏切除手术^[13-14]。同样, 三维重建技术也广泛用于指导腹腔镜超声引导门静脉穿刺ICG荧光染色^[15-16]。本例肝S7切除前按常规完善三维重建, 通过分析肝S7门脉分支的解剖特点, 个体化评估患者是否适合行荧光染色解剖性肝S7切除, 并且术前通过动画模拟术中需要穿刺的S7门脉分支数量及位置。肝S7肝蒂位于肝右后叶背侧深部肝实质内, 变异多。Minami等^[17]报道肝右后叶肝蒂45%病例呈头尾分叉形, 另外还有50%病例呈弓形、5%病例呈三分叉形, 此时S7肝蒂存在多支, 其位置距右后肝蒂起始部距离较远, 前方通常有肝S6肝蒂阻挡, 通过经肝蒂入路解剖困难, 分离解剖空间狭小解剖困难, 有较高的出血和胆汁漏风险; 本例患者术前三维重建提示肿瘤位于肝S7, 肝右后叶肝蒂为头尾分叉型, 肝S7由1支P7支供应, 术中只需处理相应P7分支及右肝静脉S7属支。鉴于门静脉及肝静脉无变异, 术前规划采用超声引导穿刺P7支联合ICG荧光正染技术, 以足侧入路方式行腹腔镜解剖性肝S7切除术, 而术中所见与

术前规划一致，缩短了手术时间、防止了脉管损伤和术后并发症的发生。

3.2 术中超声应用

腹腔镜超声在腹腔镜直视下与肝脏直接接触，避免腹壁、腹腔气体对超声波的干扰，使用高频超声扫描获得高分辨图像，提高检测的正确性，能够提高腹腔镜肝切除的安全性^[18-21]。笔者在术中超声应用有以下几点经验：(1) 超声探查前应先离断肝圆韧带、肝镰状韧带、部分左冠状韧带及右冠状韧带，完全游离右肝后使肝脏表面充分暴露，超声探头能够较好地贴合于肝脏表面以进行探查；(2) 通常使用高频超声探头，在探头上施加合适的压力，使探头和肝脏表面充分接触，在重点探查区域（拟切除肝段）时，应避免大范围移动超声探头，可采取旋转或倾斜超声探头的方式来进行，寻找到目标时应确定超声探头平面与肝脏表面的角度，以便判断接下来的手术操作的角度；(3) 门静脉因其有较厚的血管壁，其在超声探查下应该为有较厚的高回声包绕的无回声区，彩色多普勒下为蓝色的血流信号，超声探头可先找到门静脉主干，接着向目标肝段门静脉方向缓慢移动，通过顺藤摸瓜的方式找到需要穿刺门静脉起始位置；或是先找到目标肝段门静脉，通过攀枝而上的方式从门静脉分支找到门静脉主干，进而找到需要穿刺门静脉分支的起始位置；(4) 超声引导穿刺时，超声探头长轴方向应和门静脉走行方向平行，以便更好地确定穿刺路线，穿刺过程中助手应协助固定好超声探头避免移动，采用旋转探头的方式确定穿刺针尖的位置以便调整穿刺方向，穿刺路径与超声探头长轴的关系应是重合或是平行。

3.3 ICG 荧光成像技术的应用

实现解剖性肝切除的关键是术中根据相应门静脉流域的肝实质确定肝脏断面。近年来，随着荧光腹腔镜的快速发展，研究^[22-23]表明，通过超声引导穿刺目标门静脉注射 ICG 荧光染色相应流域，使各肝段间的边界在肝实质内部清晰可见。ICG 荧光肝段染色方法可分为正染法和反染法，正染法指对预先切除的目标肝蒂门静脉进行穿刺，或通过解剖第一肝门找到目标肝蒂门静脉进行穿刺后注入 ICG 显示相应门静脉流域，适用于 Glisson 蒂位置深在的肝段。反染法指使用 Glisson 蒂鞘外解剖方法找到目标肝蒂并阻断后经外周静脉注入 ICG，保留肝段即出现荧光染色，适用于 Glisson 蒂邻近

肝门、易于解剖分离的肝段。相较于负染法，正染法需要较高的术中超声穿刺技巧，但是染色边界稳定，可显示门静脉流域的界限，无需要解剖肝实质^[24-27]。对于肝 S7 染色，我国专家共识^[28]推荐肝 S7 Glisson 蒂（G7）距离右后支起始部较远，在肝外解剖 G7 困难时，超声引导下对 G7 直接穿刺，无需要切开肝实质，正染较负染法更便捷。本例患者采用术中超声引导穿刺 P7 正染行解剖性肝 S7 切除取得了较好的效果。其肝 S7 只有 1 支 P7 供应，在此情况下施行超声引导穿刺正染更容易获得成功。而在临床实践中，常会遇到肝 S7 门脉分支数量超过 3 支且直径过细的情况，这时行荧光正染腹腔镜肝 S7 解剖性切除术则不易成功。穿刺点选择在 P7 门静脉的起始位置，针尖斜面朝向门静脉血流方向，注射 ICG 速度应尽量缓慢，在超声实时监视下动态观察 ICG 注入目标肝段，避免注射 ICG 时出现反流，ICG 浓度为 0.005 mg/mL，注射量不超过 5 mL。

3.4 肝 S7 的暴露、肝实质离断

根据荧光染色确定切除范围后，在右肝充分游离的基础上，将肝 S7 向左侧翻转，由深在区域上移动端至浅在的术野正中，充分暴露后，离断肝实质^[29-30]。过程中，ICG 荧光可能会逐步浸润误导肝实质离断面，同时荧光染色肝脏平面与经典的 Couinaud 段间平面不吻合的情况也有发生，单一方式可能会误导离断肝脏平面。因此笔者认为在肝实质离断过程中需联合染色边界和脉管（右肝静脉）引导，确保肿瘤切缘，以达到肿瘤学最大获益。

综上所述，术前三维可视化评估、术中超声联合 ICG 荧光正染技术能对腹腔镜解剖性肝 S7 切除术起到良好的辅助作用，在保证肿瘤 R₀ 切缘、提高解剖性肝切除精确度具有重要的临床价值和前景，但该技术需要更多高级别循证医学证据以证明其在肿瘤学上的获益。

利益冲突：所有作者均声明不存在利益冲突。

作者贡献声明：王峥、尤楠、贺永刚、郑璐负责设计手术方案；王峥、尤楠、郑璐负责完成手术；王峥、尤楠、贺永刚、艾麦提·牙森负责论文撰写、数据整理；王峥、艾麦提·牙森、郑璐等对文章修改做出重要贡献。

参考文献

- [1] Liu QQ, Li J, Wu K, et al. Laparoscopic anatomic liver resection of segment 7 using a caudo-dorsal approach to the right hepatic vein[J]. *Surg Oncol*, 2021, 38: 101575. doi: 10.1016/j.suronc.2021.101575.
- [2] Cheng KC, Yeung YP, Hui J, et al. Multimedia manuscript: laparoscopic resection of hepatocellular carcinoma at segment 7: the posterior approach to anatomic resection[J]. *Surg Endosc*, 2011, 25(10):3437. doi:10.1007/s00464-011-1685-2.
- [3] Li YK, Wu K, Li J, et al. A safe and simple exposure and Pringle maneuver in laparoscopic anatomical liver resection of segment 7[J]. *BMC Gastroenterol*, 2023, 23(1):418. doi: 10.1186/s12876-023-03056-z.
- [4] Efanov M, Salimgereeva D, Alikhanov R, et al. Comparison between the difficulty of laparoscopic limited liver resections of tumors located in segment 7 versus segment 8: an international multicenter propensity-score matched study[J]. *J Hepatobiliary Pancreat Sci*, 2023, 30(2):177-191. doi:10.1002/jhbp.1210.
- [5] Franz M, Arend J, Wolff S, et al. Tumor visualization and fluorescence angiography with indocyanine green (ICG) in laparoscopic and robotic hepatobiliary surgery-valuation of early adopters from Germany[J]. *Innov Surg Sci*, 2021, 6(2):59-66. doi: 10.1515/iss-2020-0019.
- [6] Wang GM, Luo Y, Qi WJ, et al. Determination of surgical margins in laparoscopic parenchyma-sparing hepatectomy of neuroendocrine tumors liver metastases using indocyanine green fluorescence imaging[J]. *Surg Endosc*, 2022, 36(6):4408-4416. doi: 10.1007/s00464-021-08791-6.
- [7] Wakabayashi T, Cacciaguerra AB, Abe Y, et al. Indocyanine green fluorescence navigation in liver surgery: a systematic review on dose and timing of administration[J]. *Ann Surg*, 2022, 275(6):1025-1034. doi:10.1097/SLA.0000000000005406.
- [8] Aoki T, Yasuda D, Shimizu Y, et al. Image-guided liver mapping using fluorescence navigation system with indocyanine green for anatomical hepatic resection[J]. *World J Surg*, 2008, 32(8):1763-1767. doi:10.1007/s00268-008-9620-y.
- [9] Inoue Y, Arita J, Sakamoto T, et al. Anatomical liver resections guided by 3-dimensional parenchymal staining using fusion indocyanine green fluorescence imaging[J]. *Ann Surg*, 2015, 262(1):105-111. doi:10.1097/SLA.0000000000000775.
- [10] Dai ZY, Shen C, Mi XQ, et al. The primary application of indocyanine green fluorescence imaging in surgical oncology[J]. *Front Surg*, 2023, 10:1077492. doi:10.3389/fsurg.2023.1077492.
- [11] Takemura N, Kokudo N. Do we need to shift from dye injection to fluorescence in respective liver surgery?[J]. *Surg Oncol*, 2020, 33: 207-209. doi:10.1016/j.suronc.2019.07.003.
- [12] 董杉杉, 王琨, 李悦玮. 吲哚菁绿荧光实时成像技术在腹腔镜肝切除术中应用效果的Meta分析[J]. *腹腔镜外科杂志*, 2022, 27(3): 183-188. doi:10.13499/j.cnki.fqjwkzz.2022.03.183.
- [13] Dong SS, Wang K, Li YW. Meta-analysis of the effect of indocyanine green fluorescence real time imaging in laparoscopic hepatectomy[J]. *Journal of Laparoscopic Surgery*, 2022, 27(3):183-188. doi:10.13499/j.cnki.fqjwkzz.2022.03.183.
- [14] Bonomi AM, Kersik A, Bracchetti G, et al. 3D reconstruction in complex parenchymal sparing liver surgery[J]. *Heliyon*, 2023, 9(3): e13857. doi:10.1016/j.heliyon.2023.e13857.
- [15] 刘斌, 黄军利, 陈福真, 等. 三维可视化重建在复杂肝血管瘤精准肝切除中的应用[J]. *中华普通外科杂志*, 2015, 30(2):130-133. doi:10.3760/cma.j.issn.1007-631X.2015.02.013.
- [16] Liu B, Huang JL, Chen FZ, et al. Application of three-dimensional visualization system for precise hepatectomy in patients with complicated hepatic hemangiomas[J]. *Chinese Journal of General Surgery*, 2015, 30(2): 130-133. doi: 10.3760/cma.j.issn.1007-631X.2015.02.013.
- [17] Berardi G, Colasanti M, Meniconi RL, et al. The applications of 3D imaging and indocyanine green dye fluorescence in laparoscopic liver surgery[J]. *Diagnostics*, 2021, 11(12): 2169. doi: 10.3390/diagnostics11122169.
- [18] 王小波, 魏永刚. 基于三维重建与ICG荧光引导的腹腔镜下解剖性肝IV段切除术[J]. *中国普外基础与临床杂志*, 2021, 28(12): 1632-1636. doi:10.7507/1007-9424.202107004.
- [19] Wang XB, Wei YG. Laparoscopic anatomic segment IV hepatectomy based on three-dimensional reconstruction and ICG fluorescence guidance[J]. *Chinese Journal of Bases and Clinics in General Surgery*, 2021, 28(12): 1632-1636. doi: 10.7507/1007-9424.202107004.
- [20] Minami T, Ebata T, Yokoyama Y, et al. Study on the segmentation of the right posterior sector of the liver[J]. *World J Surg*, 2020, 44(3):896-901. doi:10.1007/s00268-019-05238-x.
- [21] Sun J, Lu ZY, Zhai JX, et al. Laparoscopic anatomical liver resection of segment VIII by using ICG fluorescence positive staining under the guidance of laparoscopic ultrasonography[J]. *Ann Surg Oncol*, 2023, 30(12): 7358-7359. doi: 10.1245/s10434-023-13920-7.
- [22] Berber E, Garland AM, Engle KL, et al. Laparoscopic ultrasonography and biopsy of hepatic tumors in 310 patients[J]. *Am J Surg*, 2004, 187(2): 213-218. doi: 10.1016/j.amjsurg.2003.11.025.
- [23] Aoki T, Koizumi T, Mansour DA, et al. Ultrasound-guided preoperative positive percutaneous indocyanine green fluorescence staining for laparoscopic anatomical liver resection[J]. *J Am Coll*

- Surg, 2020, 230(3):e7-e12. doi:10.1016/j.jamcollsurg.2019.11.004.
- [21] Araki K, Conrad C, Ogiso S, et al. Intraoperative ultrasonography of laparoscopic hepatectomy: key technique for safe liver transection[J]. J Am Coll Surg, 2014, 218(2):e37-e41. doi:10.1016/j.jamcollsurg.2013.10.022.
- [22] 王鹏飞, 陈明易, 卢实春, 等. 吲哚菁绿荧光引导腹腔镜解剖性肝脏Ⅶ段切除手术流程[J]. 中华肝胆外科杂志, 2019, 25(2):137-139. doi:10.3760/cma.j.issn.1007-8118.2019.02.017.
- Wang PF, Chen MY, Lu SC, et al. Process of indocyanine green fluorescence imaging in laparoscopic hepatectomy of segment VII[J]. Chinese Journal of Hepatobiliary Surgery, 2019, 25(2):137-139. doi:10.3760/cma.j.issn.1007-8118.2019.02.017.
- [23] Potharazu AV, Gangemi A. Indocyanine green (ICG) fluorescence in robotic hepatobiliary surgery: a systematic review[J]. Int J Med Robot, 2023, 19(1):e2485. doi:10.1002/rcs.2485.
- [24] 王晓颖. 腹腔镜解剖性肝切除术中荧光染色意外及对策[J]. 中国实用外科杂志, 2022, 42(9):1001-1004. doi:10.19538/j.cjps.issn1005-2208.2022.09.11.
- Wang XY. Unexpected ICG fluorescence staining in laparoscopic anatomic resection, how to deal with it? [J]. Chinese Journal of Practical Surgery, 2022, 42(9):1001-1004. doi:10.19538/j.cjps.issn1005-2208.2022.09.11.
- [25] Kasai M, Aihara T, Ikuta S, et al. Optimal dosage of indocyanine green fluorescence for intraoperative positive staining in laparoscopic anatomical liver resection[J]. Cureus, 2023, 15(10):e46771. doi:10.7759/cureus.46771.
- [26] Wei J, Zhang H, Zhong J, et al. Fluorescent laparoscopic central hepatectomy for liver cancer using indocyanine green negative staining[J]. J Vis Exp, 2023, (193). doi:10.3791/64869.
- [27] Alomari MAM, Wakabayashi T, Colella M, et al. Comparing the accuracy of positive and negative indocyanine green staining in guiding laparoscopic anatomical liver resection: protocol for a randomised controlled trial[J]. BMJ Open, 2023, 13(9):e072926. doi:10.1136/bmjopen-2023-072926.
- [28] 中国医师协会外科医师分会肝脏外科医师委员会. 吲哚菁绿荧光成像技术在肝脏外科应用中国专家共识(2023版)[J]. 中国实用外科杂志, 2023, 43(4):371-383. doi:10.19538/j.cjps.issn1005-2208.2023.04.02.
- Liver Surgeons Committee, Surgeons Branch of Chinese Medical Doctor Association. Chinese expert consensus on the application of indocyanine green near-infrared imaging technology in liver surgery (2023 edition) [J]. China Industrial Economics, 2023, 43(4):371-383. doi:10.19538/j.cjps.issn1005-2208.2023.04.02.
- [29] Jiang Z, Zhou B, Zheng X, et al. A novel method of ultrasound-guided positive staining using indocyanine green fluorescence in laparoscopic anatomical liver resection of segments VII and VIII [J]. Front Oncol, 2023, 13:1138068. doi:10.3389/fonc.2023.1138068.
- [30] Wang X, Teh CSC, Ishizawa T, et al. Consensus guidelines for the use of fluorescence imaging in hepatobiliary surgery[J]. Ann Surg, 2021, 274(1):97-106. doi:10.1097/SLA.0000000000004718.

(本文编辑 宋涛)

本文引用格式:王峥, 尤楠, 贺永刚, 等. 穿刺正染 ICG 荧光导航腹腔镜解剖性肝Ⅶ段切除术 1 例报告(附视频)[J]. 中国普通外科杂志, 2024, 33(7):1043-1050. doi:10.7659/j.issn.1005-6947.2024.07.003

Cite this article as: Wang Z, You N, He YG, et al. A case report on laparoscopic anatomical liver segment VII resection with ICG fluorescence-guided puncture positive staining (with video)[J]. Chin J Gen Surg, 2024, 33(7):1043-1050. doi:10.7659/j.issn.1005-6947.2024.07.003