Supplementary Table 2: Hepatic segmentation

Ref. No.	Author	Country	Journal	Year	Study design	Patient selection		Imaging techniques						Endpoint measures								
						Subject	N (cases)	Fluorogenic agent	Dose	Route	Timing	Imaging system	Quantitative measurement	Main endpoints	Imaging accuracy/success rate	Clinical impact, changes in intraoperative decision-making and outcomes	Clinical impact, advantages in postoperative outcomes	Adverse effects	Learning curve	Cost analysis	Other comments	Ref. detail
1	Aoki	Japan	World J Surg	2008	Prospective	Open subsegmentectomy or segmentectomy	35	ICG	5mg/mL	PV injection	Before liver resection with a Pringle maneuver under ultrasonography	PDE-2 imaging system (Hamamatsu Photonics)	NA	Visualization of hepatic segments	94.3% (Stained subsegments and segments of the liver were identifiable)	NA	NA	None	NA	NA		Aoki T, Yasuda D, Shimizu Y, Odaira M, Niiya T, Kusano T, Mitamura K, Hayashi K, Murai N, Koizumi T, Kato H, Enami Y, Miwa M, Kusano M. World J Surg. 2008 Aug;32(8):1763-7
2	Aoki	Japan	J Hepatobiliary Pancreat Sci	2010	Prospective	Open subsegmentectomy or segmentectomy	81	ICG	5mg/mL	PV injection	Before liver resection	PDE-2 imaging system (Hamamatsu Photonics)	NA	Visualization of hepatic segments	90.1% (Stained subsegments and segments of the liver were identifiable)	NA	NA	None	NA	NA	Detection rate in chirrhotic liver was 86.6% (13/15)	Aoki T, Murakami M, Yasuda D, Shimizu Y, Kusano T, Matsuda K, et al.. J Hepatobiliary Pancreat Sci. 2010;17(5):590-4
3	Kai	Japan	J Hepatobiliary Pancreat Sci	2010	Case series	Laparoscopic cholecystectomy	9	ICG	NA	Cystic artery injection	After superselective cannulation of the cholecystic artery	PDE (Hamamatsu Photonics)	NA	Visualization of hepatic legions perfused by the cholecystic vein	100%	NA	NA	None	NA	NA	No hepatectomy performed (only the visualizability was evaluated during cholecystectomy)	Kai K, Satoh S, Watanabe T, Endo Y. J Hepatobiliary Pancreat Sci. 2010 Mar;17(2):147-51
4	Uchiyama	Japan	Langenbecks Arch Surg	2011	Prospective	Open anatomical hepatectomy for HCC	22	ICG	0.5mg/kg	IV	After portal pedicle ligation	PDE (Hamamatsu Photonics)	NA	Visualization of hepatic segments	100% (vs. 77% by naked-eye observation of ischemic regions)	The estimated volume of the resected specimen and the true weight of the removed specimen was well correlated (R=0.982)	NA	None	None	NA	Contrast-enhanced ultrasound was also used for identification of segmental boundaries	Uchiyama K, Ueno M, Ozawa S, Kiriyama S, Shigekawa Y, Hirono S, Kawai M, Tani M, Yamaue H. Langenbecks Arch Surg. 2011 Oct;396(7):1101-7.
5	Ishizawa	Japan	Arch Surg	2012	Case series	Laparoscopic segmentectomy	2	ICG	0.025mg/mL (PV injection) 2.5mg (IV)	PV injection IV	Following puncture of a PV branch under US guidance (PV injection) After clamping portal pedicle (IV)	Prototype laparoscopic system (Olympus)	NA	Visualization of hepatic segments	100%	NA	NA	None	NA	NA	Use of the terms "positive" and "negative" staining techniques to indicate fluorescence imaging by PV injection and IV, respectively	Ishizawa T, Zuker NB, Kokudo N, Gayet B. Arch Surg. 2012 Apr;147(4):393-4.
6	Kawaguchi	Japan	J Hepatol	2013	Prospective	Open liver resection with excision of the major hepatic veins liver transplantation	63	ICG	0.0025mg/mL of remnant liver volume	IV	After liver resection with excision of the hepatic veins, harvesting of the liver graft (donor surgery), or reconstruction of all hepatic vessels (recipient surgery)	PDE (Hamamatsu Photonics)	Fluorescence intensity	Visualization of veno-occlusive regions and estimation of its portal uptake function	NA	Boundaries of veno-occlusive regions were visualized on hepatic surfaces according to decrease of portal uptake	Portal uptake function in veno-occlusive regions is approximately 40% of that in non-veno-occlusive regions The extent of venous occlusion in the remnant liver estimated by fluorescence imaging was correlated with postoperative improvement of prothrombin time	None	NA	NA		Kawaguchi Y, Ishizawa T, Miyata Y, Yamashita S, Masuda K, Satou S, Tamura S, Kaneko J, Sakamoto Y, Aoki T, Hasegawa K, Sugawara Y, Kokudo N. J Hepatol. 2013 Feb;58(2):247-53.
7	Sakoda	Japan	J Laparoendosc Adv Surg Tech A	2014	Case series	Laparoscopic segmentectomy	2	ICG	5mg/mL	PV injection	Following puncture of a PV branch under US guidance	IRI (Olympus)	NA	Visualization of hepatic segments	100%	NA	NA	None	NA	NA		Sakoda M, Ueno S, Iino S, Hiwatashi K, Minami K, Kawasaki Y, Kurahara H, Mataki Y, Maemura K, Uenosono Y, Shinchi H, Natsugoe S. J Laparoendosc Adv Surg Tech A. 2014 Dec;24(12):878-82
8	Miyata	Japan	J Am Coll Surg	2015	Prospective	Open anatomic segmentectomy	30	ICG	0.25mg/5mL indigocarmine	PV injection	Following puncture of a PV branch under US guidance	PDE-neo (Hamamatsu Photonics)	NA	Visualization of hepatic segments	100% (vs. 57% "effective" visualization by conventional indigocarmine method)	NA	NA	None	N.D.	NA	The proportion of rehepatectomy patients was significantly higher in the indigo-carmine ineffective group The ICG fluorescence lasted until the end of the hepatic transection procedures in all patients (the interval between PV-	Miyata A, Ishizawa T, Tani K, Shimizu A, Kaneko J, Aoki T, Sakamoto Y, Sugawara Y, Hasegawa K, Kokudo N. J Am Coll Surg. 2015 Aug;221(2):e27-36.
9	Abo	Japan	Eur J Surg Onco	2015	Prospective	Open anatomical hepatectomy	28	ICG	0.25 mg/mL	PV injection	Following puncture of a PV branch	PDE (Hamamatsu Photonics)	NA	Visualization of hepatic segments	89%	NA	NA	None	NA	NA	Tumor identification by fluorescence imaging was also assessed	Abo T, Nanashima A, Tobinaga S, Hidaka S, Tarura N, Takagi K, Arai J, Miyauki H, Shibata H, Nagayasu T. Eur J Surg Oncol. 2015 Feb;41(2):257-64.
10	Inoue	Japan	Ann Surg	2015	Case report	Open anatomical hepatectomy along the right hepatic vein watershed	1	ICG	2.5mg	IV	After clamping the right hepatic vein at its root	HyperEyeMedical System (Mizuho Ika-kogyo Co, Ltd)	NA	Visualization of drainage areas by the right hepatic vein	100%	NA	NA	None	NA	NA		Inoue Y, Saiura A, Arita J, Takahashi Y. Ann Surg. 2015 Dec;262(6):e98-9
11	Inoue	Japan	Ann Surg	2015	Prospective	Open anatomical liver resection	24	ICG	2.5mg/5mL indigoarmine(PV) 2.5mg (IV)	PV injection IV	Following puncture of a PV branch under US guidance (PV injection) After clamping portal pedicle (IV)	HyperEyeMedical System (Mizuho Ika-kogyo Co, Ltd)	Fluorescence intensity	Visualizability of hepatic segments based on fluorescence intensity	95.8% (vs. 41.7% by conventional demarcation technique) The contrast index of fusion fluorescence imaging was significantly higher than that of conventional demarcation technique (P < 0.001)	NA	NA	None	NA	NA	PV method was used for the procedure in which dissection of portal pedicle at hepatic hilum was judged to be difficult	Inoue Y, Arita J, Sakamoto T, Ono Y, Takahashi M, Takahashi Y, Kokudo N, Saiura A. Ann Surg. 2015 Jul;262(1):105-11.

12	Kurihara	Japan	J Am Coll Surg	2015	Caese series	Open hepatic resection of the right hepatic vein drainage area	2	ICG	0.25mg/kg	IV	After the proper hepatic artery and the right hepatic vein were clamped	HyperEyeMedical System (Mizuho Ika-kogyo Co, Ltd)	NA	Visualization of drainage areas by the right hepatic vein	100%	NA	NA	None	NA	NA		Kurihara T, Yamashita Y, Yoshida Y, Takeishi K, Itoh S, Harimoto N, Yoshizumi T, Shirabe K, Ikeda T, Maehara Y. J Am Coll Surg. 2015 Sen;221(3):e49-53.
13	Kobayashi	Japan	J Surg Oncol	2017	Prospective	Open hepatectomy	105	ICG	0.25mg/5mL indigocarmine (PV injection) 2.5mg (IV)	PV injection IV	Following puncture of a PV branch under US guidance (PV injection) After clamping portal pedicle (IV)	PDE (Hamamatsu Photonics)	NA	Visualizatio of hepatic segments and postoperative outcomes	100%	NA	The postoperative total morbidity and mortality rates were 14.3% and 0%, respectively	None	NA	NA	Fluorescence imaging techniques were classified into 5 types	Kobayashi Y, Kawaguchi Y, Kobayashi K, Mori K, Arita J, Sakamoto Y, Hasegawa K, Kokudo N. J Surg Oncol. 2017 Dec;116(7):921-931.
14	Terasawa	Japan	Surg Endosc	2017	Prospective	Laparoscopic segmentectomy	12	ICG	1.25mg	IV	After clamping the portal pedicle corresponding to the tumor-bearing hepatic segments.	PINPOINT (Novadaq)	NA	Visualization of hepatic segments	100%	NA	NA	None	NA	NA		Terasawa M, Ishizawa T, Mise Y, Inoue Y, Ito H, Takahashi Y, Saiura A. Surg Endosc. 2017 Dec;31(12):5111-5118.
15	Hong	Korea	Surg Endosc	2017	Case report	Laparoscopic living donor right hemihepatectomy	1	ICG	0.05mg/kg	IV	After closing blood flows to the right hemiliver	NA	NA	Visualization of hepatic segments	100%	NA	NA	None	NA	NA	Fluorescence imaging was also used for identification of hepatic ducts to be divided	Hong SK, Suh KS, Kim HS, Yoon KC, Ahn SW, Oh D, Kim H, Yi NJ, Lee KW. Surg Endosc. 2017 Nov;31(11):4834-4835.
16	Kawaguchi	Japan	Br J Surg	2017	Prospective	Liver resection with excision of major hepatic veins	21	ICG	0.0025mg per ml of total liver volume	IV	After hepatic veins to be resected had been taped and clamped	PDE (Hamamatsu Photonics)	Fluorescence intensity	Visualization of veno-occlusive/ischemic regions and estimation of its portal uptake function	100%	Hepatic transection lines were adjusted based on fluorescence imaging at least in 4 patients	There were no deaths in hospital or within 30 days. Postoperative complications developed in 6 patients	None	NA	NA		Kawaguchi Y, Nomura Y, Nagai M, Koike D, Sakuraoka Y, Ishida T, Ishizawa T, Kokudo N, Tanaka N. Br J Surg. 2017 Jan;104(7):904.
17	Mizuno	Japan	Ann Surg Oncol	2017	Case report	Laparoscopic segmentectomy	1	ICG	NA	IV	After portal pedicle of segment 6 was dissected out	PINPOINT (Novadaq)	NA	Visualization of hepatic segments	100%	NA	NA	None	NA	NA		Mizuno T, Sheth R, Yamamoto M, Kang HS, Yamashita S, Aloia TA, Chun YS, Lee JE, Vauthey JN, Conrad C. Ann Surg Oncol. 2017 Apr;24(4):1046-1047.
18	Zhang	China	J Cancer Res	2017	Prospective	Open hepatectomy	15	ICG	1-2mg (PV injection) 0.25mg/kg (IV)	PV injection IV	After ligation of the PV in the resected liver (PV injection) After clamping the distal PV (IV)	PDE (Hamamatsu Photonics)	NA	Visualization of hepatic segments	NA	NA	NA	None	NA	NA		Zhang YM, Shi R, Hou JC, Liu ZR, Cui ZL, Li Y, Wu D, Shi Y, Shen ZY. J Cancer Res Clin Oncol. 2017 Jan;143(1):51-58
19	Meng	China	Int J Surg Case Rep	2018	Cae report	Laparoscopic living donor right hepatectomy	1	ICG	1mg (0.5mg/mL)	PV injection	After hilar dissection	PINPOINT (Stryker)	NA	Visualization of hepatic segments	NA	NA	NA	None	NA	NA	Fluorescence imaging was also used for identification of hepatic ducts to be divided	Meng X, Wang H, Xu Y, Chen M, Duan W, Lu S. Int J Surg Case Rep. 2018;53:406-409
20	Nomi	Japan	Ann Surg Oncol	2018	Prospective	Laparoscopic anatomical liver resection	16	ICG	1.5mg	IV	After he target Glissonian pedicle was identified and temporally clamped	PINPOINT (Stryker)	NA	Visualization of hepatic segments	100%	NA	Only one patient encountered the major postoperative complication of ascites, and all the patients attained R0 resection.	None	NA	NA		Nomi T, Hokuto D, Yoshikawa T, Matsuo Y, Sho M. Ann Surg Oncol. 2018 Dec;25(13):3982
21	Ueno	Japan	Surg Endosc	2018	Case series	Laparoscopic segmentectomy	5	ICG	0.25mg	Arterial injection	After catheterization into the target arterial branches	PINPOINT (Novadaq)	NA	Visualization of hepatic segments	100%	NA	NA	None	NA	NA	Embolic agent was also injected into the arterial branches following injection of ICG solution This procedure was performed in a hybrid operation room	Ueno M, Hayami S, Sonomura T, Tanaka R, Kawai M, Hirono S, Okada KI, Yamane H. Surg Endosc. 2018 Feb;32(2):1051-1055
22	Nishino	Japan	Ann Surg	2018	Prospective	Open anatomical hepatectomy	23	ICG	0.25mg	PV injection IV	After puncturing of the target portal branches under ultrasound guidance (PV injection) After clamping the glissonian sheaths (IV)	Medical Imaging Projection System (MIPS, Panasonic)	NA	Visualization of hepatic segments	91.3%	In 5 patients, the dissection line, corresponding to the boundary between colored and noncolored areas, was consistent even in the deep regions of the liver	The rate of morbidity was comparable between patients with a use of fluorescence imaging and those without fluorescence imaging. The 1-year disease-free survival rate was, however, higher among patients in the former group , although this difference was not statistically significant.	None	NA	NA	Compared to outcomes of patients without using fluorescence	Nishino H, Hatano E, Seo S, Nitta T, Saito T, Nakamura M, Hattori K, Takatani M, Fujii H, Taura K, Uemoto S. Ann Surg. 2018 Jun;267(6):1134-1140
23	Peyrat	France	J Surg Oncol	2018	Prospective	Anatomical liver resection	20	ICG	40-80mL of 0.0078mg/mL or 0.0156mg/mL	IV	After clamping of the hepatic pedicle	Fluobeam (Fluoptics)	NA	Visualization of hepatic segments	80.0%	NA	NA	None	NA	NA		Peyrat P, Blanc E, Guillermet S, Chen Y, Ferlay C, Perol D, Basso V, Rivoire M, Dupré A. J Surg Oncol. 2018 Apr;117(5):922-927.
24	Marino	Spain	World J Surg	2019	Retrospective	Robotic liver resection	25	ICG	2.5mg/10mL (PV injection) 2.5mg (IV)	PV injection IV	After puncturing the correspondent segmental portal branch (PV injection) After temporary closure/clamping the corresponding portal branch (IV)	da Vinci Firefly (Intuitive Surgical)	NA	Visualization of hepatic segments	100% for the negative staining method (IV) and 50% for the positive staining method (PV injection)	NA	The risk of postoperative bile leakage (0% vs. 12%, p = 0.023), R1 resection (0% vs. 16%, p = 0.019) and readmission (p = 0.023) was reduced in the ICG group compared with the no-ICG group.	None	NA	NA	Compared to 25 patienets who underwent robotic hepatectomy without a use of ICG fluorescence imaging	Marino MV, Di Saverio S, Podda M, Gomez Ruiz M, Gomez Fleitas M. World J Surg. 2019 Oct;43(10):2595-2606
25	Marino	Spain	J Gastrointest Surg	2019	Retrospective	Robotic right hepatectomy	20 (+20 control)	ICG	2.5mg/10mL (PV injection) 2.5mg (IV)	PV injection IV	After puncturing the right portal vein (PV injection) After temporary clamping of the targeted portal branch (IV)	da Vinci Firefly (Intuitive Surgical)	NA	Feasibility and operative outcomes	NA	NA	Despite the similar operative time (288 vs 275 min, p = 0.778), the rate of post-operative bile leakage (0% vs 16%, p = 0.002) and the rate of post hepatectomy liver failure (4% vs 16%, p = 0.034) in the ICG-group were both inferior compared with the non-ICG group.	None	NA	NA	The mean time between the ICG injection and fluorescence visualization was higher for the negative staining method in comparison with the positive staining method (240 vs 120	Marino MV, Builes Ramirez S, Gomez Ruiz M. J Gastrointest Surg. 2019 Nov;23(11):2312-2313.

26	Kim	Korea	J Gastrointest Surg	2019	Case report	Laparoscopic living donor right hepatectomy	1	ICG	2.5mg	IV	After right hepatic artery and portal vein clamping	NA	NA	Visualization of hepatic segments	100%	NA	NA	None	NA	NA	ICG fluorescence imaging also visualized the running of the biliary tree	Kim YS, Choi SH. J Gastrointest Surg. 2019 Aug;23(8):1711-1712
27	Ogiso	Japan	Ann Surg Oncol	2019	Case report	Laparoscopic left lateral sectionectomy	1	ICG	NA	IV	After clamping the Glissonian pedicle	NA	NA	Visualization of hepatic segments	100%	NA	NA	None	NA	NA		Ogiso S, Seo S, Okumura S, Ishii T, Fukumitsu K, Ito T, Masui T, Taura K, Kaido T, Uemoto S. Ann Surg Oncol. 2019 Jun;26(6):1858.
28	Ueno	Japan	Surg Laparosc Endosc Percutan Tech	2019	Prospective	Laparoscopic anatomical liver resection	10	ICG	0.25mg	Arterial injection	After catheterization into the target arterial branches	PINPOINT (Novadaq)	Contrast index	Visualization of hepatic segments and correlation of actual resected liver weight with estimated liver resection volumes	100% Median contrast index value of fluorescence imaging was 1.12, superior to that of indigo carmine (0.21; P=0.05)	NA	Estimated liver resection volume and actual resected liver weight correlated significantly (R=0.906; P<0.01).	None	NA	NA	Compared to staining of hepatic segments using indigo-carmine	Ueno M, Hayami S, Sonomura T, Kawai M, Hirono S, Okada KI, Tanaka R, Yamane H. Surg Laparosc Endosc Percutan Tech. 2019 Aug;29(4):242-246
29	Nanashima	Japan	World J Surg	2019	Prospective	Open hepatectomy	40	ICG	0.25mg/mL	PV injection	After puncturing portal branches	PDE (Hamamatsu Photonics)	NA	Visualization of hepatic segments	88% (complete identification)	NA	NA	None	NA	NA	Compared to staining of hepatic segments using indigo-carmine (75% identification rate)	Nanashima A, Yano K, Tobinaga S. World J Surg. 2019 May;43(5):1308-1312.
30	Chiba	Japan	World J Surg	2019	Prospective	Open hepatectomy for T2 gallbladder cancer	24	ICG	NA	Cystic artery injection	After superselective cannulation of the cholecystetic artery	HyperEyeMedical System (Mizuho Ika-kogyo Co, Ltd)	NA	Visualization of hepatic legions perfused by the cholecystic vein and long-term outcomes	100%	NA	20% microscopic liver metastasis detected in the resected liver The disease-free survival rate was 59.1% at 5 years and overall survival rate was 86.2% at 5 years	None	NA	NA		Chiba N, Shimazu M, Ochiai S, Yokozuka K, Gunji T, Okihara M, Sano T, Tomita K, Tsutsui R, Oshima G, Takano K, Abe Y, Hirano H, Kawachi S. World J Surg. 2019 Feb;43(2):608-614. doi: 10.1007/s00268-018-4810-8
31	Berardi	Japan	Ann Surg Oncol	2019	Case report	Laparoscopic anatomical segmentectomy	1	ICG	NA	IV	After closing blood flows to S8	NA	NA	Visualization of hepatic segments	100%	NA	NA	None	NA	NA		Berardi G, Wakabayashi G, Igarashi K, Ozaki T, Toyota N, Tsuchiya A, Nishikawa K. Ann Surg Oncol. 2019 Aug;26(8):2577-2578
32	Lu	China	Surg Today	2020	Retrospective	Laparoscopic hepatectomy	237 (anatomical resection)	ICG	0.5 mg/kg	IV	NA	PINPOINT (Novadaq)	NA	Operative outcomes	NA	NA	Operative time and intraoperative blood loss were significantly lower in the fluorescence navigation group. The rate of R0 resection of malignant tumors was comparable in the fluorescence navigation and no-navigation groups, but the wide surgical margin rate was significantly higher in the fluorescence navigation group.	None	NA	NA	ICG fluorescence imaging was also used for tumor identification in the fluorescence navigation group	Lu H, Gu J, Qian XF, Dai XZ. Surg Today. 2020 Oct 31. doi: 10.1007/s00595-020-02163-8
33	Aoki	Japan	Surg Oncol	2020	Case report	Laparoscopic liver resection	1	ICG	0.025mg/mL	PV injectino	After puncturing the correspondent segmental portal branch with guidance from IOUS and the 3D hologram needle guide	NA	NA	Feasibility	100%	NA	NA	None	NA	NA		Aoki T, Koizumi T, Sugimoto M, Murakami M. Surg Oncol. 2020 Dec;35:476-477. doi: 10.1016/j.suronc.2020.10.013.
34	Nishino	Japan	J Hepatobiliary Pancreat Sci	2020	Prospective	Open liver resection	10	ICG	0.25-2.5mg	IV	After clamping the Glissonian sheaths flowing in the cancer-bearing hepatic segment.	Medical Imaging Projection System (MIPS, Panasonic)	Accuracy of hepatectomy was evaluated by fluorescence area ratio	Accuracy of parenchymal division along the plane between hepatic segments	100%	The accurate fluorescence area ratio of the MIPS group and the non-MIPS group was 23.0 ± 12.6% and 5.6 ± 9.5%, respectively (P = .038).	NA	None	NA	NA	Accuracy of parenchymal transection guided by MIPS (n=6) was evaluated by comparing the fluorescence area ratios of liver resections in which MIPS was used only before hepatic transection	Nishino H, Seo S, Hatano E, Nitta T, Morino K, Toda R, Fukumitsu K, Ishii T, Taura K, Uemoto S. J Hepatobiliary Pancreat Sci. 2020 Sep 8. doi: 10.1002/jhbp.824.
35	Zheng	China	J Gastrointest Surg	2020	Case report	Laparoscopic hepatectomy	1	ICG	5mg	IV	After clamping the Glissonian pedicles of target portal territory	PINPOINT (Stryker)	NA	Visualization of hepatic segments	100%	NA	NA	None	NA	NA	ICG fluorescence imaging was also used for tumor identification in the fluorescence navigation group	Zheng JH, Zhai ST, Liang X. J Gastrointest Surg. 2020 Sep 1. doi: 10.1007/s11605-020-04764-7.
36	Chiow	Korea	HPB (Oxford)	2020	Retrospective	Robotic anatomical liver resection	52	ICG	2-5mg (PV injection) 5mg (IV)	PV injection IV	After puncturing the portal vein branch (PV injection) After pedicle clamping (IV)	da Vinci Firefly (Intuitive Surgical)	NA	Visualization of hepatic segments	83%	Demarcation line visualized by fluorescence imaging was clearer than the ischemic demarcation line in 56% of the patients	NA	None	NA	NA		Chiow AKH, Rho SY, Wee IJY, Lee LS, Choi GH. HPB (Oxford). 2021;23:475-482.
37	Procopio	Italy	HPB (Oxford)	2020	Prospective	Open anatomical liver resection	15	ICG	0.5mg/kg	IV	With ultrasound-guided vessel compression	HyperEyeMedical System (Mizuho Ika-kogyo Co, Ltd)	NA	Visualization of hepatic segments	100%	NA	NA	None	NA	NA		Procopio F, Torzilli G, Franchi E, Cimino M, Viganò L, Donadon M, Del Fabbro D. HPB (Oxford). 2020 Jun 18:S1365-182X(20)31024-8
38	Xu	China	Surg Endosc	2020	Prospective	Laparoscopic anatomical liver resection	36	ICG	0.025mg/mL (PV injection) 5mg (IV)	PV injection IV	After puncturing the targeted portal branches (PV injection) After occluding the portal vein or Glissonian pedicle of targeted segments (IV)	PINPOINT (Stryker)	NA	Visualization of hepatic segments	56% for positive staining (PV injection) and 52% for negative staining (IV)	NA	NA	None	NA (failure types of positive and negative staining were classified)	NA		Xu Y, Chen M, Meng X, Lu P, Wang X, Zhang W, Luo Y, Duan W, Lu S, Wang H. Surg Endosc. 2020 Oct;34(10):4683-4691. doi: 10.1007/s00464-020-07691-5

39	Zhai	China	J Surg Oncol	2020	Case series	Laparoscopic liver resection for intrahepatic cholangiocarcinoma	8	ICG	1mg	IV	After clamping inflow vessels	PINPOINT (Novadaq)	NA	Visualization of hepatic segments	75% (demarcations were obvious until the end of the operation)	NA	NA	None	NA	NA	ICG fluorescence imaging was also used for tumor identification	Zhai ST, Liang X, Mao QJ, Liang YL, Xu JJ, Chen J, Shi L, Xie YY, Cai XJ. J Surg Oncol. 2020 Aug;122(2):226-233. doi: 10.1002/jso.25940.
40	Zheng	China	Ann Surg Oncol	2020	Case report	Laparoscopic anatomical hepatectomy	1	ICG	NA	IV	After ligating Glissonian pedicle	NA	NA	Feasibility	100%	NA	NA	None	NA	NA		Zheng J, Feng X, Cai J, Tao L, Liang X. Ann Surg Oncol. 2020 Dec;27(13):5179-5180. doi: 10.1245/s10434-020-08592-6
41	Miyashita	Japan	Surg Today	2020	Retrospective	Open liver resection	10	ICG	0.025mg/5mL indigocarmine (PV injection) 0.25mg (IV)	PV injection IV	After puncturing the portal branch of the tumor-bearing hepatic segment (PV injection) After clamping the Glisson (IV)	LIGHTVISION (Shimadzu Corporation)	NA	Visualizatio of hepatic segments	100%	NA	NA	None	NA	NA	ICG fluorescence imaging was also used for tumor identification	Miyashita S, Hatano E, Tada M, Okada T. Surg Today. 2020 Oct;50(10):1308-1313. doi: 10.1007/s00595-020-02005-7.
42	Umemura	Japan	Case Rep Gastroenterol	2020	Case report	Laparoscopic extended cholecystectomy	1	ICG	2.5mg	IV	After clamping the hilar Glissonian pedicles distal to the cystic artery	NA	NA	Visualization of cystic vein perfision area in the liver	100%	NA	NA	None	NA	NA		Umemura A, Nitta H, Takahara T, Hasegawa Y, Katagiri H, Kamso S, Ando T, Kobayashi M, Sasaki A. Case Rep Gastroenterol. 2020 Feb 25;14(1):110-115
43	Yao	China	J Cancer	2020	Retrospective	Open right hemihepatectomy for HCC	18 (+29 control)	ICG	2.5mg (2.5mg/mL) (PV injection) 2.5mg (IV)	PV injection IV	After puncturing the right branch of portal vein (PV injection) After dividing the right hepatic artery and portal branch (IV)	NA	NA	Visualization of hepatic segments and operative outcomes	100%	NA	Compared to the patients without fluorescence navigation, the intraoperative blood loss and incidence of postoperative complications of the patients with fluorescence guided surgery was significantly less, and liver function recovery was faster. The recurrence rate in one year is significantly reduced in the fluorescence guided group.	None	NA	Navigation surgery did not result in an increase in costs.		Yao S, Zhang L, Ma J, Jia W, Chen H. J Cancer. 2020 Feb 10;11(9):2465-2475
44	Kubo	Japan	J Hepatobiliary Pancreat Sci	2020	Retrospective	Hepatic resection of the right hepatic vein drainage area	12	ICG	2.5mg	IV	After clamping the right hepatic vein	HyperEyeMedical System (Mizuho Ika-kogyo) or PINPOINT (Stryker)	NA	Visualization of the right hepatic vein drainage areas and correlation of actual resected liver volumes with estimated liver resection volumes	92% (11/12)	The right hepatic vein drainage areas were not clearly identified under normal light observation in 6 of the 11 patients (55%)	Resected liver volume was significantly correlated with the results of preoperative simulation.	None	NA	NA		Kubo N, Araki K, Harimoto N, Ishii N, Tsukagoshi M, Igarashi T, Watanabe A, Shirabe K. J Hepatobiliary Pancreat Sci. 2020 Jul;27(7):371-379. doi: 10.1002/jhbp.778
45	Ito	Japan	J Hepatobiliary Pancreat Sci	2020	Case series	Laparoscopic segmentectomy	3	ICG	0.25 mg/5 mL indigocarmine	PV injection	After puncturing the portal branches	PINPOINT (Stryker) or VISERA ELITE II (Olympus)	NA	Visualization of hepatic segments	100%	NA	NA	None	NA	NA		Ito D, Ishizawa T, Hasegawa K. J Hepatobiliary Pancreat Sci. 2020 Jul;27(7):441-443. doi: 10.1002/jhbp.726.
46	He	China	Surg Endosc	2020	RCT	Hepatectomy for patients with hepatolithiasis	21 (+23 control)	ICG	0.25mg/kg	IV	During surgery	CPM-I (Key Laboratory of Molecular Imaging of Chinese Academy of Science)	NA	Operative outcomes	100% (identification of target liver regions containing IBD stones)	NA	The NIRF imaging method was associated with less blood loss (OR 1.004, 95% CI 0.999–1.010; P=0.016), briefer hospitalization (OR 1.336, 95% CI 1.016–1.756; P=0.001), lower rates of margins with dilated bile ducts (OR 1.278, 95% CI 1.030–1.585; P=0.023), lower postoperative white blood cell counts (OR 1.262, 95% CI 0.931–1.712; P=0.038), lower procalcitonin levels (OR 1.316, 95% CI 1.020–1.513; P=0.002), and lower alanine aminotransferase levels (OR 1.013, 95% CI 1.003–1.023; P=0.002) compared with traditional hepatectomy.	None	NA	NA	Compared to traditional hepatectomy without a use of fluorescence imaging	He K, Hong X, Chi C, Cai C, Wang K, Li F, Liu X, Li J, Shan H, Tian J. Surg Endosc. 2020 Nov;34(11):4975-4982. doi: 10.1007/s00464-019-07290-z.
47	He	China	J Gastrointest Surg	2020	Case report	Laparoscopic segmentectomy	1	ICG	NA	IV	After occlusion of segment VII Glissonian pedicle	NA	NA	Feasibility	100%	NA	NA	None	NA	NA		He JM, Zhen ZP, Ye Q, Mo JQ, Chen GH, Peng JX. J Gastrointest Surg. 2020 May;24(5):1228-1229. doi: 10.1007/s11605-019-04468-7.
48	Aoki	Japan	J Am Coll Surg	2020	Prospective	Laparoscopic anatomical liver resection	14	ICG	0.025mg/mL	PV injection	After puncturing the portal branch under ultrasound guidance just before surgery	PINPOINT (Stryker)	NA	Visualization of hepatic segments	86%	NA	NA	None	NA	NA		Aoki T, Koizumi T, Mansour DA, Fujimori A, Kusano T, Matsuda K, Tashiro Y, Watanabe M, Otsuka K, Murakami M. J Am Coll Surg. 2020 Mar;230(3):e7-e12.
49	Zhang	China	Surg Endosc	2020	Retrospective	Laparoscopic hepatectomy	30 (+34 control)	ICG	2.5mg (PV injection) 2.5mg (IV)	PV injection IV	After puncturing the tumor-bearing hepatic segment of the portal branches (PV injection) After clamping the segmental portal pedicle (IV)	PINPOINT (Novadaq)	NA	Feasibility and operative outcomesof the novel laparoscopic hepatec tomy navigation system (LHNS), which fuses preoperative 3D) models with ICG fuorescence imaging to achieve real-time surgical navigation	97% for fluorescence imaging (90% for the LENS)	NA	The LHNS group had a signifcantly less blood loss (285.0±163.0 mL vs. 391.1±242.0 mL; P=0.047), less intraoperative blood transfusion rate (13.3% vs. 38.2%; P=0.045), and shorter postoperative hospital stay (7.8±2.1 days vs. 10.6±3.8 days; P<0.001) than the Non-LHNS group.	None	NA	NA	Compared to liver resection without a use of the LENS ICG fluorescence imaging was also used for tumor identification	Zhang P, Luo H, Zhu W, Yang J, Zeng N, Fan Y, Wen S, Xiang N, Jia F, Fang C. Surg Endosc. 2020 Aug;34(8):3449-3459.
50	Marino	Spain	HPB (Oxford)	2020	Retrospective	Robotic-assisted liver resection	40	ICG	0.25mg/mL (PV injection) 2.5mg (IV)	PV injection IV	After puncturing the portal branch (PV injection) After clamping the inflow to the target vessels (IV)	da Vinci Firefly (Intuitive Surgical)	(Questionnaire formulated for the investigation of fluorescence images quality and surgeons comfort was used)	Visualization of hepatic segments and operative outcomes	80% for positive staining (PV injection) and 95% for negative staining (IV)	The previously marked transaction line was changed after the staining method in 12 out of 40 patients (30%).	NA	None	Surgeons' satisfaction and comfort scores were 42 for positive staining and 51 for negative staining (full score: 60)	NA	ICG fluorescence imaging was also used for tumor identification	Marino MV, Podda M, Fernandez CC, Ruiz MG, Fleitas MG. HPB (Oxford). 2020 Mar;22(3):422-431
51	Urade	Japan	Asian J Surg	2020	Case series	Laparoscopic anatomical liver resection	3	ICG	2.5mg	IV	After clamping or closing the Glissonian pedicles	1588 Advanced Imaging Modality (Stryker) or VISERA ELITE II (Olympus)	NA	Visualization of hepatic segments	100%	NA	NA	None	NA	NA		Urade T, Sawa H, Iwatani Y, Abe T, Fujinaka R, Munta K, Mii Y, Man-I M, Oka S, Kuroda D. Asian J Surg. 2020 Jan;43(1):362-368.

NA, Not available or not assessed