Supplementary Table 1: Cholangiography

Ref. No.	Author	Country	Journal	Year	Study design	Patient selection		Imaging techniques						Endpoint measures			Adverse effects	Learning curve	Cost analysis	Other comments	Ref. detail
						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					
1	Mitsuhashi	Japan	J Hepatobiliary Pancreat Surg.	2008	Case series	Open cholecystectomy	5	ICG	2.5mg	IV	Before anesthesia	PDE (Hamamatsu)	NA	Visualization of the biliary anatomy	CyD (100%), CHD (100%), CBD (100%), and CyD-CHD junction (-)	NA	NA	None	NA	NA	Manuscript combines animan and human studies	Mitsuhashi N, Kimura F, Shimizu H, Imamaki M, Yoshidome H, Ohtsuka M, et al. J Hepatobiliary Pancreat Surg. 2008;15(5):508-14
2	Ishizawa	Japan	J Am Coll Surg	2009	Prospective	Open cholecystectomy	10 (+13 hepatectomy)	ICG	2.5mg	IV (biliary injection for hepatectomy)	1 hour before operation or at the time of conversion	PDE (Hamamatsu)	NA	Visualization of the biliary anatomy	CyD (100% by IV, 90% by biliary injection), CHD (-), CBD (-), and CyD-CHD junction (-) Right lateral sector branch draining into the CHD was visualized by	NA	NA	None	NA	NA	Right lateral sector branch draining into the CHD was visualized by FC in all 4 patients.	Ishizawa T, Tamura S, Masuda K, Aoki T, Hasegawa K, Imamura H, Beck Y, Kokudo N. J Am Coll Surg 2009;208(1): e1-4.
3	Ishizawa	Japan	Arch Surg	2009	Case report	Lap-cholecystectomy	1	ICG	2.5mg	IV	2 hours before surgery	Prototype (Shinko optical)	NA	Feasibility	NA	NA	NA	None	NA	NA		Ishigawa T, Bandai Y, Kokudo N. Arch Surg 2009;144(4):381-?
4	Ishizawa	Japan	Br J Surg	2010	Prospective	Lap-cholecystectomy	52	ICG	2.5mg	IV	30 min before the patient entered the operating room or following intubation.	Prototype (Shinko optical)	NA	Visualization of the biliary anatomy	CyD (100% before dissection/100% after dissection), CHD (96%/100%), CBD (100%/100%), and CyD-CHD junction	NA	NA	None	NA	NA	Compared with intraoperative drip infusion cholangiography	Ishizawa T, Bandai Y, Ijichi M, Kaneko J, Hasegawa K, Kokudo N. Br J Surg. 2010;97(9):1369-77.
5	Tagaya	Japan	J Hepatobiliary Pancreat Sci	2010	Prospective	Open cholecystectomy in 4 Lap-cholecsyectomy in 8	12	ICG	2.5mg	IV	1-2 hours before surgery	Prototype	NA	Visualization of the biliary anatomy	CyD (100%), CHD (100%), CBD (100%), and CyD-CHD junction (100%)	NA	NA	None	NA	NA	Manuscript combines animan and human studies	Tagaya N, Shimoda M, Kato M, Nakagawa A, Abe A, Iwasaki Y, et al. J Hepatobiliary Pancreat Sci. 2010;17(5):595-600
6	Aoki	Japan	J Hepatobiliary Pancreat Sci	2010	Prospective	Lap-cholecystectomy	14	ICG	12.5mg	IV	30 minutes preoperatively	Prototype (Hamamatsu)	NA	Visualization of the biliary anatomy	CyD (71%), CHD (-), CBD (71%), and CyD-CHD junction (-)	NA	NA	None	NA	NA		Aoki T, Murakami M, Yasuda D, Shimizu Y, Kusano T, Matsuda K, et al. J Hepatobiliary Pancreat Sci. 2010;17(5):590-4
7	Ishizawa	Japan	Surg Endosc	2011	Prospective	Single-incision laparoscopic cholecystectomy	7	ICG	2.5mg	IV	35-75 minutes before fluorescence imaging	Prototype (Hamamatsu)	NA	Visualization of the biliary anatomy	CyD (71% before dissection), CHD (100%), CBD (-), and CyD-CHD junction (100%)	NA	NA	None	NA	NA		Ishizawa T, Kaneko J, Inoue Y, Takemura N, Seyama Y, Aoki T, et al. Surg Endosc. 2011;25(8):2631-6.
8	Buchs	Switzerland	Int J Med Robot	2012	Prospective	Robotic single site cholecystectomy	12	ICG	2.5mg	IV	45 minutes before surgery	da Vinci Si HD	NA	Visualization of the biliary anatomy	CyD (92% before dissection/100% after dissection), CHD (33%/67%), CBD (50%/83%), and CyD-CHD junction	NA	NA	None	NA	NA		Buchs NC, Hagen ME, Pugin F, Volonte F, Bucher P, Schiffer E, et al. MRCAS. 2012;8(4):436-40
9	Kaneko	Japan	Surg Laparosc Endosc Percutan Tech	2012	Prospective	Lap-cholecystectomy	28	ICG	2.5mg for FC (0.05mg/kg was reinjected intravenously for	IV	15 minutes before surgery	Prototype (Hamamatsu)	NA	Visualization of the biliary anatomy and cystic artery	CyD (93%), CHD (96%), CBD (-%), and CyD-CHD junction (-) Cystic artery was identified in 89% cases	NA	NA	None	NA	NA		Kaneko J, Ishizawa T, Masuda K, Kawaguchi Y, Aoki T, Sakamoto Y, et al. Surg Laparosc Endosc Percutan Tech. 2012;22(4):341-4.
10	Scherwinter	US	J Gastrointest Surg	2012	Case report	Lap-cholecystectomy	1	ICG	1cm^3	IV	Prior to surgery	PINPOINT (Novadaq)	NA	Feasibility	Cystic duct visualized	CyD could be devided distal to the anomalous duct	NA	None	NA	NA		Sherwinter DA. J Gastrointest Surg. 2012;16(4):814-5
11	Calatayud	US	Liver Int	2012	Case report	Robot cholecystectomy	1	ICG	NA	IV	NA	da Vinci (Intuitive Surgery)	NA	Feasibility	Identification pf aberrant cannaliculus from segment VI to CBD	NA	NA	None	NA	NA		Calatayud D, Milose L, Elli, EF, Giulianotti PC. Liver International 2012;32(4):602-607
12	Schols	The Netherlands	Surg Endosc	2013	Prospective	Lap-cholecystectomy	15	ICG	2.5mg	IV	After induction of anesthesia	Imaging system (Karl Storz)	Fluorescence intensity	Time to identification of the biliary anatomy	CyD (100%), CHD (-), CBD (100%), and CyD-CHD junction (-) CBD and CyD could be identified significantly earlier using FC compared with WL imaging	NA	NA	None	NA	NA		Schols RM, Bouvy ND, Masclee AA, van Dam RM, Dejong CH, Stassen LP. Surg Endosc. 2013;27(5):1530-6
13	Spinoglio	Italy	Surg Endosc	2013	Prospective	Robotic single site cholecystectomy	45	ICG	2.5mg	IV	30-40 min prior to start of operation	da Vinci Fluorescent Imaging Vsion System	NA	Visualization of the biliary anatomy	CyD (93% before dissection/97% after dissection), CHD (88%/97%), CBD (91%/97%), and CyD-CHD junction	NA	NA	None	NA	NA		Spinoglio G, Priora F, Bianchi PP, Lucido FS, Licciardello A, Maglione V, et al. Surg Endosc. 2013;27(6):2156-62
14	Buchs	Switzerland	Surg Endosc	2013	Prospective	Robotic single site cholecystectomy	23 (+21 control)	ICG	2.5mg	IV	30-45 min prior to start of operation	da Vinci (Intuitive Surgery)	NA	Operative outcomes	NA	NA	The overall operative time was shorter for the FC group, especially for patients with a body mass index (BMI) equal or less than 25 (-24 min) but without reaching statistical significance (P=0.06). For BMI>25, no	None	NA	NA		Buchs NC, Pugin F, Azagury DE, Jung M, Volonte F, Hagen ME, et al. Surg Endosc. 2013;27(10):3897-901
15	Schols	The Netherlands	Surg Endosc	2013	Prospective	Lap-cholecystectomy	30	ICG	2.5mg	IV	After induction of anesthesia	Imaging system (Karl Storz)	Fluorescence intensity	Time to identification of the biliary anatomy	CyD (83%), CHD (-), CBD (87%), and CyD-CHD junction (-) CBD and CyD could be identified significantly earlier using FC compared with WL imaging	NA	NA	None	NA	NA		Schols RM, Bouvy ND, van Dam RM, Masclee AA, Dejong CH, Stassen LP. Surg Endosc. 2013;27(12):4511-7
16	Mohsen	Egypt	Surg Innov	2013	Case series	Lap-cholecystectomy	5	Fluorescein	7.5mg/kg	IV	After induction of pneumoperitoneum	Device designed by the authors	NA	Visualization of the biliary anatomy	100% (the extrahepatic ducts)	NA	NA	None	NA	NA		Mohsen AA, Elhasiouny MS, Fawzy YS. Surg Innov. 2013 Apr;20(2):105-8
17	Dip	US	Surg Endosc	2014	Prospective	Lap-cholecystectomy	43	ICG	0.05mg/kg	IV	1 hour prior to surgery	D-light P light-source unit (Karl Storz)	NA	Visualization of the biliary anatomy, cost	93% success rate; CyD (98% before dissection), CHD (58%), CBD (79%), and CyD-CHD junction (-)	NA	NA	None	NA	The costs per surgery generated by the use of IOC are greater than the costs of using FC (US$778.43 ± 0.40 vs.	FC was faster than IOC, with a mean time of 0.71 ± 0.26 and 7.13 ± 3.76 min, respectively (p < 0.0001).	Dip FD, Asbun D, Rosales-Velderrain A, Lo Menzo E, Simpfendorfer CH, Szomstein S, et al. Surg Endosc. 2014;28(6):1838-43
18	Prevot	France	J Gastrointest Surg	2014	Prospective	Lap-cholecystectomy	23	ICG	0.5mg/kg	IV	After induction of anesthesia	NIR 1 (Karl Storz)	NA	Visualization of the biliary anatomy	CyD (61% before dissection/100% after dissection), CHD (13%/48%), CBD (74%/78%), and CyD-CHD junction (48%/74%)	NA	NA	None	NA	NA		Prevot F, Rebibo L, Cosse C, Browet F, Sabbagh C, Regimbeau JM. J Gastrointest Surg. 2014;18(8):1462-8
19	Larsen	Denmark	Dan Med J	2014	Prospective	Lap-cholecystectomy	35	ICG	0.05mg/kg	IV	After induction of anesthesia	Laparoscopic Imaging System (Olympus)	NA	Visualization of the biliary anatomy	CyD (100%), CHD (100%), and CyD-CHD junction (100%)	An extra-hepatic aberrant bile duct entering into CHD was identified by FC and left intact in one case	NA	None	NA	NA		Larsen SS, Schulze S, Bisgaard T. Dan Med J. 2014;61(8):A4891
20	Daskalaki	US	Surg Innov	2014	Retrospective	Robotic cholecystectomy	184	ICG	2.5mg	IV	45 minutes before surgery	da Vinci (Intuitive Surgery)	NA	Visualization of the biliary anatomy	CyD (98%), CHD (94%), CBD (96%), and CyD-CHD junction (84%) An anatomical variation of the biliary tree was identified by FC in 5	NA	NA	None	NA	NA		Daskalaki D, Fernandes E, Wang X, Bianco FM, Elli EF, Ayloo S, et al. Surg Innov. 2014;21(6):615-21

21	Morita	Japan	Asian J Endosc Surg	2014	Case report	Full-thickness laparoscopic cholecystectomy	1	ICG	2.5mg	IV	After induction of anesthesia	Prototype (Olympus)	NA	Visualization of the biliary anatomy and boundaries between the liver and gallbladder	NA (boudaries between the liver and gallbladder bed was identified)	NA	NA	None	NA	NA		Morita K, Ishizawa T, Tani K, Harada N, Shimizu A, Yamamoto S, Takemura N, Kaneko J, Aoki T, Sakamoto Y, Sugawara Y, Hasegawa K, Kokudo N. Asian J Endosc Surg. 2014 May;7(2):193-5. doi: 10.1111/ases.12083
22	Osayi	US	Surg Endosc	2015	Prospective	Lap-cholecystectomy	82	ICG	2.5mg	IV	60 minutes prior to surgical incision	Infrared Fluo-rescence (IRF) Imaging System (Stryker)	NA	Visualization of the biliary anatomy		NA	NA	None	There was a learning curve effect associated with performing FC, with the first 41 cases requiring 2.7 ± 2.0 min compared to 1.2 ± 0.7 min for the final 41 cases (p <	NA	FC required 1.9 ± 1.7 min to complete compared to 11.8 ± 5.3 min for IOC (p < 0.001). In 20 patients where IOC could not be obtained, FC successfully identified biliary structures in 80 % of the cases. Comparison with IOC	Osayi SN, Wendling MR, Drosdeck JM, Chaudhry UI, Perry KA, Noria SF, et al. Surg Endosc. 2015;29(2):368-75
23	Dip	US	Surg Endosc	2015	Prospective	Lap-cholecystectomy	45	ICG	0.05mg/kg	IV	1 hour prior to surgery	D-light P light-source unit (Karl Storz)	NA	Visualization of the biliary anatomy	CyD (98%), CHD (60%), CBD (80%), and CyD-CHD junction (-)	NA	NA	None	NA	NA	No significant time difference between the two groups (0.77 ± 0.3 vs 0.65	Dip F, Roy M, Lo Menzo E, Simpfendorfer C, Szomstein S, Rosenthal RJ. Surg Endosc. 2015;29(6):1621-6
24	Boni	Italy	Surg Endosc	2015	Retrospective	Lap-cholecystectomy	52 (+56 other procedures)	ICG	0.04mg/kg	IV	At least 15 minutes before surgery	Laparoscopic system (Karl Storz)	NA	Visualization of the biliary anatomy	CyD (-), CHD (-), CBD (-), and CyD-CHD junction (100%)	NA	NA	None	NA	NA		Boni L, David G, Mangano A, Dionigi G, Rausei S, Spampatti S, et al. Surg Endosc. 2015;29(7):2046-55
25	van Dam	The Netherlands	J Laparoendosc Adv Surg Tech	2015	Prospective	Lap-cholecystectomy	30	ICG	0.05mg/kg	IV	After induction of anesthesia	Laparoscopic Imaging System (Olympus)	NA	Visualization of the biliary anatomy	CyD (33% before dissection/97% after dissection), CHD (-), CBD (67%/87%), and CyD-CHD junction (-) FC visualized the CBD and CyD in 11 minutes (P=.008) and 8.6 minutes (P=.001) earlier than with a conventional white light camera	NA	NA	None	NA	NA		van Dam DA, Ankersmit M, van de Ven P, van Rijswijk AS, Tuynman JB, Meijerink WJ. J Laparoendosc Adv Surg Tech A. 2015;25(6):486-92
26	Kono	Japan	Medicine	2015	Prospective	Lap-cholecystectomy	108	ICG	2.5mg	IV	Prior to surgery	Laparoscopic imaging systems (prototype, Olympus, Karl Storz, Novadaq)	Fluorescence intensity	Visualization of the biliary anatomy, optimal timing of ICG administration	CyD (81% before dissection/95% after dissection), CHD (87%/93%), CBD (-), and CyD-CHD junction (74%/92%) Accessory hepatic ducts were detected using FC after dissecting Calot's triangle in 9 of 10 cases.	FC allowed for visualization of gallstones in the CyD in 5 patients, leading to adjustment of CyD division.	NA	None	NA	NA	The interval between ICG injection and FC before dissection of Calot's triangle was significantly longer in the 80 patients in whom the CyD–CHD confluence was detected by fluorescence imaging before dissection (median, 90 min; range, 15–165 min) than in the remaining 28 patients in whom the confluence was undetectable (median, 47 min; range, 21–205 min; P<0.01). Enrichment factors	Kono Y, Ishizawa T, Tani K, Harada N, Kaneko J, Saiura A, Bandai Y, Kokudo N. Medicine (Baltimore). 2015 Jun;94(25):e1005.
27	Dip	US	Obes Surg	2016	Prospective	Lap-cholecystectomy	71	ICG	0.05mg/kg	IV	1 hour prior to surgery	D-light P light-source unit (Karl Storz)	NA	Visualization of the biliary anatomy in morbidly obese subjects	CyD (100% before dissection), CHD (70%), CBD (87%), and CyD-CHD junction (-) An accessory duct was seen in 7 cases No differences in CHD, CBD, and accessory duct visualization were detected in the obese and non-obese groups (p value 0.09, 0.16, and 0.66)	NA	NA	None	NA	NA	Comparison patients with BMI >30 and below 30.	Dip F, Nguyen D, Montorfano L, Noste MF, Lo Menzo E, Simpfendorfer C, et al. Obes Surg. 2016;26(3):525-30
28	Igami	Japan	Surg Today	2016	Prospective	Single-incision laparoscopic cholecystectomy	21	ICG	2.5mg	IV	After endotracheal intubation	D-light P light-source unit (Karl Storz)	NA	Visualization of the biliary anatomy	CyD (48% before dissection), CHD (81%), CBD (-), and CyD-CHD junction (71%)	NA	NA	None	NA	NA	The mean operative time for the patients in whom FC could identify the running course of the cystic duct before dissection in Calot's triangle was significantly shorter than those in whom it could not (68 ± 16 min (range 51–98 min) vs. 91 ± 35 min (range 45–153 min)).	Igami T, Nojiri M, Shinohara K, Ebata T, Yokoyama Y, Sugawara G, et al. Surg Today 2016 Dec;46(12):1443-1450.
29	Zroback	Canada	Am J Surg	2016	Retrospective	Lap-cholecystectomy	12	ICG	3.75mg	IV	In the preholding area	NA	NA	Visualization of the biliary anatomy and perceived benefit for surgeons	CyD (100%), CHD (50%), CBD (83%), and CyD-CHD junction (-)	NA	NA	Nonw	NA	NA	Lower detection rate in patients 83% of the surgeons strongly agreed that FC incorporated smoothly into the operation, 67% strongly agreed that the equipment was easy to set up, 92% strongly agreed that the equipment did not impede operating room space, 75%strongly agreed that FC facilitated identification of biliary anatomy, and 58% thought it was helnful in	Zroback C, Chow G, Meneghetti A, Warnock G, Melnyche M, Chiu CJ, et al. Am J Surg. 2016;211(5):933-7

30 Nojiri	Japan	Surg Laparosc Endosc Percutan Tech	2016	Case report	Single-incision laparoscopic cholecystectomy	1	ICG	2.5mg	IV	After endotracheal intubation	D-light P light-source unit (Karl Storz)	NA	Visualization of the biliary anatomy	The border of the lesion in the cystic duct was identified	Appropriate resection line could be set	NA	None	NA	NA		Nojiri M, Igami T, Tanaka H, Toyoda Y, Ebata T, Yokoyama Y, Sugawara G, Mizuno T, Yamaguchi J, Nagino M. Surg Laparosc Endosc Percutan Tech. 2016 Dec;26(6):e171-e173.
31 Zarrinpar	US	Surg Innov	2016	Prospective	Laparoscopic cholecystectomy and other hepatobiliary procedures	37	ICG	0.02-0.25 mg/kg	IV	10-180 min prior to planned visualization	PINPOINT (Novadaq)	Fluorescence intensity	Visualization of the biliary anatomy	Visualization of the extrahepatic biliary tract improved with increasing doses of ICG, with qualitative scores improving from 1.9 ± 1.2 (out of 5) with a 0.02-mg/kg dose to 3.4 ± 1.3 with a 0.25-mg/kg dose (P < .05 for 0.02 vs 0.25 mg/kg) Visualization was also significantly better with increased time after ICG administration (1.1 ± 0.3 for 10 minutes vs 3.4 ± 1.1 for 45 minutes, P <	NA	NA	None	NA	NA		Zarrinpar A, Dutson EP, Mobley C, Busuttil RW, Lewis CE, Tillou A, Cheaito A, Hines OJ, Agopian VG, Hiyama DT. Surg Innov. 2016 Aug;23(4):360-5.
32 Gangemi	US	J Robot Surg	2017	Retrospective	Robotic cholecystectomy	676 (+289 control)	ICG	2.5mg	IV	45 minutes prior to surgery	da Vinci (Intuitive Surgery)	NA	Reduction in open conversion rate	RC with FC resulted in the highest percentage of biliary anomalies identified (2.07 %).	NA	Statistically significant variations were found between RC with FC and LC in minor biliary injuries (p = 0.049), overall open conversion (p =< 0.001), open conversion in the acute setting (p = 0.002), and mean blood loss (p < 0.001). RC with FC resulted in the lowest percentages of major biliary injuries (0 %).	None	NA	NA		Gangemi A, Danilkowicz R, Elli FE, Bianco F, Masrur M, Giulianotti PC. J Robot Surg. 2017;11(1):77-82
33 Ankersmit	The Netherlands	Surg Innov	2017	Prospective	Lap-cholecystectomy	20	ICG	0.2mg/kg	IV	After induction of anesthesia	Laparoscopic Imaging System (Olympus)	NA	Visualization of the biliary anatomy	CyD (22% before dissection/72% after dissection), CHD (-), CBD (11%/39%), and CyD-CHD junction (-)	In 1 patient, conversion could be prevented by detecting the CD and CBD with FC before CVS was reached	NA	None	NA	NA		Ankersmit M, van Dam DA, van Rijswijk AS, van den Heuvel B, Tuynman JB, Meijerink W. Surg Innov. 2017;24(3):245-52
34 Boogerd	The Netherlands	Surg Innov	2017	Prospective	Lap-cholecystectomy	28	ICG	5mg (n=16) or 10 mg (n=12)	IV	30 minutes, 2h, 4h, 6h or 24h before surgery	D-light P light-source unit (Karl Storz)	Fluorescence intensity	Visualization of the biliary anatomy, optimal timing and dose of ICG administration	CyD (96%), CHD (-), CBD (-), and CyD-CHD junction (-) The highest bile duct-to-liver ratio was achieved 3 to 7 hours after administration of 5 mg and 5 to 25 hours after administration of 10 mg ICG	NA	NA	None	NA	NA		Boogerd LSF, Handgraaf HJM, Huurman VAL, Lam HD, Mieog JSD, van der Made WJ, et al. Surg Innov. 2017;24(4):386-96
35 Graves	US	J Laparoendosc Adv Surg Tech	2017	Prospective	Lap-cholecystectomy	11	ICG	0.25mg	Gallbladder injection	During surgery	Laparoscopic Imaging System (Stryker)	NA	Visualization of the biliary anatomy	CyD (91%), CHD (-), CBD (-), and CyD-CHD junction (91%)	NA	NA	None	NA	NA		Graves C, Ely S, Idowu O, Newton C, Kim S. J Laparoendosc Adv Surg Tech A. 2017 Oct;27(10):1068-1073.
36 Diana	France	Ann Surg	2017	Prospective	Robotic cholecystectomy	54	ICG	0.1-0.4mg/kg	IV	45 to 60 minutes before surgery	da Vinci Firefly (Intuitive Surgical)	NA	Visualization of the biliary anatomy	CyD (-), CHD (-), CBD (-), and CyD-CHD junction (98%) Mean time to obtain relevant images was shorter with FC versus augumented reality (P = 0.008) and versus IOC (P < 0.000000)	NA	NA	None	NA	NA	Image quality scores were lower with FC versus augumented reality (P = 0.018) and versus IOC (P < 0.0001).	Diana M, Soler L, Agnus V, D'Urso A, Vix M, Dallemagne B, et al. Ann Surg. 2017 Nov;266(5):890-897.
37 Maker	US	J Gastrointest Surg	2017	Prospective	Robotic cholecystectomy	35	ICG	2.5mg	IV	At the time of intubation	da Vinci Firefly (Intuitive Surgical)	NA	Visualization of the biliary anatomy	100%?	IOC or conversion to open was avoided in some cases	NA	None	NA	NA		Maker AV, Kunda N. J Gastrointest Surg. 2017 Nov;21(11):1961-1967
38 Roy	US	Surg Endosc	2017	Prospective	Lap-cholecystectomy	10	ICG	0.05mg/kg	IV	Before surgery	D-light P light-source unit (Karl Storz)	NA	Identification of the biliary anatomy by students and residents	NA	NA	NA	None	Subjects identified the biliary anatomy more accurately with a use of fluorescence cholangiography than	NA		Roy M, Dip F, Nguyen D, Simpfendorfer CH, Menzo EL, Szomstein S, Rosenthal RJ. Surg Endosc. 2017 Jun;31(6):2483-2490.
39 Liu	Taiwan	Surg Endosc	2018	Prospective	Lap-cholecystectomy	46	ICG	10mL (1.25mg/mL)	Gallbladder injection	During surgery	D-light P light-source unit (Karl Storz)	NA	Visualization of the relevant biliary structures	In patients with cholecystitis, 84% visualization of Hartmann's pouch prior to dissection, 68-84% visualization of the extrahepatic ducts after dissection, which were significantly better than	NA	NA	None	NA	NA	In cases of lithiasis with no inflammation, NIR cholecystocholangiography visualization rate was similar to that of White Light observation.	Liu YY, Liao CH, Diana M, Wang SY, Kong SH, Yeh CN, et al.Surg Endosc. 2018 Mar;32(3):1506-1514.
40 Hiwatashi	Japan	Medicine	2018	Prospective	Lap-cholecystectomy	65	ICG	2.5mg	IV	2 hours before surgery	D-light P light-source unit (Karl Storz)	Fluorescence intensity	Delineation of the extrahepatic biliary anatomy	CyD (83.1%)	NA	NA	None	NA	NA	Presence of cholecystitis decreased the identification of the cystic duct by fluorescence cholangiography	Hiwatashi K, Okumura H, Setoyama T, Ando K, Ogura Y, Aridome K, Maenohara S, Natsugoe S. Medicine (Baltimore). 2018 Jul;97(30):e11654.
41 Tsutsui	Japan	Asian J Endosc Surg	2018	Prospective	Lap-cholecystectomy	72	ICG	25mg	IV	Immediately before surgery, 3h, 6h, 12h, 15h, 18h, or 24h before surgery	PINPOINT (Novadaq)	Fluorescence intensity	Optimal timing of ICG administration	The proportion of cases in which evaluators classified the visibility of the gallbladder and bile ducts as grade A (best visibility) reached a peak in the 15h group and decreased thereafter	NA	NA	None	NA	NA		Tsutsui N, Yoshida M, Nakagawa H, Ito E, Iwase R, Suzuki N, et al. Asian J Endosc Surg. 2018 Aug;11(3):199-205.
42 Sharma	US	J Robot Surg	2018	Retrospective	Robotic cholecystectomy	96 (+ 191 lap-cholecystectomies without fluorescence cholangiography)	ICG	NA	IV	NA	da Vinci Firefly (Intuitive Surgical)	NA	Incidence of open conversion	NA	Fewer open conversions were found in the robotic cholecystectomy with FC than the laparoscopic group [2 (2.1%) vs. 17 (8.9%), p = 0.03]. In multiple logistic regression, robotic cholecystectomy with FC also showed a lower risk of conversion compared to laparoscopic cholecystectomy, but the difference did not reach statistical significance (OR 0.42, 95% CI 0.11–1.65, p = 0.22).	Hospital stay was significantly shorter in the robotic cholecystectomy with FC group than the laparoscopic group (3.0 vs. 1.6, p < 0.001).	None	NA	NA	Total OR time was significantly shorter in the laparoscopic group than the robotic with FC group (98.2 vs. 115.7, p	Sharma S, Huang R, Hui S, Smith MC, Chung PJ, Schwartzman A, et al. J Robot Surg. 2018 Sep;12(3):481-485.
43 Dip	US, Argentina, Germany, Italy, Japan	Ann Surg	2019	RCT (8 centers)	Lap-cholecystectomy	321 (+ 318 control)	ICG	0.05 mg/kg	IV	At least 45 min before surgery	Image 1 S system with OPAL1 technology (Karl Storz)	NA	Visualization of the biliary anatomy	Frozen-section detection rates were significantly superior in the fluorescence cholangiography group for all 7 biliary structures, ranging from 9.1% versus 2.9% to 66.6% versus 36.6% for the right hepatic duct (RHD) and cystic duct (CD), respectively, with odds ratios ranging from 2.3 (95% CI 1.6-3.2) for the cystic-gallbladder junction to 3.6 (1.6-9.3)	NA	2 patients in the control group sustained a biliary duct injury	None	NA	NA		Dip F, LoMenzo E, Sarotto L, Phillips E, Todeschini H, Nahmod M, Alle L, Schneider S, Kaja L, Boni L, Fermina P, Carus T, Kokudo N, Ishizawa T, Walsh M, Simpfendorfer C, Mayank R, White K, Rosenthal RJ. Ann Surg. 2019 Dec;270(6):992-999

44	Yoshiya	Japan	World J Surg	2019	Retrospective	Lap-cholecystectomy following preoperative percutaneous transhepatic gallbladder drainage	39 (+ 91 control)	ICG	2.5mg	IV	After induction of anesthesia	Image 1 SPIES system (Karl Storz)	NA	Operative outcomes	NA	Patients with fluorescence cholangiography had a markedly lower conversion rate (2.6% vs. 22.0%, p = 0.0017) and lower proportion of subtotal cholecystectomy (0.0% vs. 6.6%, p = 0.0359) than patients without ICG fluorescence imaging.	Patients with fluorescence cholangiography had a significantly shorter operative time (129 ± 46 vs. 150 ± 56 min, p = 0.0455).	None	NA	NA		Yoshiya S, Minagawa R, Kamo K, Kasai M, Taketani K, Yukaya T, Kimura Y, Koga T, Kai M, Kajiyama K, Yoshizumi T. World J Surg. 2019 Jan;43(1):127-133. doi: 10.1007/s00268-018-4760-1
45	Esposito	Italy	Pediatr Surg Int	2019	Case series	Lap-cholecystectomy (pediatric)	5 (+41 other procedures)	ICG	0.4mg/kg	IV	18h prior to the procedure	Image 1 S system with D-LIGHT P (Karl Storz)	NA	Visualization of the biliary anatomy	100%	NA	NA	None	NA	NA		Esposito C, Del Conte F, Cerulo M, Gargiulo F, Izzo S, Esposito G, Spagnuolo MI, Escolino M. Pediatr Surg Int. 2019 Oct;35(10):1043-1060
46	Esposito	Italy	J Laparoendosc Adv Surg Tech A	2019	Retrospective	Lap-cholecystectomy (pediatric)	15 (+200 control)	ICG	0.4mg/kg	IV	18h prior to the procedure	Image 1 S system with D-LIGHT P (Karl Storz)	NA	Operative outcomes	100%	NA	The average operative time was 69 minutes and fell down to 52 minutes after introduction of ICG fluorescence (P = .001).	None	NA	NA		Esposito C, Corcione F, Settimi A, Farina A, Centonze A, Esposito G, Spagnuolo MI, Escolino M. J Laparoendosc Adv Surg Tech A. 2019 Nov;29(11):1185-1191
47	Iwasaki	Japan	Int J Surg Case Rep	2019	Case report	Open cholecystectomy with full thickness dissection	1	ICG	2.5mg	IV	Prior to surgery	NA	NA	Feasibility	Aberrant subvesical bile duct was successfully identified	Ligation of the aberrant subvesical bile duct	No postoperative bile leak	None	NA	NA		Iwasaki T, Takeyama Y, Yoshida Y, Kawaguchi K, Matsumoto M, Marase T, Kamei K, Takebe A, Matsumoto I, Nakai T. Int J Surg Case Rep. 2019;61:115-119.
48	Fernández-Bautista	Spain	European J Pediatr Surg Rep	2019	Case report	Lap-cholecystectomy (pediatric)	1 (+4 other procedures)	ICG	0.2mg/kg	IV	NA	A high-definition camera (10 mm) (Stryker)	NA	Feasibility	The extrahepatic biliary anatomy was identified	NA	NA	None	NA	NA		Fernández-Bautista B, Mata DP, Parente A, Pérez-Caballero R, De Agustín JC. European J Pediatr Surg Rep. 2019 Jan;7(1):e43-e46.
49	Kitamura	Japan	Int J Surg Case Rep	2019	Case report	Lap-cholecystectomy	1	ICG	2.5mg	IV	Following Induction of anesthesia	D-light P system (Karl Stozr)	NA	Feasibility	The unexpected subvesical bile ducts were identified	Ligation of the aberrant subvesical bile ducts	No postoperative bile leak	None	NA	NA		Kitamura H, Tsuji T, Yamamoto D, Takahashi T, Kadoya S, Kurokawa M, Bando H. Int J Surg Case Rep. 2019;57:194-196.
50	Ambe	Germany	Patient Saf Surg	2019	Retrospective	Lap-cholecystectomy	29 (+41 control)	ICG	0.5 mL	IV	1h prior to surgery	PINPOINT (Novadaq)	NA	Operative outcomes	NA	The rate of conversion was 2.4% in the group without ICG, while no conversion was performed in the group with ICG.	The median duration of surgery was 53.0 vs. 54.0 min while the median length of stay was 2.0 d in the group with and without ICG respectively (statistically not significant).	None	NA	NA		Ambe PC, Plambeck J, Fernandez-Jeiberg V, Zarras K. Patient Saf Surg. 2019 Jan 12;13:2. doi: 10.1186/s13037-019-0187-8
51	Wang	China	J Int Med Res	2020	Retrospective	Lap-cholecystectomy	34 (+36 control)	ICG	2.5mg	IV	30min prior to laparoscopic procedure	PINPOINT (Novadaq)	NA	Identification of the extrahepatic biliary anatomy and operative outcomes	100% success rate CyD (91% before dissection), CHD (53%), CBD (79%), and CyD-CHD junction (-)	NA	The median operation time and intraoperative blood loss were not significantly different between the two groups.	None	NA	NA	Fluorescence cholangiography was more effective for visualizing biliary structures in patients with a BMI of <25 than >25 kg/m²	Wang C, Peng W, Yang J, Li Y, Yang J, Hu X, Xia L, Zhang L, Zhong Y, Qiao L, Pan W. J Int Med Res. 2020 Dec;48(12):300060520979922
52	Koong	Malaysia	Asian J Surg	2020	RCT	Lap-cholecystectomy	30 (+33 control)	ICG	2.5mg	IV	Before induction of anesthesia	Near infrared camera (Karl Storz)	NA	Early identification of critical view of safety (CVS)	Mean time (min) to achieve CVS was 22.3 ± 12.9 in FC-LC (n = 30) and 22.8 ± 14.3 in conventional LC (p = 0.867).	NA	NA	None	NA	The total saving for each patient after deduction of the shared ICG is MYR 176.00 (USD 40.00)	FC-LC reduces time to CVS across all difficulty levels but not statistically significant.	Koong JK, Ng GH, Ramayah K, Koh PS, Yoong BK. Asian J Surg. 2021 Mar;44(3):537-543. doi: 10.1016/j.asjsur.2020.11.002. Epub 2020 Nov 19.
53	Matsumura	Japan	J Hepatobiliary Pancreat Sci	2020	Prospective	Lap-cholecystectomy	20	ICG	2.5 mg or 0.25 mg/kg	IV	After intubation (2.5mg, surgery-day group) or in the evening before surgery (0.25mg/kg, one-day-before group)	PINPOINT (Novadaq)	NA	Signal to background ratio	CBD-Liver, 0.6–1.2 vs 2.5, 0.9 = -4.8; P < .001), and CBD–HDL contrast (1.7, 1.4–2.4 vs 2.3, 1.5–13.3; P = .038) were significantly higher in the one-day-before group than in the surgery-day group.	NA	NA	None	NA	NA		Matsumura M, Kawaguchi Y, Kobayashi Y, Kobayashi K, Ishizawa T, Akamatsu N, Kaneko J, Arita J, Kokudo N, Hasegawa K. J Hepatobiliary Pancreat Sci. 2020 Oct 22. doi: 10.1002/jhbp.855.
54	Di Maggio	UK	Surg Innov	2020	Prospective	Lap-cholecystectomy (emergency)	33 (+24 control)	ICG	0.25 mg	IV	30 min prior to surgery	4K laparoscopic stack with NIR technology provided by Olvmmas	NA	Length of hospital stay, conversion to open and complications rate	NA	NA	Fluorescence cholangiography group had the same post-operative hospitalisation and complications rate of the control group, with a shorter operating time	None	NA	NA		Di Maggio F, Hossain N, De Zanna A, Husain D, Bonomo L. Surg Innov. 2020 Sep 16:1553350620958562.
55	Škrabec	Spain	Langenbecks Arch Surg	2020	Retrospective	Lap-cholecystectomy	20 (+20 control)	ICG	0.25 mg/mL	Gallbladder injection	During surgery	EndoEye (Olympus)	NA	Visualization of the biliary anatomy and operative outcomes	CyD (100%), CHD (-), CBD (-), and CyD-CHD junction (50%)	NA	No significant differences neither in the operative time nor in the length of stay.	None	NA	NA	Compared with lap-cholecystectomy without FC	Genzé Škrabec C, Pardo Aranda F, Espín F, Cremades M, Navinés J, Zárate A, Cugat E. Langenbecks Arch Surg. 2020 Sep;405(6):857-857
56	Nitta	Japan	Ann Med Surg (Lond)	2020	Case report	Lap-cholecystectomy	1	ICG	0.0025 mg/mL	Gallbladder injection	During surgery	NA	NA	Feasibility	CyD identified	NA	NA	None	NA	NA		Nitta T, Kataoka J, Ohta M, Ueda Y, Senpuku S, Kurashima Y, Shimizu T, Ishibashi T. Ann Med Surg (Lond). 2020 Aug 8;57:218.
57	Turcotte	US	Surgery	2020	Retrospective	Lap-cholecystectomy (emergency)	105 (+93 control)	ICG	2.5mg	IV	Before surgery	1588 system (Stryker)	NA	The rate of bail-out operation (subtotal cholecystectomy or conversion to an open operation)	CyD (33% in non-acute cholecystitis / 21% in acute cholecystitis), CHD (-), CBD (70%/63%), and CyD-CHD junction (-)	The rate of bail-out operation was not different between patients with FC (6.7%) and those without FC (4.3%, P = .468).	Those patients with FC did have a decreased duration of stay (74 hours vs 107 hours, P = .031). No significant differences in complications were observed.	None	NA	NA		Turcotte J, Leydorf SD, Ali M, Feather C, Klune JR. Indocyanine green does not decrease the need for bail-out operation in an acute care surgery population. Surgery. 2021 Feb;169(2):757-761
58	Asai	Japan	ANZ J Surg	2020	Case report	Single-incision laparoscopic cholecystectomy	1	ICG	NA	IV	NA	NA	NA	Feasibility	Cystohepatic duct identified	NA	NA	None	NA	NA		Asai Y, Igami T, Ebata T, Yokoyama Y, Mizuno T, Yamaguchi J, Onoe S, Watanabe N, Nagino M. ANZ J Surg. 2020 Jul 18. doi: 10.1111/ans.16167
59	Esposito	Italy	Front Pediatr	2020	Prospective	Lap-cholecystectomy (pediatric)	12	ICG	0.4mg/kg	IV	15-18h before surgery	Image 1 S system (Karl Storz)	NA	Feasibility	92% success rate	NA	NA	None	NA	NA		Esposito C, Settimi A, Del Conte F, Cerulo M, Coppola V, Farina A, Crocetto F, Ricciardi E, Esposito G, Escolino M. Front Pediatr. 2020 Jun 17;8:314. doi: 10.3389/fped.2020.00314
60	Calabro	US	J Laparoendosc Adv Surg Tech A	2020	Prospective (2 centers)	Lap-cholecystectomy (pediatric)	31	ICG	2.5mg	IV	Before trocar placement		NA	Visualization of the biliary anatomy	CyD (-), CHD (-), CBD (-), and CyD-CHD junction (100%)	NA	NA	None	NA	NA		Calabro KA, Harmon CM, Vali K. J Laparoendosc Adv Surg Tech A. 2020 May;30(5):586-589
61	Rungsakulkij	Thailand	World J Gastrointest Surg	2020	Case series	Lap-cholecystectomy	5	ICG	2.5mg	IV	15min before skin incision	NA	NA	The benefit of FC for enhancing identification skills of surgical residents	NA	NA	NA	None	In the without-FC phase, the overall misidentification rate by SRs (21.7%) was greater than that of the SS (11.8%; P = 0.018), However, in the FC phase, the two groups did not significantly differ in misidentification rates (23.3% vs 23.3%, P =	NA		Rungsakulkij N, Thewmorakot S, Suragul W, Vassanasiri W, Tangtawee P, Muangkaew P, Mingphruedhi S, Aeesoa S. World J Gastrointest Surg. 2020 Mar 27;12(3):93-103.

62	Jao	Taiwan	Int J Surg Case Rep	2020	Case series	Lap-cholecystectomy	2	ICG	12.5mg/5mL	Gallbladder injection (through PTGBD tube)	During surgery	Image 1 S system (Karl Storz)	NA	Feasibility	100% visualization of CVS	NA	NA	None	NA	NA		Jao ML, Wang YY, Wong HP, Bachhav S, Liu KC. Int J Surg Case Rep. 2020;68:193-197.
63	Lehrskov	Denmark	Br J Surg	2020	RCT	Lap-cholecystectomy	60 (+60 control)	ICG	0.05 mg/kg	IV	Immediately after induction of anaesthesia	S343020 (Olympus)	NA	Visualization of the critical junction between the CyD, CHD, and CBD (non-inferiority trial)	No difference between the fluorescence and X-ray cholangiography groups in ability to visualize the critical junction (49 of 60 versus 51 of 60 respectively; P = 0·230). FC was faster by a few minutes: median 2·0 (range 0·5–5·0) versus 4·8 (1·3–17·6) min (P < 0·001).	NA	NA	None	NA	NA	There was a significant intergroup difference in surgeon-reported ease of cholangiography performance: mean(s.d.) 1·90(0·89) and 2·36(1·03) for FC and X-ray cholangiography respectively (95 per cent c.i. for difference −0·82 to	Lehrskov LL, Westen M, Larsen SS, Jensen AB, Kristensen BB, Bisgaard T. Br J Surg. 2020 May;107(6):655-661
64	Bleszynski	Canada	Surg Innov	2020	Prospective	Lap-cholecystectomy	108	ICG	4mg	IV	After endotracheal tube placement	NA	NA	Identification of biliary structures	The identification rate were 90%, 84%, and 48% for the CD, CBD, and CHD	NA	NA	None	NA	NA		Bleszynski MS, DeGirolamo KM, Meneghetti AT, Chiu CJ, Panton ON. Surg Innov. 2020 Feb;27(1):84-91.
65	Datta	Germany	Surg Endosc	2020	Case series	Single-incision laparoscopic cholecystectomy using symphonX	9 (+3 cases without FC)	ICG	5mg	IV	3h before surgery	1588 system (Stryker)	NA	Feasibility	NA	NA	NA	None	NA	NA	FC was used to assure safety of LC with a new surgical device	Datta RR, Dieplinger G, Wahba R, Kleineri R, Thomas M, Gebauer F, Schiffmann L, Stippel DL, Bruns CJ, Fuchs HF. Surg Endosc. 2020 Jun;34(6):2773-2779.
66	Pesce	Italy	Surg Endosc	2020	Retrospective	Lap-cholecystectomy	26	ICG	0.5mg/kg	IV	30-45 min prior to surgery	D-light P light-source unit (Karl Storz)	NA	Effectiveness of FC in the detection of CyD-CHD anatomy intra-operatively in comparison with pre-operatiise MRCP.	86.9% accuracy for the visualization of CyD. The level of insertion, course, and wall implantation of cystic duct were achieved by FC with diagnostic accuracy values of 65.2%, 78.3%, and 91.3%, respectively	NA	NA	None	NA	NA		Pesce A, La Greca G, Esposto Ultimo L, Basile A, Puleo S, Palmucci S. Surg Endosc. 2020 Jun;34(6):2715-2721.
67	Agnus	Italy, France The Netherlands, Spain, Lithuania, Switzerland	Surg Endosc	2020	Retrospective (registry, 12 centers)	Lap- and robotic cholecystectomy	314	ICG	0.3 mg/kg (median, ranging from 0.02 to 0.62 mg/kg)	IV (gallbladder injection in 2 cases)	57 min (median, ranging from 1 min to more than 2 days (3120 min) before observation	D-Light P (Karl Storz) Firefly (Surgical Intuitive), SPY (Stryker), Pinpoint (Novadaq)	NA	Visualization of the extrahepatic biliary tract, operative outcomes	CyD (88% before dissection/97% after dissection), CHD (59%/69%), CBD (-), and CyD-CHD junction (76%/87%) At multivariate analysis, pathology and timing remained significant factors affecting the visualization scores of all three structures, whereas ICG dose remained correlated with HD visualization only.	NA	NA	None	NA	NA	Visualization scores before dissection were significantly correlated, at univariate analysis, with ICG timing (all structures), ICG dose (CD-CBD), device (CD and CD-CBD), surgeon (CD and CD-CBD), and pathology (CD and CD-CBD). BMI	Agnus V, Pesce A, Boni L, Van Den Bos J, Morales-Conde S, Paganini AM, Quaresima S, Balla A, La Greca G, Plaudis H, Moretto G, Castagnola M, Santi C, Casali L, Tartaruella L, Saadi A, Picchetto A, Arezzo A, Mutrescaux J, Diana M. Surg Endosc. 2020 Sep;34(9):3888-3896.
68	Quaresima	Italy	Surg Endosc	2020	Prospective	Lap-cholecystectomy	44 (+44 control)	ICG	3.5-13.5mg	IV (gallbladder injection in 2 cases)	10.7 h (mean, ranging 2–52h) before surgery	Image 1S D-Light system (Stryker)	NA	Visualization of the extrahepatic biliary tract, operative outcomes	CyD (95% before dissection/95% after dissection), CHD (90%/98%), CBD (90%/98%), and CyD-CHD junction (80%/80%)	NA	Mean operative time was 86.9 ± 36.9 (30–180) min in FC group and 117.9 ± 43.4 (40–220) min in IOC group (p = 0.0006).	None	NA	NA		Quaresima S, Balla A, Palmieri L, Seitaj A, Fingerhut A, Ursi P, Paganini AM. Surg Endosc. 2020 May;34(5):1959-1967.

NA, Not available or not assessed