Supplementary Table 4: Ureterography

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	Verbeek	The Netherlands	J Urol	2013	Prospective	Gynaecology and urology patients undergoing open pelvic surgery	12	Methylene blue	0.25-1mg/kg	IV	After exposure of the ureters as part of the pelvic dissection. Imaging was performed for up to 60 minutes after injection.	NIR imaging using Mini-FLARE system	Fluorescence intensity	Visualization of the ureters	100% The mean signal-to-background ratio of the ureter was 2.27 ± 1.22 (N = 4), 2.61 ± 1.88 (N = 4) and 3.58 ± 3.36 (N = 4) for the 0.25, 0.5 and 1 mg/kg doses, respectively	NA	NA	None	NA	NA		Verbeek FP, van der Vorst JR, Schaafsma BE, Swijnenburg RJ, Gaarenstroom KN, Elzevier HW, van de Velde CJ, Frangioni JV, Vahrmeijer AL. J Urol. 2013 Aug;190(2):574-9
2	Lee	US	Urology	2013	Retrospective	Robot-assisted ureteroureterostomy	7	ICG	25 mg in 10 mL distilled water	Ureteral catheter or percutaneous nephrostomy tube or both	After insertion of the catheter or at the time of retrograde pyelography	NIR modality on da Vinci Si	NA	Localize ureteral stenosis in real time; real-time delineation of the ureter and discernment of healthy from diseases tissue	100%	Tension-free anastomosis was achieved in all 7 patients	No evidence of stricture recurrence at follow-up	None	CT urogram was performed 2 weeks and 3, 6, and 12 months after surgery to confirm patency of the ureters and support the surgeon's learning	NA		Lee Z, Simhan J, Parker DC, Reilly C, Llukani E, Lee DI, et al. Urology. 2013 Sep;82(3):729-33
3	Siddighi	US	Am J Obstet Gynecol	2014	Prospective	Robot-assisted laparoscopic sacrocolpopexy	>10 (exact number not stated)	ICG	25 mg in 10 mL sterile water	Ureteral catheter (both sides)	Intermittently throughout the procedure	NIR modality on da Vinci Si	NA	Localize the ureter intraoperatively to prevent iatrogenic ureteral injury during pelvic surgery	100% (although there were some variations in brightness owing to the depth of the ureter from the peritoneal surface)	NA	NA	None	NA	$100 for ICG		Siddighi S, Yune JJ, Hardesty J. Am J Obstet Gynecol. 2014 Oct;211(4):436.e1-2
4	Lee	US	Eur Urol	2015	Retrospective	Robot-assisted ureteral reconstruction	26 , 26 ureteral reconstructions (8our ureterolysis procedures, eight pyeloplasty procedures, nine ureteroureterostomy procedures, and five ureteroneocystostomy procedures)	ICG	25 mg in 10 mL sterile water	Ureteral catheter or percutaneous nephrostomy tube or both	After insertion of the catheter and when needed during the procedure to localize the margins of ureteral strictures	NIR modality on da Vinci Si	NA	Localize the margins of ureteral strictures	100%	Imaging aided in successful performance of all 26 procedures	No postoperative complications within 12 months of surgery	None	NA	$50 for ICG and 20 minutes of extra operating time		Lee Z, Moore B, Giusto L, Eun DD. Eur Urol. 2015 Feb;67(2):291-8
5	Lee	US	Korean J Urol	2015	Case report	Robotic partial nephroureterectomy in a patient with complete ureteral triplication	1	ICG	25 mg in 10 mL distilled water	Intraureteral (by catheter) and IV	After pyelography (intraureteral) and after transecting the renal artery and vein (intravenous)	NIR modality on da Vinci Si	NA	Facilitate real-time imaging of pathologic ureter and renal pelvis (intraureteral) and to assess perfusion in the kidney and delineate diseased renal parenchyma (intravenous)	All endpoints of interest were identified successfully	NA	NA	None	NA	NA		Lee M, Lee Z, Eun D. Korean J Urol. 2015 Jun;56(6):473-6
6	Al-Taher	The Netherlands	J Laparoendosc Adv Surg Tech A	2016	Prospective	Laparoscopic colorectal surgery	10	Methylene blue	Between 0.125 and 1 mg/kg	IV	Preoperative (during administration of anesthesia) and before the first trocar	Laparoscope with fluorescence imaging	Highest contrast was detected at doses between 0.75 and 1 mg/kg; target to background ratio was between 6 and 9 in the 4 patients where fluorescence visualization was successful Maximum fluorescence was detected between 9 and 20 minutes after administration (mean: 14.4 minutes); mean signal to background ratio was 7.54	Assess feasibility of imaging the ureter with methylene blue during laparoscopic colorectal surgery	Successful visualization in 5 of the 10 patients (50%)	NA	NA	None	NA	NA	Fluorescent signal was only visible after the ureter had already been visualized successfully under a conventional white light from the laparoscope, so the imaging did not add clinical value	Al-Taher M, van den Bos J, Schols RM, Bouvy ND, Stassen LP. J Laparoendosc Adv Surg Tech A. 2016 Nov;26(11):870-875
7	Yeung	UK	Ann Surg	2016	Case series	Laparoscopic and open colorectal surgery	8 (6 laparoscopic and 2 open colorectal surgery)	Methylene blue	Between 0.25 and 1 mg/kg at a concentration of 10 mg/mL	IV, slow infusion over 5 minutes	During surgery	In-house device at 660 nm excitation		Compare ureter identification under white light illumination versus fluorescence of methylene blue and quantify the signal to background ratio for methylene blue	10 of the 11 ureters were successfully visualized	The authors considered the methylene blue technique useful in only 4 of the patients; the methylene blue interfered with pulse oximetry readings	NA	None	NA	NA	1 mg/kg methylene blue yielded the strongest fluorescence signal	Yeung TM, Volpi D, Tullis ID, Nicholson GA, Buchs N, Cunningham C, et al. Ann Surg. 2016 Jan;263(1):e1-2
8	Morozov	Russia	Urologia	2017	Case report	Retropubic and lymph node dissection, partial nephrectomy, and ureteroplasty	10 (4 retropubic and lymph node dissection procedures, 5 partial nephrectomy procedures, and 1 ureteroplasty)	ICG	2.5 mg/mL, using 3-5 mL, except for retropubic and lymph node dissection patients, who received 0.25 mg/kg	Transrectally (during retropubic procedure), intravenously (during partial nephrectomy), and by injection into the renal pelvis during ureteroplasty	Immediately before surgery in the case of retropubic and lymph node dissection; after surgery began for partial nephrectomy and ureteroplasty	SPY Elite (Novadaq)	NA	Assess the lymph nodes, differentiate tumor from parenchyma, and localize ureter strictures	Sensitivity was 100% and specificity was 73.3%	NA	NA	None	NA	NA		Morozov AO, Alyaev YG, Rapoport LM, Tsarichenko DG, Berzinkov EA, Butnaru DV, et al. Urologia. 2017 Aug 1;84(3):197-202
9	Barnes	UK	Surg Endosc	2018	Prospective	Elective colorectal surgery (laparoscopic or open)	42 (69 ureters)	Methylene blue	Between 0.25 and 1 mg/kg at a concentration of 10 mg/mL	IV, slow infusion over 5 minutes	10-15 minutes before the procedure	PINPOINT Deep Red laparoscopic system	Signal to background ratio declined more rapidly with the lowest dose (0.25 mg/kg)	Localize the ureter intraoperatively	64 of the 69 ureters were visualized successfully (14 of these were not visible under white light)	In 10 cases, imaging showed the ureter to be in a different place from the presumed location	NA	None	NA	$90 for the methylene blue and the imaging system is expensive	Visualization was useful only in laparoscopic cases, not in open surgeries	Barnes TG, Hompes R, Birks J, Mortensen NJ, Jones O, Lindsey I, et al. Surg Endosc. 2018 Sep;32(9):4036-4043
10	Lee	US	World J Urol	2019	Case series	Robotic ureteroenteric reimplantation (benign anastomotic strictures)	8 (10 procedures)	ICG	25 mg in 10 mL distilled water	Injection antegrade and/or retrograde into the lumen of the ureter and retrograde into the lumen of the urinary diversion	Beginning of surgery	NIR modality on da Vinci Si or Xi	NA	Identify the strictured ureter and urinary diversion and localize stricture margins	Not reported (presumably 100%)	NA	3 of the 8 patients suffered a minor postoperative complication within 90 days of surgery; 2 of the 8 patients suffered a major postoperative complication within 90 days of surgery	None	NA	NA	Although ICG is a good and safe tool, robotic ureteroenteric reimplantation is a difficult procedure with morbidity	Lee Z, Sterling ME, Keehn AY, Lee M, Metro MJ, Eun DD. World J Urol. 2019 Jun;37(6):1211-1216
11	Farnam	US	J Biomed Opt	2019	Prospective	Hysterectomy	24	IS-001	10, 20, or 40 mg	IV over 1 minute	NA	NIR modality on da Vinci Si or Xi	Ureter to background signal did not vary between dose groups	Ureter visualization during hysterectomy	Fluorescence varied even within dose groups but imaging was successful in all patients	NA	4 adverse events not typical of hysterectomy were observed in 2 subjects who received the lowest dose (10 mg); these events were deemed by the investigators not related to the dye (headache, neck pain, urinary tract infection, and device site pain)	None	NA	NA		Farnam RW, Arms RG, Klaassen AH, Songer JM. J Biomed Opt. 2019 Jun;24(6):1-8

12	Huh	US	J Minim Invasive Gynecol	2020	Prospective	Minimally invasive (gynecologic) pelvic surgery	41		Nerindocianine	0.06, 0.12, and 0.045 mg/kg	IV	NA	PINPOINT system and AIM endoscope	NA	Image the ureter and compare imaging systems (degree of concordance between laparoscopic and robotic devices)	Visualization was successful in 88.9% of cases	NA	Vaginal hemorrhage, abdominal pain, nausea, constipation	None	NA	NA	No difference in scores between the PINPOINT system and the AIM endoscope	Huh WK, Johnson JL, Elliott E, Boone JD, Leath CA 3rd, Kovar JL, et al. J Minim Invasive Gynecol. 2020 Jun 29:S1553-4650(20)30323-X
13	Ryu	Japan	Surg Oncol	2020	Retrospective	Laparoscopic left-sided colon and rectal cancer	59		Near-infrared fluorescent resin and ICG	Not reported	IV for ICG; the resin was incorporated into the clip and catheters	NA	VISERA ELITE II (Olympus)	NA	Determine usefulness of fluorescence imaging in surgeries involving colorectal cancer	Fluorescence of the resin-impregnated clip could not be observed in 1 case (the clip was probably hidden under a layer of fat); fluorescence was successful in all ICG cases	In 5 cases, the ICG data changed the surgical plan	No postoperative leakage or stoma necrosis occurred in the 5 cases where ICG changed the surgical plan; in other patients, there was 1 case of ureter injury and 1 case of abdominal abscess formation	None	NA	NA		Ryu S, Ishida K, Okamoto A, Nakashima K, Hara K, Ito R, et al. Surg Oncol. 2020 Dec;35:434-440
14	White	US	Colorectal Dis	2020	Prospective	Robot-assisted colorectal surgery	16		ICG	5 mL of 2.5 mg/mL	Ureteral catheter, with instillation time of 4-21 minutes (median: 11.5 minutes)	After catheter advancement (no more details given)	da Vinci	NA	Identify the ureter to avoid it during surgery	15 of 16 patients were successfully imaged (1 patient had severe inflammation in the area and so the ICG infiltrated the surrounding tissue)	NA	1 case of acute kidney injury and 1 case of prostatic bleeding; 3 cases of utinary tract infections within 1 month of surgery	None	NA	$100 for ICG per procedure		White LA, Joseph JP, Yang DY, Kelley SR, Mathis KL, Behm K, et al. Colorectal Dis. 2020 Oct 16

NA, Not available or not assessed