



COMPENDIUM ON  
AESCULAP® *EinsteinVision*® 3.0 FI



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# SEE BETTER. SEE BEYOND.

*EinsteinVision*® 3.0 FI - 3D Fluorescence Imaging in real-time



# TAKE A DIFFERENT LOOK AT ANATOMY

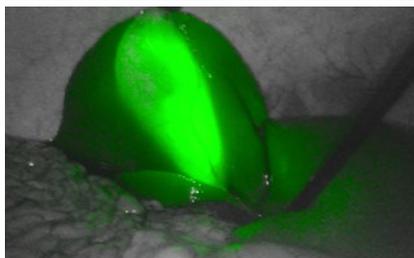
Fluorescence Imaging (FI) aims for the best patient outcome during diagnostics or surgery.<sup>1</sup> In minimally invasive surgery it is used in numerous applications such as vessel or visceral perfusion assessment, visualization of bile duct anatomy or (sentinel) lymph node mapping.

## CUSTOMER BENEFITS

of the *EinsteinVision*<sup>®</sup> 3.0 FI system

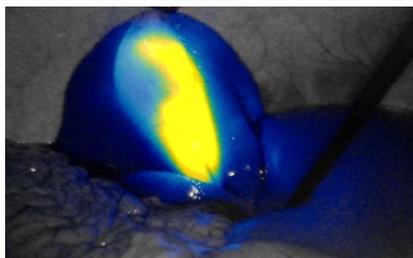
- Shorter operating times using 3D technology<sup>2</sup>
- Clear view through integrated, controlled anti-fog function
- Extended product life due to unique 3D sterile delivery concept<sup>3</sup>
- Extended system use, as both 2D and 3D camera heads can be connected to the visualization platform
- Interdisciplinary use
- Application flexibility through three fluorescence overlay modes
- Simultaneous display of live image and superimposed fluorescence mode
- Switch between live image and fluorescence modes via foot switch or camera head control

The Aesculap 3D Fluorescence Imaging technology offers three different FI overlay modes in real-time



This fluorescence mode indicates the presence of ICG in green color.

FI Green



The display of the ICG signal in different colors (yellow represents a high FI intensity signal) enables the visual representation of the ICG intensity in the tissue.

FI Intensity



The monochromatic view provides the greatest possible image contrast for the best possible differentiation of the ICG signal.

FI White

1 Dip F et al. Randomized Trial of Near-infrared Incisionless Fluorescent Cholangiography. *Ann Surg.* 2019 Dec;270(6):992-999. DOI: 10.1097/SLA.0000000000003178

2 Vettoretto N et al. Why laparoscopists may opt for three-dimensional view: a summary of the full HTA report on 3D versus 2D Laparoscopy by S.I.C.E. (Società Italiana de Chirurgia Endoscopia e Nuove Tecnologie). *Surg Endosc* 2018 (32):2986-93. DOI: 10.1007/s00464-017-6006-y

3 Autoclaving exposes endoscopes and light cables to repeated thermal stress, resulting in a shorter life span. As the EV3.0 FI camera head is not autoclaved, this does not affect the life of the product.

# GENERAL USE OF FLUORESCENCE IMAGING

## ABSTRACT

### CONSENSUS CONFERENCE STATEMENT ON THE GENERAL USE OF NEAR-INFRARED FLUORESCENCE IMAGING AND INDOCYANINE GREEN GUIDED SURGERY

Dip F., Boni L., Bouvet M., et al.

Annals of Surgery, 2020, (modified Delphi study)

#### BACKGROUND/AIM:

In recent decades, the use of near-infrared light and fluorescence-guidance during open and laparoscopic surgery has exponentially expanded across various clinical settings. However, tremendous variability exists in how it is performed.

In this first published survey of international experts on fluorescence-guided surgery, we sought to identify areas of consensus and nonconsensus across 4 areas of practice: fundamentals; patient selection/ preparation; technical aspects; and effectiveness and safety.

#### PATIENTS AND METHODS:

A Delphi survey was conducted among 19 international experts in fluorescence-guided surgery attending a 1-day consensus meeting in Frankfurt, Germany on September 8th, 2019. Using mobile phones, experts were asked to anonymously vote over 2 rounds of voting, with 70% and 80% set as a priori thresholds for consensus and vote robustness, respectively.

#### RESULTS:

Experts from 5 continents reached consensus on 41 of 44 statements, including strong consensus that near-infrared fluorescence-guided surgery is both effective and safe across a broad variety of clinical settings, including the localization of critical anatomical structures like vessels, detection of tumors and sentinel nodes, assessment of tissue perfusion and anastomotic leaks, delineation of segmented organs, and localization of parathyroid glands. Although the minimum and maximum safe effective dose of ICG were felt to be 1 to 2 mg and >10 mg, respectively, there was strong consensus that determining the optimum dose, concentration, route and timing of ICG administration should be an ongoing research focus.

#### CONCLUSION:

Although fluorescence imaging was almost unanimously perceived to be both effective and safe across a broad range of clinical settings, considerable further research remains necessary to optimize its use.



DOI: 10.1097/SLA.0000000000004412

#### Fundamentals of Fluorescent Imaging With ICG

- In general, the use of fluorescence-guidance during surgery should be considered very safe.
- In general, the use of ICG during fluorescence-guided surgery should be considered very safe.
- Using fluorescence technology, with or without ICG, decreases or has no effect on the overall cost of a patient's peri- and postoperative care.
- Fluorescence imaging, with and without ICG, should be part of routine surgical practice.
- In general, the use of ICG should not be considered experimental.

#### Patient selection

- Prior to administering ICG, patients should be asked if they are allergic to iodine

#### Technical Aspects of Fluorescence Imaging and ICG Use

- The dose, concentration and timing of ICG administration as well as the length of time to wait after the administration of ICG is important
- The minimum effective dose of ICG for fluorescence imaging is 1-2 mg
- The maximum safe dose of ICG is > 10 mg

#### Indications for and Effectiveness of Fluorescence Imaging With ICG

- Fluorescence imaging technology has the potential to significantly enhance patient outcomes.
- Fluorescence imaging technology has the potential to dramatically alter the way that many surgical procedures are performed.
- In general, fluorescence imaging is an important tool for
  - o the evaluation of tissue perfusion
  - o the visualization of vital anatomical structures such as arteries and veins
  - o the visualization of cancerous lesions
  - o the visualization of sentinel lymph nodes
  - o the visualization of segmented organs such as the liver and lungs

<sup>1</sup> The above results of this Delphi survey do not necessarily indicate truth; what they demonstrate is the degree of consensus that can be reached in the opinions of field experts. The expert panel selected for this survey was comprised of widely acknowledged leaders in the field of fluorescence-guided surgery, all having published research in the field, and 17 of 19 having academic appointments.

All are highly versed in the literature currently published on fluorescence-guided surgery and the use of ICG, and this is reflected in their voting, particularly with respect to the effectiveness and safety of fluorescence imaging and ICG use.

# GENERAL USE OF FLUORESCENCE IMAGING

## ABSTRACT

### COULD FLUORESCENCE-GUIDED SURGERY BE AN EFFICIENT AND SUSTAINABLE OPTION? A SICE (ITALIAN SOCIETY OF ENDOSCOPIC SURGERY) HEALTH TECHNOLOGY ASSESSMENT SUMMARY

Vettoretto, N., Foglia, E., Ferrario, L., et al.

*Surgical Endoscopy*, 2020, (evaluation/comparative study)

#### BACKGROUND/AIM:

Indocyanine green fluorescence vision is an upcoming technology in surgery. It can be used in three ways: angiographic and biliary tree visualization and lymphatic spreading studies. The present paper shows the most outstanding results from a health technology assessment study design, conducted on fluorescence-guided compared with standard vision surgery.

#### PATIENTS AND METHODS:

A health technology assessment approach was implemented to investigate the economic, social, ethical, and organizational implications related to the adoption of the innovative fluorescence-guided view, with a focus on minimally invasive approach. With the support of a multidisciplinary team, qualitative and quantitative data were collected, by means of literature evidence, validated questionnaires and self-reported interviews, considering the dimensions resulting from the EUnetHTA Core Model.

#### RESULTS:

From a systematic search of literature, we retrieved the following studies: 6 on hepatic, 1 on pancreatic, 4 on biliary, 2 on bariatric, 4 on endocrine, 2 on thoracic, 11 on colorectal, 7 on urology, 11 on gynecology, 2 on gastric surgery. Fluorescence guide has shown advantages on the length of hospitalization particularly in colorectal surgery, with a reduction of the rate of leakages and re-do anastomoses, in spite of a slight increase in operating time, and is confirmed to be a safe, efficacious, and sustainable vision technology. Clinical applications are still presenting a low evidence in the literature.

#### CONCLUSION:

The present paper, under the patronage of Italian Society of Endoscopic Surgery, based on an HTA approach, sustains the use of fluorescence-guided vision in minimally invasive surgery, in the fields of general, gynecologic, urologic, and thoracic surgery, as an efficient and economically sustainable technology.



<https://doi.org/10.1007/s00464-020-07542-3>



# GENERAL SURGERY

## CHOLECYSTECTOMY

### ABSTRACT

#### COULD FLUORESCENCE-GUIDED SURGERY BE AN EFFICIENT AND SUSTAINABLE OPTION? A SICE (ITALIAN SOCIETY OF ENDOSCOPIC SURGERY) HEALTH TECHNOLOGY ASSESSMENT SUMMARY

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<https://doi.org/10.1007/s00464-020-07542-3>

## FLUORESCENCE OR X-RAY CHOLANGIOGRAPHY IN ELECTIVE LAPAROSCOPIC CHOLECYSTECTOMY: A RANDOMIZED CLINICAL TRIAL

ABSTRACT

Lehrskov L.L., Westen M., Larsen S.S., et al.

BJS, 2020, (randomized clinical trial)

### BACKGROUND/AIM:

Safe laparoscopic cholecystectomy may necessitate biliary imaging, and non-invasive fluorescence cholangiography may have advantages over contrast X-ray cholangiography. This trial compared fluorescence and X-ray cholangiography for visualization of the critical junction between the cystic, common hepatic and common bile ducts.

### PATIENTS AND METHODS:

This non-inferiority blinded RCT included patients who had either intraoperative fluorescence cholangiography using 0.05 mg/kg indocyanine green or X-ray cholangiography during elective laparoscopic cholecystectomy.

### RESULTS:

Between March 2015 and August 2018, a total of 120 patients were randomized (60 in each group). There were no drop-outs and 30-day follow-up data were available for all patients. In intention-to-treat analysis, there was 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;  $P=0.230$ ). Fluorescence cholangiography was faster by a few minutes: median 2.0 (range 0.5–5.0) versus 4.8 (1.3–17.6) min ( $P<0.001$ ).

### CONCLUSION:

Fluorescence cholangiography was confirmed to be non-inferior to X-ray cholangiography in visualizing the critical junction during laparoscopic cholecystectomy.



# GENERAL SURGERY

## CHOLECYSTECTOMY

### ABSTRACT

### RANDOMIZED TRIAL OF NEAR-INFRARED INCISIONLESS FLUORESCENT CHOLANGIOGRAPHY

Dip F., LoMenzo E., Sarotto L., et al.

Annals of Surgery, 2019, (multicenter randomized, single-blinded, controlled clinical trial)

#### BACKGROUND/AIM:

Incisionless near-infrared fluorescent cholangiography (NIFC) is emerging as a promising tool to enhance the visualization of extrahepatic biliary structures during laparoscopic cholecystectomies.

#### PATIENTS AND METHODS:

We conducted a single-blind, randomized, 2-arm trial comparing the efficacy of NIFC (n = 321) versus white light (WL) alone (n = 318) during laparoscopic cholecystectomy. We evaluated the detection rate for 7 biliary structures - cystic duct (CD), right hepatic duct (RHD), common hepatic duct, common bile duct, cystic common bile duct junction, cystic gallbladder junction (CGJ), and accessory ducts - before and after surgical dissection. Secondary calculations included multivariable analysis for predictors of structure visualization and comparing intergroup biliary duct injury rates.

#### RESULTS:

Predissection detection rates were significantly superior in the NIFC group for all 7 biliary structures, ranging from 9.1% versus 2.9% to 66.6% versus 36.6% for the RHD and CD, respectively, with odds ratios ranging from 2.3 (95% CI 1.6-3.2) for the CGJ to 3.6 (1.6-9.3) for the RHD. After dissection, similar intergroup differences were observed for all structures except CD and CGJ, for which no differences were observed. Significant odds ratios ranged from 2.4 (1.7-3.5) for the common hepatic duct to 3.3 (1.3-10.4) for accessory ducts. Increased body mass index was associated with reduced detection of most structures in both groups, especially before dissection. Only 2 patients, both in the WL group, sustained a biliary duct injury.

#### CONCLUSION:

In a randomized controlled trial, NIFC was statistically superior to WL alone visualizing extrahepatic biliary structures during laparoscopic cholecystectomy.



doi: 10.1097/SLA.0000000000003178

## UNDERSTANDING INTRAOPERATIVE FLUORESCENT CHOLANGIOGRAPHY: TEN STEPS FOR AN EFFECTIVE AND SUCCESSFUL PROCEDURE

ABSTRACT

Dip F., Aleman R., Frieder J.S., et al.

Surgical Endoscopy, 2021, (retrospective study)

### BACKGROUND/AIM:

Common bile duct injuries (BDI) during laparoscopic cholecystectomy (LC) continue to be the source of morbidity and mortality. The reason for BDI is mostly related to the misidentification of the extrahepatic bile duct structures and the anatomic variability. Near-infrared fluorescent cholangiography (NIFC) has proven to enhance visualization of extrahepatic biliary structures during LCs. The purpose of this study was to describe the most important steps in the performance of NIFC.

### PATIENTS AND METHODS:

In accordance to the most current surgical practice of LC at our institution, a consensus was achieved on the most relevant steps to be followed when utilizing NIFC. Dose of indocyanine green (ICG), time of administration, and identification of critical structures were previously determined based on prospective and randomized controlled studies performed at CCF.

### RESULTS:

The ten steps identified as critical when performing NIFC during LC are preoperative administration of ICG, exposure of the hepatoduodenal ligament, initial anatomical evaluation, identification of the cystic duct and common bile duct junction, the cystic duct and its junction to the gallbladder, the CHD, the common bile duct, accessory ducts, cystic artery and, time-out and identification of Calot's triangle, and evaluation of the liver bed.

### CONCLUSION:

Routine use of NIFC is a useful diagnostic tool to better visualize the extrahepatic biliary structures during LC. The implementation of specific standardized steps might provide the surgeon with a better algorithm to use this technology and consequently reduce the incidence of BDI.



# GENERAL SURGERY

## CHOLECYSTECTOMY

### ABSTRACT

### FLUORESCENCE-BASED CHOLANGIOGRAPHY: PRELIMINARY RESULTS FROM THE IHU-IRCAD-EAES EURO-FIGS REGISTRY

Agnus, V., Pesce, A., Boni, L. et al.

*Surgical Endoscopy*, 2020 (registry study)

#### BACKGROUND/AIM:

Near-infrared fluorescence cholangiography (NIRF-C) is a popular application of fluorescence image-guided surgery (FIGS). NIRF-C requires near-infrared optimized laparoscopes and the injection of a fluorophore, most frequently Indocyanine Green (ICG), to highlight the biliary anatomy. It is investigated as a tool to increase safety during cholecystectomy. The European registry on FIGS (EURO-FIGS: [www.euro-figs.eu](http://www.euro-figs.eu)) aims to obtain a snapshot of the current practices of FIGS across Europe. Data on NIRF-C are presented.

#### PATIENTS AND METHODS:

EURO-FIGS is a secured online database which collects anonymized data on surgical procedures performed using FIGS. Data collected for NIRF-C include gender, age, Body Mass Index (BMI), pathology, NIR device, ICG dose, ICG timing of administration before intraoperative visualization, visualization (Y/N) of biliary structures such as the cystic duct (CD), the common bile duct (CBD), the CD-CBD junction, the common hepatic duct (CHD), visualization scores, adverse reactions to ICG, operative time, and surgical complications.

#### RESULTS:

Fifteen surgeons (12 European surgical centers) uploaded 314 cases of NIRF-C during cholecystectomy (cholelithiasis  $n = 249$ , cholecystitis  $n = 58$ , polyps  $n = 7$ ), using 4 different NIR devices. ICG doses (mg/kg) varied largely (mean  $0.28 \pm 0.17$ , median 0.3, range: 0.02-0.62). Similarly, injection-to-visualization timing (minutes) varied largely (mean  $217 \pm 357$ ; median 57), ranging from 1 min (direct intragallbladder injection in 2 cases) to 3120 min ( $n = 2$  cases). 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 was not correlated. 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.

#### CONCLUSION:

The EURO-FIGS registry has confirmed a wide disparity in ICG dose and timing in NIRF-C. EURO-FIGS can represent a valuable tool to promote and monitor FIGS-related educational and consensus activities in Europe.



<https://doi.org/10.1007/s00464-019-07157-3>

## DOES NEAR-INFRARED FLUORESCENT CHOLANGIOGRAPHY WITH INDOCYANINE GREEN REDUCE BILE DUCT INJURIES AND CONVERSIONS TO OPEN SURGERY DURING LAPAROSCOPIC OR ROBOTIC CHOLECYSTECTOMY? – A META-ANALYSIS

Dip F., Lo Menzo E., White K.P., et al.

Surgery - Infrared Fluorescence, 2021, (meta analysis)

### BACKGROUND/AIM:

Bile duct injury and conversion-to-open-surgery rates remain unacceptably high during laparoscopic and robotic cholecystectomy. In a recently published randomized clinical trial, using near-infrared fluorescent cholangiography with indocyanine green intraoperatively markedly enhanced biliary-structure visualization. Our systematic literature review compares bile duct injury and conversion-to-open-surgery rates in patients undergoing laparoscopic or robotic cholecystectomy with versus without near-infrared fluorescent cholangiography.

### PATIENTS AND METHODS:

A thorough PubMed search was conducted to identify randomized clinical trials and nonrandomized clinical trials with  $\geq 100$  patients. Because all near-infrared fluorescent cholangiography studies were published since 2013, only studies without near-infrared fluorescent cholangiography published since 2013 were included for comparison. Incidence estimates, weighted and unweighted for study size, were adjusted for acute versus chronic cholecystitis, and for robotic versus laparoscopic cholecystectomy and are reported as events/10,000 patients. All studies were assessed for bias risk and high-risk studies excluded.

### RESULTS:

In total, 4,990 abstracts were reviewed, identifying 5 near-infrared fluorescent cholangiography studies (3 laparoscopic cholecystectomy/2 robotic cholecystectomy;  $n = 1,603$ ) and 11 not near-infrared fluorescent cholangiography studies (5 laparoscopic cholecystectomy/4 robotic cholecystectomy/2 both;  $n = 5,070$ ) for analysis. Overall weighted rates for bile duct injury and conversion were 6 and 16/10,000 in near-infrared fluorescent cholangiography patients versus 25 and 271/10,000 in patients without near-infrared fluorescent cholangiography. Among patients undergoing laparoscopic cholecystectomy, bile duct injuries, and conversion rates among near-infrared fluorescent cholangiography versus patients without near-infrared fluorescent cholangiography were 0 and 23/10,000 versus 32 and 255/10,000, respectively. Bile duct injury rates were low with robotic cholecystectomy with and without near-infrared fluorescent cholangiography (12 and 8/10,000), but there was a marked reduction in conversions with near-infrared fluorescent cholangiography (12 vs 322/10,000).

### CONCLUSION:

Although large comparative trials remain necessary, preliminary analysis suggests that using near-infrared fluorescent cholangiography with indocyanine green intraoperatively sizably decreases bile duct injury and conversion-to-open-surgery rates relative to cholecystectomy under white light alone.

<https://doi.org/10.1016/j.surg.2020.12.008>



# GENERAL SURGERY

## CHOLECYSTECTOMY

### ABSTRACT

### FLUORESCENT CHOLANGIOGRAPHY WITH DIRECT INJECTION OF INDOCYANINE GREEN (ICG) INTO THE GALLBLADDER: A SAFETY METHOD TO OUTLINE BILIARY ANATOMY

Gené Škrabec, C., Pardo Aranda, F., Espín, F. et al.

Langenbeck's Archives of Surgery, 2020, (case-controlled study)

#### BACKGROUND/AIM:

Near infrared cholangiography (NIRC) with indocyanine green (ICG) directly injected into the gallbladder is a novel technique to outline biliary anatomy. The purpose of this article is to analyze the usefulness and feasibility of NIRC as a safety method during laparoscopic cholecystectomies.

#### PATIENTS AND METHODS:

A case-controlled study comparing 20 patients undergoing laparoscopic cholecystectomies with NIRC with direct injection of ICG into the gallbladder to 20 consecutive standard cholecystectomies. Operative time, length of stay, complications, conversion rates, and biliary injury were analyzed.

#### RESULTS:

Both groups were comparable in epidemiological characteristics. In the ICG group fluorescent visualization of the junction of the Hartmann pouch and the whole cystic duct was achieved in 16 (80%) patients. Median surgical time was 65 (50-76) and 55 (45-71) min. for the ICG and the control group, respectively ( $p=0.113$ ). There were no postoperative complications and no biliary duct injuries in any of the groups, and a patient from both groups underwent conversion to open surgery.

#### CONCLUSION:

NIRC with direct injection of ICG into the gallbladder is a feasible method that is not time-consuming; it does not require a different learning curve from standard laparoscopic cholecystectomies and has no major complications described so far.



<https://doi.org/10.1007/s00423-020-01967-z>

# ROUTINE NEAR INFRA-RED INDOCYANINE GREEN FLUORESCENT CHOLANGIOGRAPHY VERSUS INTRAOPERATIVE CHOLANGIOGRAPHY DURING LAPAROSCOPIC CHOLECYSTECTOMY: A CASE-MATCHED COMPARISON

ABSTRACT

Quaresima, S., Balla, A., Palmieri, L. et al.

Surgical Endoscopy, 2020, (case-controlled prospective study)

## BACKGROUND/AIM:

The aim is to evaluate safety and efficacy of near infra-red (NIR) indocyanine green (ICG) fluorescence structural imaging during laparoscopic cholecystectomy (LC) (Group A) and to compare perioperative data, including operative time, with a series of patients who underwent LC with routine traditional intraoperative cholangiography (IOC) (Group B).

## PATIENTS AND METHODS:

Forty-four patients with acute or chronic cholecystitis underwent NIR-ICG fluorescent cholangiography during LC. ICG was administered intravenously at different time intervals or by direct gallbladder injection during surgery. Fluorescence intensity and anatomy identification were scored according to a visual analogue scale between 1 (least accurate) and 5 (most accurate). Group B patients (n = 44) were chosen from a prospectively maintained database of patients who underwent LC with routine IOC, matched for age, sex, body mass index, and diagnosis with group A patients.

## RESULTS:

No adverse reactions were recorded. In group A, mean time between intravenous administration of ICG and surgery was  $10.7 \pm 8.2$  (range 2–52) h. Administered doses ranged from 3.5 to 13.5 mg. Fluorescence was present in all cases, scoring  $\geq 3$  in 41 patients. Mean operative time was  $86.9 \pm 36.9$  (30–180) min in group A and  $117.9 \pm 43.4$  (40–220) min in group B ( $p = 0.0006$ ). No conversion to open surgery nor bile duct injuries were observed in either group.

## CONCLUSION:

LC with NIR-ICG fluorescent cholangiography is safe and effective for early recognition of anatomical land-marks, reducing operative time as compared to LC with IOC, even when residents were the main operator. NIR-ICG fluorescent cholangiography was effective in patients with acute cholecystitis and in the obese. Data collection into large registries on the results of NIR-ICG fluorescent cholangiography during LC should be encouraged to establish whether this technique might set a new safety standard for LC.



# GENERAL SURGERY

## CHOLECYSTECTOMY

### ABSTRACT

### NEAR-INFRARED FLUORESCENCE CHOLANGIOGRAPHY CAN BE A USEFUL ADJUNCT DURING EMERGENCY CHOLECYSTECTOMIES

Di Maggio F., Hossain N., De Zanna A., et al.

Innovative Technologies, 2020, (controlled prospective study)

#### BACKGROUND/AIM:

Emergency cholecystectomy is the gold standard treatment for acute cholecystitis according to National Institute for Health and Care Excellence recommendations. The procedure is feasible but carries a higher risk of iatrogenic injury to the bile duct, which should be considered preventable. Intraoperative fluorescence cholangiography following injection of indocyanine green (ICG) has been reported to aid identification of the extrahepatic bile duct. Data on its feasibility in the context of emergency cholecystectomies are missing.

#### PATIENTS AND METHODS:

Fluorescent ICG was used intraoperatively to enhance the biliary anatomy during 33 consecutive emergency laparoscopic cholecystectomies at our institution. Primary outcomes of surgery were considered the length of hospital stay, conversion to open and complications rate, including bile duct injury. Secondary outcome was operating time. A historical population of emergency cholecystectomies was used as control.

#### RESULTS:

There were no common bile duct injuries, no adverse effects from ICG, no conversion to open surgery and no deaths. 90% of patients went home within 48 hours after the operation in the absence of complications. ICG demonstrated intraoperative biliary anatomy allowing greater confidence to the surgeon performing emergency cholecystectomies. Six patients were operated beyond 72 hours from admission, without experiencing any complication Clavien–Dindo  $\geq 3$ . ICG population had the same post-operative hospitalisation and complications rate of the control group, with a shorter operating time.

#### CONCLUSION:

Intraoperative augmented visualisation of biliary anatomy with ICG cholangiography can be a useful technology tool, with the potential to extend the 72 hours window of safety for emergency cholecystectomies.



<https://doi.org/10.1177/1553350620958562>

## NEAR-INFRARED CHOLECYSTOCHOLANGIOGRAPHY WITH DIRECT INTRAGALLBLADDER INDOCYANINE GREEN INJECTION: PRELIMINARY CLINICAL RESULTS

ABSTRACT

Liu Y.-Y., Liao C.-H., Diana M., et al.

Surgical Endoscopy, 2018, (controlled prospective study)

### BACKGROUND/AIM:

Near-infrared (NIR) fluorescence cholangiography by systemic administration of indocyanine green (ICG) enhances the visualization of the biliary tree anatomy. However, the simultaneous enhancement of liver parenchyma can disturb the visualization of critical details. We herein proposed a new technique of NIR cholecystocholangiography by intragallbladder ICG injection to increase the safety during laparoscopic cholecystectomy.

### PATIENTS AND METHODS:

A total of 46 patients scheduled for laparoscopic cholecystectomy for symptomatic lithiasis (n = 21) or cholecystitis (n = 25) were enrolled. A fluorescence cholangiography by direct gallbladder injection of ICG was performed in all cases. Of them, the ICG was injected through a previously placed percutaneous transhepatic gallbladder drainage catheter (n = 18) or by intraoperative, percutaneous needle puncture of the gallbladder (n = 28). Visualization of biliary structures, including the cystic duct (CD), the common bile and hepatic ducts (CBD and CHD), the gallbladder neck, and the Hartmann's pouch (HP), was performed using White Light (served as control modality) and by NIR enhancement.

### RESULTS:

Cholecystocholangiography provided a significantly higher rate of visualization of the CD in case of cholecystitis with mild adhesions, and an improved visualization of the HP, CBD, and CHD in case of severe inflammation, when compared to White Light observation. There were no benefits of NIR in case of non-inflamed lithiasis.

### CONCLUSION:

Clinical translation of NIR cholecystocholangiography has been successful with a noise-free visualization of biliary anatomy. It can be considered in difficult cases to increase the safety of laparoscopic cholecystectomy.



# GENERAL SURGERY

## CHOLECYSTECTOMY

### ABSTRACT

### FLUORESCENT CHOLANGIOGRAPHY SIGNIFICANTLY IMPROVES PATIENT OUTCOMES FOR LAPAROSCOPIC CHOLECYSTECTOMY

Broderick, R.C., Lee, A.M., Cheverie, J.N. et al.

Surgical Endoscopy, 2020, (controlled prospective study)

#### BACKGROUND/AIM:

Laparoscopic cholecystectomy (LC) is the most common elective abdominal surgery in the USA, with over 750,000 performed annually. Fluorescent cholangiography (FC) using indocyanine green dye (ICG) permits identification of extrahepatic biliary structures to facilitate dissection without requiring cystic duct cannulation. Achieving the "critical view of safety" with assistance of ICG cholangiogram may support identification of anatomy, safely reduce conversion to open procedures, and decrease operative time. We assess the utility of FC with respect to anatomic visualization during LC and its effects on patient outcomes.

#### PATIENTS AND METHODS:

A retrospective review of a prospectively maintained database identified patients undergoing laparoscopic cholecystectomy at a single academic center from 2013 to 2019. Exclusion criteria were primary open and single incision cholecystectomy. Patient factors included age, sex, BMI, and Charlson Comorbidity Index. Outcomes included operative time, conversion to open procedure, length of stay (LOS), mortality rate, and 30-day complications. A multivariable logistic regression was performed to determine independent predictors for open conversion.

#### RESULTS:

A total of 1389 patients underwent laparoscopic cholecystectomy. 69.8% were female; mean age 48.6 years (range 15–94), average BMI 29.4 kg/m<sup>2</sup> (13.3–55.6). 989 patients (71.2%) underwent LC without fluorescence and 400 (28.8%) underwent FC with ICG. 30-day mortality detected 2 cases in the non-ICG group and zero with ICG. ICG reduced operative time by 26.47 min per case ( $p < 0.0001$ ). For patients with BMI  $\geq 30$  kg/m<sup>2</sup>, operative duration for ICG vs non-ICG groups was 75.57 vs 104.9 min respectively ( $p < 0.0001$ ). ICG required conversion to open at a rate of 1.5%, while non-ICG converted at a rate of 8.5% ( $p < 0.0001$ ). Conversion rate remained significant with multivariable analysis (OR 0.212,  $p = 0.001$ ). A total of 19 cases were aborted (1.35%), 8 in the ICG group (1.96%) and 11 in the non-ICG group (1.10%), these cases were not included in LC totals. Average LOS was 0.69 vs 1.54 days in the ICG compared to non-ICG LCs ( $p < 0.0001$ ), respectively. Injuries were more common in the non-ICG group, with 9 patients sustaining Strasberg class A injuries in the non-ICG group and 2 in the ICG group. 1 CBDI occurred in the non-ICG group. There was no significant difference in 30-day complication rates between groups.

## CONCLUSION:

ICG cholangiography is a non-invasive adjunct to laparoscopic cholecystectomy, leading to improved patient outcomes with respect to operative times, decreased conversion to open procedures, and shorter length of hospitalization. Fluorescence cholangiography improves visualization of biliary anatomy, thereby decreasing rate of CBDI, Strasberg A injuries, and mortality. These findings support ICG as standard of care during laparoscopic cholecystectomy. NIR-ICG fluorescent cholangiography was effective in patients with acute cholecystitis and in the obese. Data collection into large registries on the results of NIR-ICG fluorescent cholangiography during LC should be encouraged to establish whether this technique might set a new safety standard for LC.



# GENERAL SURGERY

## COLORECTAL SURGERY

### ABSTRACT

#### COULD FLUORESCENCE-GUIDED SURGERY BE AN EFFICIENT AND SUSTAINABLE OPTION? A SICE (ITALIAN SOCIETY OF ENDOSCOPIC SURGERY) HEALTH TECHNOLOGY ASSESSMENT SUMMARY

Vettoretto, N., Foglia, E., Ferrario, L. et al.

*Surgical Endoscopy*, 2020, (evaluation/comparative study)

#### BACKGROUND/AIM:

Indocyanine green fluorescence vision is an upcoming technology in surgery. It can be used in three ways: angiographic and biliary tree visualization and lymphatic spreading studies. The present paper shows the most outstanding results from a health technology assessment study design, conducted on fluorescence-guided compared with standard vision surgery.

#### PATIENTS AND METHODS:

A health technology assessment approach was implemented to investigate the economic, social, ethical, and organizational implications related to the adoption of the innovative fluorescence-guided view, with a focus on minimally invasive approach. With the support of a multidisciplinary team, qualitative and quantitative data were collected, by means of literature evidence, validated questionnaires and self-reported interviews, considering the dimensions resulting from the EUnetHTA Core Model.

#### RESULTS:

From a systematic search of literature, we retrieved the following studies: 6 on hepatic, 1 on pancreatic, 4 on biliary, 2 on bariatric, 4 on endocrine, 2 on thoracic, 11 on colorectal, 7 on urology, 11 on gynecology, 2 on gastric surgery. Fluorescence guide has shown advantages on the length of hospitalization particularly in colorectal surgery, with a reduction of the rate of leakages and re-do anastomoses, in spite of a slight increase in operating time, and is confirmed to be a safe, efficacious, and sustainable vision technology. Clinical applications are still presenting a low evidence in the literature.

#### CONCLUSION:

The present paper, under the patronage of Italian Society of Endoscopic Surgery, based on an HTA approach, sustains the use of fluorescence-guided vision in minimally invasive surgery, in the fields of general, gynecologic, urologic, and thoracic surgery, as an efficient and economically sustainable technology.



<https://doi.org/10.1007/s00464-020-07542-3>

## INTRAOPERATIVE ANGIOGRAPHY WITH INDOCYANINE GREEN TO ASSESS ANASTOMOSIS PERFUSION IN PATIENTS UNDERGOING LAPAROSCOPIC COLORECTAL RESECTION: RESULTS OF A MULTICENTER RANDOMIZED CONTROLLED TRIAL

ABSTRACT

De Nardi, P., Elmore, U., Maggi, G. et al.

Surgical Endoscopy, 2020, (multicenter randomized controlled trial)

### BACKGROUND/AIM:

Insufficient vascular supply is one of the main causes of anastomotic leak in colorectal surgery. Intraoperative indocyanine-green (ICG) angiography has been shown to provide information on tissue perfusion, identifying a well-perfused location for colonic and rectal transections, and thus possibly reducing the leak rate. Aim of this study was to evaluate the usefulness of intraoperative assessment of anastomotic perfusion using ICG angiography in patients undergoing left-sided colon or rectal resection with colorectal anastomosis.

### PATIENTS AND METHODS:

This randomized trial involved 252 patients undergoing laparoscopic left-sided colon and rectal resection randomized 1:1 to intraoperative ICG or to subjective visual evaluation of the bowel perfusion without ICG. The primary aim was to assess whether ICG angiography could lead to a reduction in anastomotic leak rate. Secondary outcomes were possible changes in the surgical strategy and postoperative morbidity.

### RESULTS:

After randomization, 12 patients were excluded. Accordingly, 240 patients were included in the analysis; 118 were in the study group, and 122 in the control group. ICG angiography showed insufficient perfusion of the colic stump, which led to extended bowel resection in 13 cases (11%). An anastomotic leak developed in 11 patients (9%) in the control group and in 6 patients (5%) in the study group ( $p = n.s.$ ).

### CONCLUSION:

Intraoperative ICG fluorescent angiography can effectively assess vascularization of the colic stump and anastomosis in patients undergoing colorectal resection. This method led to further proximal bowel resection in 13 cases, however, there was no statistically significant reduction of anastomotic leak rate in the ICG arm.



# GENERAL SURGERY

## COLORECTAL SURGERY

### ABSTRACT

### THE SIGNIFICANCE OF INTRAOPERATIVE FLUORESCENCE ANGIOGRAPHY IN MINIINVASIVE LOW RECTAL RESECTIONS

Skrovina M., Bencurik V., Martinek L., et al.

Retrospective onrolled study

#### BACKGROUND/AIM:

Anastomotic leak is a very serious complication in colorectal surgery. Tissue perfusion of the anastomosis plays an integral role in its multifactorial etiology. Fluorescence angiography using indocyanine green allows visualization of perfusion in real time.

Aim: To evaluate the effectiveness of intraoperative fluorescence angiography as a tool to decrease the incidence of anastomotic leak after laparoscopic or robotic low resection of the rectum for cancer

#### PATIENTS AND METHODS:

Intraoperative fluorescence angiography was performed sequentially in 50 patients during low rectal resection for cancer with total mesorectal excision, primary anastomosis and protective ileostomy using laparoscopic or robotic technique. The results were compared to a historical control group of 50 patients with the same procedure without the use of fluorescence angiography.

#### RESULTS:

The patient sets were comparable in basic demographic and clinical parameters. Intraoperative visualization of perfusion by fluorescence angiography was achieved in all patients without unwanted side-effects. In 6 (12%) patients, the resection line was adjusted based on the fluorescence angiography. The incidence of anastomotic leak was insignificantly lower in the group with fluorescence angiography (18% vs. 10%), which led to significantly shorter hospital stay. Other postoperative complications were comparable between the two groups.

#### CONCLUSION:

Fluorescence angiography using indocyanine green is a safe and effective method with the potential of reducing anastomotic leak during minimally invasive low resection of the rectum for cancer.



<https://doi.org/10.5114/wiitm.2019.84851>

## INTRAOPERATIVE FLUORESCENCE ANGIOGRAPHY AND RISK FACTORS OF ANASTOMOTIC LEAKAGE IN MINI-INVASIVE LOW RECTAL RESECTIONS

ABSTRACT

Benčurik, V., Škrovina, M., Martinek, L. et al.

Surgical Endoscopy, 2021, (controlled prospective study)

### BACKGROUND/AIM:

One of the prerequisites for proper healing of the anastomosis after a colorectal resection is adequate blood supply to the connected intestinal segments. It has been proposed that adequate visualization of the blood flow using indo-cyanine green (ICG) could lead to the reduction in the incidence of anastomotic leakage (AL). The aim of this study was to assess the effectiveness of intraoperative fluorescence angiography (FA) in decreasing the incidence of AL after minimally invasive low anterior resection (LAR) with total mesorectal excision (TME) in rectal cancer patients and to determine pre-dictors of anastomotic leak.

### PATIENTS AND METHODS:

From August 2015 to January 2019, data from 100 patients who underwent mini-invasive TME for rectal cancer using FA with indocyanine green (ICG) were prospectively collected and analyzed. They were compared with retrospectively analyzed data from a historical control group operated by one team of surgeons before the introduction of FA from November 2012 to August 2015 (100 patients). All patients from both groups were operated sequentially in one oncological center in Nový Jičín.

### RESULTS:

The incidence of AL was significantly lower in the ICG group (19% vs. 9%,  $p = 0.042$ , 2 test). In fifteen patients in the ICG group (15%), the resection line was moved due to insufficient perfusion. Using Pearson's  $\chi^2$  test, diabetes ( $p = 0.036$ ) and application of a transanal drain (NoCoil) ( $p = 0.032$ ) were identified as other risk factors (RFs) for AL.

### CONCLUSION:

The use of ICG to visualize tissue perfusion in low rectal resections for cancer can lead to a reduction of AL.



# GENERAL SURGERY

## COLORECTAL SURGERY

### ABSTRACT

#### APPLICATION OF INDOCYANINE GREEN-ENHANCED NEAR-INFRARED FLUORESCENCE-GUIDED IMAGING IN LAPAROSCOPIC LATERAL PELVIC LYMPH NODE DISSECTION FOR MIDDLE-LOW RECTAL CANCER

Zhou S.-C., Tian Y.-T., Wang X.-W., et al.

World Journal of Gastroenterology, 2019, (retrospective study)

#### BACKGROUND/AIM:

As one effective treatment for lateral pelvic lymph node (LPLN) metastasis (LPNM), laparoscopic LPLN dissection (LPND) is limited due to the complicated anatomy of the pelvic sidewall and various complications after surgery. With regard to improving the accuracy and completeness of LPND as well as safety, we tried an innovative method using indocyanine green (ICG) visualized with a near-infrared (NIR) camera system to guide the detection of LPLNs in patients with middle-low rectal cancer. To investigate whether ICG-enhanced NIR fluorescence-guided imaging is a better technique for LPND in patients with rectal cancer.

#### PATIENTS AND METHODS:

A total of 42 middle-low rectal cancer patients with clinical LPNM who underwent total mesorectal excision (TME) and LPND between October 2017 and March 2019 at our institution were assessed and divided into an ICG group and a non-ICG group. Clinical characteristics, operative outcomes, pathological outcomes, and postoperative complication information were compared and analysed between the two groups.

#### RESULTS:

Compared to the non-ICG group, the ICG group had significantly lower intraoperative blood loss ( $55.8 \pm 37.5$  mL vs  $108.0 \pm 52.7$  mL,  $P = 0.003$ ) and a significantly larger number of LPLNs harvested ( $11.5 \pm 5.9$  vs  $7.1 \pm 4.8$ ,  $P = 0.017$ ). The LPLNs of two patients in the non-ICG group were residual during LPND. In addition, no significant difference was found in terms of LPND, LPNM, operative time, conversion to laparotomy, preoperative complication, or hospital stay ( $P > 0.05$ ).

#### CONCLUSION:

ICG-enhanced NIR fluorescence-guided imaging could be a feasible and convenient technique to guide LPND because it could bring specific advantages regarding the accuracy and completeness of surgery as well as safety.



<https://dx.doi.org/10.3748/wjg.v25.i31.4502>

## PREDICTIVE VALUE OF THE SENTINEL LYMPH NODE PROCEDURE IN THE STAGING OF NON-METASTATIC COLORECTAL CANCER

ABSTRACT

Carrara A., Motter M., Amabile D., et al.

International Journal of Colorectal Disease, 2020, (prospective observational study)

### BACKGROUND/AIM:

Despite the recent growing interest of the scientific community, there is still no consensus on the actual applicability and effectiveness of sentinel lymph node (SL) procedure in colon cancers. This study aims to quantify feasibility, detection rate, negative predictive value and accuracy of the SL identified with fluorescent dye in early colon cancers (ECC).

### PATIENTS AND METHODS:

This study conducted a consecutive sampling of 95 patients with non-metastatic colorectal cancer who have been treated with laparoscopic colon resection and complete mesocolic excision after a 25mg indocyanine green peritumoral lapa-rosopic injection and SL identification with a near-infrared camera. The SL was later isolated and sent to ultra-staging.

### RESULTS:

Ninety-five patients with an average age of 71 (range 37-90) and a mean BMI of 25 (range 18-39) have been recruited. On the patient sample (92 Pts), an average of 1.49 SL (range 1-5) and a mean time of 4 min were identified. The detection rate was 96.8% and the negative predictive value and accuracy rates were 96.2% and 93.4%, respectively.

### CONCLUSION:

Mapping the SL with fluorescent dye can play an important role in the treatment of colon cancers, particularly those at early stages, and can lead to ultra-conservative surgery.



# GENERAL SURGERY

## ESOPHAGEAL SURGERY

### ABSTRACT

#### COULD FLUORESCENCE-GUIDED SURGERY BE AN EFFICIENT AND SUSTAINABLE OPTION? A SICE (ITALIAN SOCIETY OF ENDOSCOPIC SURGERY) HEALTH TECHNOLOGY ASSESSMENT SUMMARY

Vettoretto, N., Foglia, E., Ferrario, L. et al.

*Surgical Endoscopy*, 2020, (evaluation/comparative study)

#### BACKGROUND/AIM:

Indocyanine green fluorescence vision is an upcoming technology in surgery. It can be used in three ways: angiographic and biliary tree visualization and lymphatic spreading studies. The present paper shows the most outstanding results from a health technology assessment study design, conducted on fluorescence-guided compared with standard vision surgery.

#### PATIENTS AND METHODS:

A health technology assessment approach was implemented to investigate the economic, social, ethical, and organizational implications related to the adoption of the innovative fluorescence-guided view, with a focus on minimally invasive approach. With the support of a multidisciplinary team, qualitative and quantitative data were collected, by means of literature evidence, validated questionnaires and self-reported interviews, considering the dimensions resulting from the EUnetHTA Core Model.

#### RESULTS:

From a systematic search of literature, we retrieved the following studies: 6 on hepatic, 1 on pancreatic, 4 on biliary, 2 on bariatric, 4 on endocrine, 2 on thoracic, 11 on colorectal, 7 on urology, 11 on gynecology, 2 on gastric surgery. Fluorescence guide has shown advantages on the length of hospitalization particularly in colorectal surgery, with a reduction of the rate of leakages and re-do anastomoses, in spite of a slight increase in operating time, and is confirmed to be a safe, efficacious, and sustainable vision technology. Clinical applications are still presenting a low evidence in the literature.

#### CONCLUSION:

The present paper, under the patronage of Italian Society of Endoscopic Surgery, based on an HTA approach, sustains the use of fluorescence-guided vision in minimally invasive surgery, in the fields of general, gynecologic, urologic, and thoracic surgery, as an efficient and economically sustainable technology.



<https://doi.org/10.1007/s00464-020-07542-3>

## INDOCYANINE GREEN PERFUSION ASSESSMENT OF THE GASTRIC CONDUIT IN MINIMALLY INVASIVE IVOR LEWIS ESOPHAGECTOMY

ABSTRACT

Pather K., Deladisma A.M., Guerrier C., et al.

Surgical Endoscopy, 2021, (retrospective study)

### BACKGROUND/AIM:

Anastomotic leak is a serious complication following esophagectomy. The aim of the study was to report our experience with indocyanine green fluorescence angiography (ICG-FA) in minimally invasive Ivor Lewis esophagectomy (MILE) and assess factors associated with anastomotic leak.

### PATIENTS AND METHODS:

We reviewed consecutive patients undergoing MILE from 2013 to 2018. Intraoperative real-time assessment of gastric conduit was performed using ICG-FA. Perfusion was categorized as good perfusion (brisk ICG visualization to conduit tip) or non-perfusion (any demarcation along the conduit).

### RESULTS:

100 patients (81 males, median age 68 [60–72]) underwent MILE for malignancy in 96 patients and benign disease in 4 patients. There were six anastomotic leaks all managed with endoscopic stent placement. There was no intraoperative mortality and no 30-day mortality in leak patients. Patients with a leak were more likely to be overweight with BMI > 25 (100% versus 53%,  $p = 0.03$ ), have pre-existing diabetes (50% versus 13%,  $p = 0.04$ ), and have higher intraoperative estimated blood loss (260 mL [95–463] versus 75 mL [48–150],  $p = 0.03$ ). Anastomotic leaks occurred more frequently in the non-perfusion (67%) versus the good perfusion category (33%,  $p = 0.03$ ). By multivariable analysis, diabetes (odds ratio [OR] 6.42;  $p = 0.04$ ) and non-perfusion (OR 6.60;  $p = 0.04$ ) were independently associated with leak.

### CONCLUSION:

Intraoperative use of ICG-FA may be a useful adjunct to assess perfusion of the gastric conduit with non-perfusion being independently associated with a leak. While perfusion plays an important role in anastomotic integrity, development of a leak is multifactorial, and ICG-FA should be used in conjunction with the optimization of patient and procedural components to minimize leak rates. Prospective, randomized studies are required to validate the interpretation, efficacy, and application of this novel technology in minimally invasive esophagectomies.



# GENERAL SURGERY

## ESOPHAGEAL SURGERY

### ABSTRACT

### NEAR-INFRARED FLUORESCENT IMAGE-GUIDED LYMPHATIC MAPPING IN ESOPHAGEAL SQUAMOUS CELL CARCINOMA

Jiang, H., Teng, H., Sun, Y. et al

Annals of Surgical Oncology, 2020, (retrospective study)

#### BACKGROUND/AIM:

Recently, the feasibility of near-infrared (NIR) image-guided sentinel lymph node (SLN) mapping has been tested in patients with gastrointestinal cancer. The aim of this study is to investigate whether SLN mapping can be used to identify mediastinal lymph node metastases during minimally invasive esophagectomy and explore the lymphatic drainage pattern of esophageal squamous cell carcinoma (ESCC) using NIR fluorescent imaging.

#### PATIENTS AND METHODS:

A total of 21 patients diagnosed with cT1–3 stage ESCC were enrolled. Patients received submucosal injection of indocyanine green diluted with sodium chloride (0.9%) at the start of the esophagectomy procedure followed by NIR mapping.

#### RESULTS:

Thoracoscopic-assisted McKeown esophagectomy with NIR imaging was successfully performed in all patients. The detection rate and number of NIR+ lymphnodes were 95.2% (20/21) and 4.0 (2.0–6.5), respectively. The accuracy, false-negative rates, and negative predictive value were 100% (10 of 10 cases), 0% (0 of 4), and 100% (6 of 6), respectively, for pT1/T2 diseases; and 80.0% (8 of 10), 40% (2 of 5), and 71.4% (5 of 7), respectively, for pT3 diseases. The NIR+ region was the most commonly detected in the right recurrent laryngeal nerve (80%), and the NIR+ region was identified in the upper mediastinal zone in 20 patients.

#### CONCLUSION:

Evaluation of the lymphatic drainage pattern and the application of sentinel lymph node in ESCC with real-time NIR imaging could be effective, especially in pT1/2 disease. NIR imaging-guided SLN navigation appears to be a clinically beneficial less-invasive method for treating ESCC.



<https://doi.org/10.1245/s10434-019-07969-6>

## NEAR-INFRARED IMAGE-GUIDED LYMPHATIC MAPPING IN MINIMALLY INVASIVE OESOPHAGECTOMY OF DISTAL OESOPHAGEAL CANCER

ABSTRACT

Helminen O., Mrena J., Sihvo E.

European Journal of Cardio-Thoracic Surgery, 2017, (controlled prospective study)

### BACKGROUND/AIM:

We aimed to assess the potential of near-infrared (NIR) imaging during minimally invasive oesophagectomy in patients with distal oesophageal cancer for detection of nodal metastases inside and outside the standard en bloc surgical field.

### PATIENTS AND METHODS:

We enrolled 6 patients diagnosed with distal oesophageal cancer for intraoperative lymphatic mapping with NIR imaging. Indocyanine green dye was injected endoscopically in 8 corners of the primary tumour at the start of the operation. The minimally invasive oesophagectomy with en bloc lymphadenectomy was performed using 3D optics. A separate endoscopic fluorescence imaging system was used to systematically detect the NIR signal of 23 lymphatic stations. The NIR-positive stations outside the en bloc resection area were also removed for histological analysis.

### RESULTS:

Lymphatic mapping was successful in all patients. The NIR-positive areas were most commonly detected in the lower mediastinum (100% of patients), cardia (83%), region of the left gastric artery (67%), celiac axis (50%) and pericardial–diaphragmatic groove (50%). We detected NIR-positive areas outside the traditional en bloc field above the azygous arch in 50% of the patients. A total of 182 lymph nodes were resected from 6 patients. In 3 patients, a total of 19 lymph node metastases were detected, 4 of which were outside the en bloc field.

### CONCLUSION:

NIR imaging can be useful for detecting lymphatic stations that most likely present with metastatic disease and to guide the tailored extension of the traditional lymphadenectomy.



doi:10.1093/ejcts/ezx141

# GENERAL SURGERY

## GASTRIC SURGERY

### ABSTRACT

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<https://doi.org/10.1007/s00464-020-07542-3>

## ASSESSMENT OF DIAGNOSTIC VALUE OF FLUORESCENT LYMPHOGRAPHY-GUIDED LYMPHADENECTOMY FOR GASTRIC CANCER

ABSTRACT

Jung, M.K., Cho, M., Roh, C.K. et al.

Gastric Cancer, 2020, (retrospective study)

### BACKGROUND/AIM:

Indocyanine green fluorescent lymphography helps visualize the lymphatic drainage pattern in gastric cancer; however, it is unknown whether fluorescent lymphography visualizes all metastatic lymph nodes. This study aimed to evaluate the sensitivity of fluorescent lymphography to detect metastatic lymph node stations and lymph nodes and the risk of false-negative findings.

### PATIENTS AND METHODS:

Patients with clinical T1–4a gastric cancer were included. Indocyanine green was peritumorally injected the day prior to surgery by endoscopy. Gastrectomy with systematic D1+ or D2 lymphadenectomy was performed. Stations and lymph nodes were retrieved at the back-table using near-infrared imaging and classified as “fluorescent” or “non-fluorescent” and later matched with histopathological findings.

### RESULTS:

Among 592 patients who underwent minimally invasive gastrectomy from September 2013 until December 2016, lymph node metastases were present in 150. The sensitivity of fluorescent lymphography in detecting all metastatic lymph node stations was 95.3% (143/150 patients), with a false-negative rate of 4.7% (7/150 patients) and the sensitivity in detecting all metastatic lymph nodes was 81.3% (122/150 patients). The negative predictive value was 99.3% for non-fluorescent stations and 99.2% for non-fluorescent LNs. For detecting all metastatic LN stations, subgroup analysis revealed 100% sensitivity for pT1a, 96.8% for pT1b, 100% for pT2, 91.3% for pT3, and 93.6% for pT4a tumors.

### CONCLUSION:

Fluorescent lymphography-guided lymphadenectomy can be a useful method for radical lymphadenectomy by facilitating the complete dissection of all potentially positive LN stations. Fluorescent lymphography-guided lymphadenectomy appears to be a reasonable alternative to conventional systematic lymphadenectomy for gastric cancer.



# GENERAL SURGERY

## GASTRIC SURGERY

### ABSTRACT

#### SAFETY AND EFFICACY OF INDOCYANINE GREEN TRACER-GUIDED LYMPH NODE DISSECTION DURING LAPAROSCOPIC RADICAL GASTRECTOMY IN PATIENTS WITH GASTRIC CANCER: A RANDOMIZED CLINICAL TRIAL

Chen Q.-Y., Xie J.-W., Zhong Q., et al.

*JAMA Surgery*, 2020, (randomized clinical prospective trial)

#### BACKGROUND/AIM:

The application of indocyanine green (ICG) imaging in laparoscopic radical gastrectomy is in the preliminary stages of clinical practice, and its safety and efficacy remain controversial. To investigate the safety and efficacy of ICG near-infrared tracer-guided imaging during laparoscopic D2 lymphadenectomy in patients with gastric cancer.

#### PATIENTS AND METHODS:

Patients with potentially resectable gastric adenocarcinoma (clinical tumor stage cT1–cT4a, N0/+, M0) were enrolled in a prospective randomized clinical trial at a tertiary referral teaching hospital between November 2018 and July 2019. Patients were randomly assigned to the ICG group or the non-ICG group. The number of retrieved lymph nodes, rate of lymph node noncompliance, and postoperative recovery data were compared between the groups in a modified intention-to-treat analysis. Statistical analysis was performed from August to September 2019. The ICG group underwent laparoscopic gastrectomy using near-infrared imaging after receiving an endoscopic peritumoral injection of ICG to the submucosa 1 day before surgery. Main Outcomes and Measures: Total number of retrieved lymph nodes.

#### RESULTS:

Of 266 participants randomized, 133 underwent ICG tracer-guided laparoscopic gastrectomy, and 133 underwent conventional laparoscopic gastrectomy. After postsurgical exclusions, 258 patients were included in the modified intention-to-treat analysis, which comprised 129 patients (86 men and 43 women; mean [SD] age, 57.8 [10.7] years) in the ICG group and 129 patients (87 men and 42 women; mean [SD] age, 60.1 [9.1] years) in the non-ICG group. The mean number of lymph nodes retrieved in the ICG group was significantly more than the mean number retrieved in the non-ICG group (mean [SD], 50.5 [15.9] lymph nodes vs 42.0 [10.3] lymph nodes, respectively;  $P < .001$ ). Significantly more perigastric and extraperigastric lymph nodes were retrieved in the ICG group than in the non-ICG group. In addition, the mean total number of lymph nodes retrieved in the ICG group within the scope of D2 lymphadenectomy was also significantly greater than the mean number retrieved in the non-ICG group (mean [SD], 49.6 [15.0] lymph nodes vs 41.7 [10.2] lymph nodes, respectively;  $P < .001$ ). The lymph node noncompliance rate of the ICG group (41 of 129 patients [31.8%]) was lower than that of the non-ICG group (74 of 129 patients [57.4%];  $P < .001$ ). The postoperative recovery process was comparable, and no significant difference was found between the ICG and non-ICG groups in the incidence (20 of 129 patients [15.5%] vs 21 of 129 [16.3%], respectively;  $P = .86$ ) or severity of complications within 30 days after surgery.

## CONCLUSION:

Indocyanine green can noticeably improve the number of lymph node dissections and reduce lymph node noncompliance without increased complications in patients undergoing D2 lymphadenectomy. Indocyanine green fluorescence imaging can be performed for routine lymphatic mapping during laparoscopic gastrectomy, especially total gastrectomy.



# GENERAL SURGERY

## GASTRIC SURGERY

### ABSTRACT

#### FLUORESCENT LYMPHOGRAPHY DURING MINIMALLY INVASIVE TOTAL GASTRECTOMY FOR GASTRIC CANCER: AN EFFECTIVE TECHNIQUE FOR SPLENIC HILAR LYMPH NODE DISSECTION

Lee S., Song J.H., Choi S., et al.

*Surgical Endoscopy*, 2021, (retrospective study)

#### BACKGROUND/AIM:

Fluorescent lymphography is an excellent technique for complete lymph node dissection during minimally invasive surgery for gastric cancer. This study aimed to evaluate the role of fluorescent lymphography in splenic hilar lymph node dissection during minimally invasive total gastrectomy.

#### PATIENTS AND METHODS:

We retrospectively analyzed 168 gastric cancer patients who underwent minimally invasive total gastrectomy with D2 + No. 10 lymph node dissection from 2013 to 2018. Fluorescent lymphography was used whenever it is possible. However, when near-infrared imaging system and endoscopic indocyanine green injection were not available, we performed surgery without fluorescent lymphography. A total of 74 patients underwent surgery with fluorescent lymphography (FL group) and 94 underwent surgery without it (non-FL group). Perioperative and long-term outcomes including the number of retrieved lymph nodes at each nodal station were compared between groups.

#### RESULTS:

The median number of retrieved lymph nodes at the splenic hilum was larger in the FL group {2.5 [Interquartile range (IQR), 1–5]} than in the non-FL group [1 (IQR, 1–3);  $P = 0.012$ ]. The negative predictive value of fluorescent lymphography for lymph node metastasis at the splenic hilum was 97.1%, although the sensitivity was 66.7%. The overall survival (FL: 96.9% vs. non-FL: 88.9%;  $P = 0.334$ ) and relapse-free survival (FL: 90.5% vs. non-FL: 65.5%;  $P = 0.054$ ) were higher in the FL group, although there were no statistical differences. However, among the patients without lymph node metastasis, the relapse-free survival was significantly higher in the FL group (100%) than in the non-FL group (67.1%;  $P = 0.017$ ).

#### CONCLUSION:

Fluorescent lymphography is an effective tool for complete lymph node dissection at the splenic hilum. Moreover, it may help select patients who do not need splenic hilar lymph node dissection during a total gastrectomy.



<https://doi.org/10.1007/s00464-021-08584-x>

## REAL-TIME VESSEL NAVIGATION USING INDOCYANINE GREEN FLUORESCENCE DURING ROBOTIC OR LAPAROSCOPIC GASTRECTOMY FOR GASTRIC CANCER

ABSTRACT

Kim M., Son S.-Y., Cui L.-H., et al.

Journal of Gastric Cancer, 2017, (controlled prospective study)

### BACKGROUND/AIM:

Identification of the infrapyloric artery (IPA) type is a key component of pylorus-preserving gastrectomy. As the indocyanine green (ICG) fluorescence technique is known to help visualize blood vessels and flow during reconstruction, we speculated that this emerging technique would be helpful in identifying the IPA type.

### PATIENTS AND METHODS:

From August 2015 to February 2016, 20 patients who underwent robotic or laparoscopic gastrectomy were prospectively enrolled. After intravenous injection of approximately 3 mL of ICG (2.5 mg/mL), a near-infrared fluorescence apparatus was applied. The identified shape of the IPA was confirmed by examining the actual anatomy following infrapyloric dissection.

### RESULTS:

The mean interval time between ICG injection and visualization of the artery was 22.2 seconds (range, 14–30 seconds), and the mean duration of the arterial phase was 16.1 seconds (range, 9–30 seconds). The overall positive predictive value (PPV) of ICG fluorescence in identifying the IPA type was 80% (16/20). The IPA type was incorrectly predicted in four patients, all of whom were obese with a body mass index (BMI) of more than 25 kg/m<sup>2</sup>.

### CONCLUSION:

Our preliminary results indicate that intraoperative vascular imaging using the ICG fluorescence technique may be helpful for robotic or laparoscopic pylorus-preserving gastrectomy.



# GENERAL SURGERY

## URETER IDENTIFICATION

### ABSTRACT

### REAL-TIME VISUALIZATION OF URETERS USING INDOCYANINE GREEN DURING LAPAROSCOPIC SURGERIES: CAN WE MAKE SURGERY SAFER?

Mandovra P., Vishaka K., Roy V. P.

Surgical Innovation. 2019, (controlled prospective study)

#### BACKGROUND/AIM:

Intraoperative ureteral injury is rare, but a grave complication during laparoscopic surgery. Several methods for intraoperative localization of ureters are described with their own pitfalls. Intraoperative localization using near-infrared (NIR) fluorescence with indocyanine green (ICG) is an easier and assured method during laparoscopic pelvic surgeries.

#### PATIENTS AND METHODS:

From September 2017 to December 2017, patients undergoing laparoscopic pelvic surgeries were administered cystoscopic-guided intraureteral ICG immediately preoperatively with tip of a 6-Fr ureteral catheter. The fluorescence of ureters was visualized in the NIR mode of the camera system, localizing the ureters precisely and in real time.

#### RESULTS:

This technique was used to visualize ureters in 30 surgeries. Median age of the patients was 46.7 years with median body mass index of 23.2 kg/m<sup>2</sup>. Mean duration between administration of dye and insertion of trocar was 10 minutes. Mean duration for insertion of cystoscopically guided intraureteral ICG was 7 minutes. Ureteral fluorescence was visualized in all cases with some variation in intensity of the brightness perceived depending on surrounding fat. Duration of the lengthiest surgery was 240 minutes, and fluorescence was appreciated till the end. There were no intraoperative or postoperative complications attributed to ICG administration. In 10 patients (33%), there was difficulty in identifying the ureters on conventional white light mode, in which ICG localization was extremely helpful.

#### CONCLUSION:

ICG-stained ureteral visualization under NIR light is a safe and feasible method that provides real-time ureteral demarcation. This easily replicable, sensitive, and specific method of ureteral visualization can make complex laparoscopic pelvic surgeries safer.



<https://doi.org/10.1177/1553350619827152>

## INDOCYANINE GREEN FLUORESCENCE IMAGING FOR LAPAROSCOPIC COMPLEX UPPER URINARY TRACT RECONSTRUCTIONS: A COMPARATIVE STUDY

ABSTRACT

Zhu W., Xiong S., Wu Y., et al.

Translational Andrology and Urology, 2021, (comparative study/retrospective review)

### BACKGROUND/AIM:

To describe our technique for using an intraureteral injection of indocyanine green (ICG) and visualization under near-infrared fluorescence (NIRF) to facilitate challenging upper urinary tract reconstructions (UUTRs) and to present the comparative outcomes.

### PATIENTS AND METHODS:

We collected 36 patients who underwent laparoscopic UUTRs between April 2019 and March 2020, and we divided the patients into two groups based on the use of ICG (ICG group and non-ICG group). Demographic characteristics, perioperative outcomes, and functional outcomes were compared between the two groups.

### RESULTS:

There were 18 cases in the ICG group and 18 cases in the non-ICG group, respectively. There were no differences in the baseline characteristics between the two groups. The intraoperative time to identification of the ureter (TIU;  $20.9 \pm 11.7$  vs.  $30.0 \pm 14.6$  min,  $P=0.03$ ) and length of postoperative hospital stay (LPHS;  $11.1 \pm 3.0$  vs.  $16.6 \pm 10.0$  days,  $P=0.03$ ) were significantly shorter in the ICG group. There was also a trend for lesser time for locating the stricture ( $43.0 \pm 27.9$  vs.  $55.4 \pm 18.6$  min,  $P=0.14$ ) and lower estimated blood loss (EBL) in the ICG group patients ( $88.3 \pm 75.4$  vs.  $91.7 \pm 46.2$  mL,  $P=0.22$ ). During the mean 3.8-month follow-up for the ICG group and the 6.2-month for the non-ICG group, there was a trend for more severe complications in the non-ICG group.

### CONCLUSION:

Visualizing intraureteral ICG under NIRF is useful in challenging UUTRs, allows for rapid ureteral identification and accurate real-time delineation of the ureteral stricture margins, and provides encouraging follow-up outcomes compared with those in the non-ICG group.



DOI: 10.21037/tau-20-1261

# GENERAL SURGERY

## URETER IDENTIFICATION

### ABSTRACT

#### INTRA-OPERATIVE IDENTIFICATION OF URETERS USING INDOCYANINE GREEN FOR GYNECOLOGICAL ONCOLOGY PROCEDURES

Cabanés M., Boria F., Gutiérrez A. H., et al.

International Journal of Gynecological Cancer, 2020, Video article

#### BACKGROUND/AIM:

It is well known that ureteral injury is a possible complication of gynecological surgery. The literature reports rates for ureteral injuries for pelvic surgery ranging from 1% to 10% as the complexity of the procedure increases. Many of these injuries remain unrecognized during the surgery. Patients with prior surgical procedures, endometriosis, inflammatory bowel disease, or gynecological cancers are more likely to present this complication. Different identification techniques have been described, such as regular ureteral stent placement, methylene blue injection, or illuminated ureteral catheter positioning. However, all of them are moderately expensive, time consuming, or with a lack of high-quality ureteral visualization.

#### PATIENTS AND METHODS:

We present a new ureteral visualization technique in order to avoid complications related to ureteral injury during gynecological oncologic surgeries (video). By using indocyanine green (ICG) injection in the ureters by cystoscopy, the fluorescent ureters can be easily identified to assess their location or facilitate their dissection. Ureteral visualization by ICG has been previously used experimentally in different medical areas such as colorectal surgery. Our simplification of the technique includes the following steps: (1) cystoscopy to place in the ureter 10 cm of a 6 Fr catheter; (2) ureteral injection of 8 mL ICG solution (concentration 1.25 mg/mL); (3) removal of ureteral catheters (full ureteral catheterization is not needed); (4) intra-operative identification using near infrared light at the locations needed (transperitoneally, infundibulopelvic area, lateral parametria, or ventral parametria). This technique may be used both in laparoscopic and open surgery by using a laparoscopic endoscope or a specific near infrared camera, respectively.

#### RESULTS:

We have carried out this technique in 16 patients to date with 100% success in ureteral identification. The equipment used was Olympus endoscopy tower Visera Elite II S200 with 0° infrared scope (OLYMPUS IBERIA S.A.U, Barcelona, Spain). The main advantage is a lower risk of ureteral injury due to real-time identification during the surgical procedure.

Moreover, our technique is a cheaper option than others with high-quality visualization, is much less time-consuming (15 additional minutes to the procedure), and has a low adverse event profile.

## CONCLUSION:

We conclude that ureteral identification using ICG injection is a feasible option to facilitate ureteral dissection and assessment of its location during gynecological oncologic surgery, with a low cost and good safety profile that could prevent ureteral injury.

## ABSTRACT



# GENERAL SURGERY

## HEPATIC SURGERY

### ABSTRACT

#### COULD FLUORESCENCE-GUIDED SURGERY BE AN EFFICIENT AND SUSTAINABLE OPTION? A SICE (ITALIAN SOCIETY OF ENDOSCOPIC SURGERY) HEALTH TECHNOLOGY ASSESSMENT SUMMARY

Vettoretto, N., Foglia, E., Ferrario, L. et al.

*Surgical Endoscopy*, 2020, (evaluation/comparative study)

#### BACKGROUND/AIM:

Indocyanine green fluorescence vision is an upcoming technology in surgery. It can be used in three ways: angiographic and biliary tree visualization and lymphatic spreading studies. The present paper shows the most outstanding results from a health technology assessment study design, conducted on fluorescence-guided compared with standard vision surgery.

#### PATIENTS AND METHODS:

A health technology assessment approach was implemented to investigate the economic, social, ethical, and organizational implications related to the adoption of the innovative fluorescence-guided view, with a focus on minimally invasive approach. With the support of a multidisciplinary team, qualitative and quantitative data were collected, by means of literature evidence, validated questionnaires and self-reported interviews, considering the dimensions resulting from the EUnetHTA Core Model.

#### RESULTS:

From a systematic search of literature, we retrieved the following studies: 6 on hepatic, 1 on pancreatic, 4 on biliary, 2 on bariatric, 4 on endocrine, 2 on thoracic, 11 on colorectal, 7 on urology, 11 on gynecology, 2 on gastric surgery. Fluorescence guide has shown advantages on the length of hospitalization particularly in colorectal surgery, with a reduction of the rate of leakages and re-do anastomoses, in spite of a slight increase in operating time, and is confirmed to be a safe, efficacious, and sustainable vision technology. Clinical applications are still presenting a low evidence in the literature.

#### CONCLUSION:

The present paper, under the patronage of Italian Society of Endoscopic Surgery, based on an HTA approach, sustains the use of fluorescence-guided vision in minimally invasive surgery, in the fields of general, gynecologic, urologic, and thoracic surgery, as an efficient and economically sustainable technology.



<https://doi.org/10.1007/s00464-020-07542-3>

## DEMARCATING THE EXACT MIDPLANE OF THE LIVER USING INDOCYANINE GREEN NEAR-INFRARED FLUORESCENCE IMAGING DURING LAPAROSCOPIC DONOR HEPATECTOMY

ABSTRACT

Kim J., Hong S.K., Lim J., et al.

Liver Transplantation, 2021, (retrospective study)

### BACKGROUND/AIM:

Indocyanine green (ICG) near-infrared fluoroscopy has been recently implemented in pure laparoscopic donor hepatectomy (PLDH). This study aims to quantitatively evaluate the effectiveness of ICG fluoroscopy during liver midplane dissection in PLDH and to demonstrate that a single injection of ICG is adequate for both midplane dissection and bile duct division.

### PATIENTS AND METHODS:

Retrospective analysis was done with images acquired from recordings of PLDH performed without ICG (pre-ICG group) from November 2015 to May 2016 and with ICG (post-ICG group) from June 2016 to May 2017. 30 donors from the pre-ICG group were compared with 46 donors from the post-ICG group.

### RESULTS:

The operation time was shorter ( $P = 0.002$ ) and postoperative peak aspartate aminotransferase (AST) and alanine aminotransferase (ALT) levels were lower ( $P = 0.031$  and  $P = 0.019$ , respectively) in the post-ICG group than the pre-ICG group. Within the post-ICG group, the color intensity differences between the clamped versus nonclamped regions in the natural, black-and-white, and fluorescent modes were  $39.7 \pm 36.2$ ,  $89.6 \pm 46.9$ , and  $19.1 \pm 36.8$  (mean  $\pm$  SD,  $P < 0.001$ ), respectively. The luminosity differences were  $37.2 \pm 34.5$ ,  $93.8 \pm 32.1$ , and  $26.7 \pm 25.7$  ( $P < 0.001$ ), respectively. Meanwhile, the time from when ICG was injected to when the near-infrared camera was turned on for bile duct visualization was  $85.6 \pm 25.8$  minutes. All grafts received from the 46 donors were successfully transplanted.

### CONCLUSION:

In conclusion, ICG fluoroscopy helps to reduce operation time and lower postoperative AST/ALT levels. ICG injection visualized with black-and-white imaging is most effective for demarcating the liver midplane during PLDH. A single intravenous injection of ICG is sufficient for midplane dissection as well as bile duct division.



# GENERAL SURGERY

## PANCREATIC SURGERY

### ABSTRACT

#### COULD FLUORESCENCE-GUIDED SURGERY BE AN EFFICIENT AND SUSTAINABLE OPTION? A SICE (ITALIAN SOCIETY OF ENDOSCOPIC SURGERY) HEALTH TECHNOLOGY ASSESSMENT SUMMARY

Vettoretto, N., Foglia, E., Ferrario, L. et al.

*Surgical Endoscopy*, 2020, (evaluation/comparative study)

#### BACKGROUND/AIM:

Indocyanine green fluorescence vision is an upcoming technology in surgery. It can be used in three ways: angiographic and biliary tree visualization and lymphatic spreading studies. The present paper shows the most outstanding results from a health technology assessment study design, conducted on fluorescence-guided compared with standard vision surgery.

#### PATIENTS AND METHODS:

A health technology assessment approach was implemented to investigate the economic, social, ethical, and organizational implications related to the adoption of the innovative fluorescence-guided view, with a focus on minimally invasive approach. With the support of a multidisciplinary team, qualitative and quantitative data were collected, by means of literature evidence, validated questionnaires and self-reported interviews, considering the dimensions resulting from the EUnetHTA Core Model.

#### RESULTS:

From a systematic search of literature, we retrieved the following studies: 6 on hepatic, 1 on pancreatic, 4 on biliary, 2 on bariatric, 4 on endocrine, 2 on thoracic, 11 on colorectal, 7 on urology, 11 on gynecology, 2 on gastric surgery. Fluorescence guide has shown advantages on the length of hospitalization particularly in colorectal surgery, with a reduction of the rate of leakages and re-do anastomoses, in spite of a slight increase in operating time, and is confirmed to be a safe, efficacious, and sustainable vision technology. Clinical applications are still presenting a low evidence in the literature.

#### CONCLUSION:

The present paper, under the patronage of Italian Society of Endoscopic Surgery, based on an HTA approach, sustains the use of fluorescence-guided vision in minimally invasive surgery, in the fields of general, gynecologic, urologic, and thoracic surgery, as an efficient and economically sustainable technology.



<https://doi.org/10.1007/s00464-020-07542-3>

## HOW TO PERFORM TOTAL LAPAROSCOPIC DUODENUM-PRESERVING PANCREATIC HEAD RESECTION SAFELY AND EFFICIENTLY WITH INNOVATIVE TECHNIQUES

ABSTRACT

Hong, D., Cheng, J., Wu, W. et al.

Annals of Surgical Oncology, 2020, (retrospective study)

### BACKGROUND/AIM:

Although rapid progress has been achieved in laparoscopic pancreaticoduodenectomy (PD) over the last decade, laparoscopic duodenum-preserving pancreatic head resection (LDPPHR) remains a challenging surgery that has been rarely reported due to not only requiring complicated pancreaticojejunostomy (PJ) but also ensuring sufficient blood supplies to duodenum and common bile duct (CBD). We completed LDPPHR for 22 patients safely and efficiently with innovative techniques.

### PATIENTS AND METHODS:

Clinical outcomes, including rate of conversion to laparotomy, time of residual pancreatic duct reconstruction, incidence of postoperative complications, and time of hospital stay, were collected for 22 consecutive patients who underwent LDPPHR with innovative techniques as follows: application of indocyanine green (ICG) to visualize and preserve CBD and the vessels supplying the duodenum and CBD, Hong's PJ, and pancreatic duct end-to-end anastomosis (ETEA) for the residual pancreas.

### RESULTS:

All surgeries were performed successfully under laparoscopy except for one case. The duration of ETEA was significantly shorter than PJ ( $18.2 \pm 5.1$  min versus  $27.5 \pm 8.3$  min,  $p < 0.05$ ). There was no significant difference in incidence of postoperative complications between the Hong's PJ and ETEA group. The overall incidence of postoperative pancreatic fistula (POPF) in the Hong's PJ and ETEA group was 23.5% and 20%, respectively, without grade C fistula. All complications were resolved after conservative treatment.

### CONCLUSION:

By utilizing intraoperative ICG navigation, LDPPHR is a minimally invasive, safe, and efficient approach for chronic pancreatitis with pancreatic head stones by using pancreatic duct ETEA and benign or low-grade malignant tumors of the pancreatic head by using Hong's PJ.



# GENERAL SURGERY

## SENTINEL LYMPH NODE MAPPING

### ABSTRACT

#### COULD FLUORESCENCE-GUIDED SURGERY BE AN EFFICIENT AND SUSTAINABLE OPTION? A SICE (ITALIAN SOCIETY OF ENDOSCOPIC SURGERY) HEALTH TECHNOLOGY ASSESSMENT SUMMARY

Vettoretto, N., Foglia, E., Ferrario, L. et al.

*Surgical Endoscopy*, 2020, (evaluation/comparative study)

#### BACKGROUND/AIM:

Indocyanine green fluorescence vision is an upcoming technology in surgery. It can be used in three ways: angiographic and biliary tree visualization and lymphatic spreading studies. The present paper shows the most outstanding results from a health technology assessment study design, conducted on fluorescence-guided compared with standard vision surgery.

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A health technology assessment approach was implemented to investigate the economic, social, ethical, and organizational implications related to the adoption of the innovative fluorescence-guided view, with a focus on minimally invasive approach. With the support of a multidisciplinary team, qualitative and quantitative data were collected, by means of literature evidence, validated questionnaires and self-reported interviews, considering the dimensions resulting from the EUnetHTA Core Model.

#### RESULTS:

From a systematic search of literature, we retrieved the following studies: 6 on hepatic, 1 on pancreatic, 4 on biliary, 2 on bariatric, 4 on endocrine, 2 on thoracic, 11 on colorectal, 7 on urology, 11 on gynecology, 2 on gastric surgery. Fluorescence guide has shown advantages on the length of hospitalization particularly in colorectal surgery, with a reduction of the rate of leakages and re-do anastomoses, in spite of a slight increase in operating time, and is confirmed to be a safe, efficacious, and sustainable vision technology. Clinical applications are still presenting a low evidence in the literature.

#### CONCLUSION:

The present paper, under the patronage of Italian Society of Endoscopic Surgery, based on an HTA approach, sustains the use of fluorescence-guided vision in minimally invasive surgery, in the fields of general, gynecologic, urologic, and thoracic surgery, as an efficient and economically sustainable technology.



<https://doi.org/10.1007/s00464-020-07542-3>

## SENTINEL NODES DETECTION WITH NEAR-INFRARED IMAGING IN GYNECOLOGICAL CANCER PATIENTS: USHERING IN AN ERA OF PRECISION MEDICINE

ABSTRACT

Namazov A., Volchok V., Liboff A., et al.

IMAJ, 2019 (retrospective study)

### BACKGROUND/AIM:

The sentinel lymph node (SLN) biopsy procedure is a well-known method for identifying solid tumors such as breast cancer, vulvar cancer, and melanoma. In endometrial and cervical cancer, SLN has recently gained acceptance. To evaluate the detection rate of SLN with an indocyanine green and near-infrared fluorescent imaging (ICG/NIR) integrated laparoscopic system in clinically uterine-confined endometrial or cervical cancer.

### PATIENTS AND METHODS:

Patients with clinically early-stage endometrial or cervical cancer were included in this retrospective study. ICG was injected into the uterine cervix and an ICG/NIR integrated laparoscopic system was used during the surgeries. The National Comprehensive Cancer Network (NCCN) protocol was followed. SLN and/or suspicious lymph nodes were resected. Side-specific lymphadenectomy was performed when mapping was unsuccessful. Systematic lymphadenectomy was completed in patients with high-grade histology or deep myometrial invasion. Enhanced pathology using ultra-staging and immunohistochemistry were performed in all cases.

### RESULTS:

We analyzed 46 eligible patients: 39 endometrial and 7 cervical cancers. Of these, 44 had at least one SLN (93.6%). In 41 patients (89%) we detected bilateral SLN, in 3 (7%) only unilateral, and in 2 (4%) none were detected. Seven patients presented with lymph node metastasis. All were detected by NCCN/SLN protocol. Of these cases, two were detected with only pathological ultra-staging.

### CONCLUSION:

SLN mapping in endometrial and cervical cancer can easily be performed with a high detection rate by integrating ICG/NIR into a conventional laparoscopic system. Precision medicine in patients evaluated by SLN biopsy changes the way patients with endometrial or cervical cancer are managed.

<https://pubmed.ncbi.nlm.nih.gov/31280507/>



# GYNECOLOGY

## SENTINEL LYMPH NODE MAPPING

### ABSTRACT

### LAPAROSCOPIC SENTINEL NODE MAPPING IN ENDOMETRIAL CANCER AFTER HYSTEROSCOPIC INJECTION OF INDOCYANINE GREEN

Martinelli F., Ditto A., Bogani G., et al.

JMIG, 2016, (controlled prospective study)

#### BACKGROUND/AIM:

To report the detection rate (DR) of sentinel lymph nodes (SLNs) in endometrial cancer (EC) patients after hysteroscopic injection of indocyanine green (ICG) and laparoscopic near-infrared (L-NIR) fluorescence mapping.

#### PATIENTS AND METHODS:

Consecutive patients with apparent early-stage endometrioid EC scheduled for surgical treatment: total laparoscopic hysterectomy, bilateral salpingo-oophorectomy, SLN mapping. The mapping technique consisted in an intraoperative hysteroscopic peritumoral injection of 5 mg ICG followed by L-NIR fluorescence mapping. Evaluations of the SLN DR and sites of mapping were performed.

#### RESULTS:

A total of 57 procedures was performed. Patient mean age was 60 years (range, 28-80) and mean body mass index was 28.2 kg/m<sup>2</sup> (range, 19-43). At least 1 SLN was detected in 89.5% of the whole population (51/57). After the first 16 cases, L-NIR camera technical improvement led to a 95% DR (39/41). The mean number of harvested SLNs was 4.1 (range, 1-8), and in 47% of cases SLNs mapped to aortic nodes (24/51). Bilateral pelvic mapping was found in 74.5% of cases (38/51). Three patients had SLN metastases: 1 in the pelvic area only, 1 both in the pelvic and aortic area, and 1 presented with 2 metastatic aortic SLNs with negative pelvic SLNs. Overall, 2 of 3 node-positive patients (67%) had aortic SLN involvement. No adverse events were reported.

#### CONCLUSION:

Laparoscopic SLN mapping after the hysteroscopic injection of ICG has comparable DRs with both radioactive tracer series and ICG series with cervical injection, overcoming the need for radioactive substances. Hysteroscopic injection leads to a higher mapping in the aortic area compared with cervical injection. Further investigation is warranted on this topic.



<https://doi.org/10.1016/j.jmig.2016.09.020>

## INDOCYANINE GREEN AND INFRARED FLUORESCENCE IN DETECTION OF SENTINEL LYMPH NODES IN ENDOMETRIAL AND CERVICAL CANCER STAGING – A SYSTEMATIC REVIEW

ABSTRACT

Rocha A., Domínguez A.M., Lécuru F., et al.

EJOG, 2016, (systematic review)

### BACKGROUND/AIM:

Sentinel lymph node (SLN) mapping for endometrial (EC) and cervical cancers (CC) is a current technique that could provide benefits over traditional lymphadenectomy. Near-infrared (NIR) fluorescence imaging is a promising technique to perform this procedure. We conducted a systematic review of the evidence regarding the technique and the effectiveness of indocyanine green (ICG) during SLN biopsy, using robotic and laparoscopic assisted surgery and laparotomy.

### PATIENTS AND METHODS:

We conducted a computer literature search for published English language studies in humans using PubMed since January 2010 up to May 2015. The initial search came up with 17 articles, of which 10 articles used ICG as tracer in SLN biopsy in EC and CC.

### RESULTS:

422 patients were included in 10 studies, ranging from 1 to 227 patients. The main surgical approach used in ICG SLN biopsy was robotic-assisted surgery in 368 patients. Laparotomy was performed in 39 patients and laparoscopy in 15. The detection rate in SLN mapping using ICG ranged from 78% to 100% for cervical injection and from 33% to 100% for hysteroscopic injection. Sensitivity and negative predictive value (NPV) vary from 50% to 100% and 88% to 100%, respectively. The most common site of injection was the cervix (two quadrants); this technique is correlated with a high detection rate (ranging from 78% to 95%). The cervical submucosal and stromal injections were the most frequent sites used. No complications related to ICG administration were described.

### CONCLUSION:

NIR fluorescence imaging using ICG is performed in robotic-assisted surgery in laparoscopy and in laparotomy, being a feasible, safe, time-efficient and seemingly reliable method for lymphatic mapping in early stage of CC and EC. Although it has promising results in SLN mapping, randomized studies, with larger patient samples, are needed.



# GYNECOLOGY

## URETER IDENTIFICATION

### ABSTRACT

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Mandovra P., Vishaka K., Roy V. P.

Surgical Innovation. 2019, (controlled prospective study)

#### BACKGROUND/AIM:

Intraoperative ureteral injury is rare, but a grave complication during laparoscopic surgery. Several methods for intraoperative localization of ureters are described with their own pitfalls. Intraoperative localization using near-infrared (NIR) fluorescence with indocyanine green (ICG) is an easier and assured method during laparoscopic pelvic surgeries.

#### PATIENTS AND METHODS:

From September 2017 to December 2017, patients undergoing laparoscopic pelvic surgeries were administered cystoscopic-guided intraureteral ICG immediately preoperatively with tip of a 6-Fr ureteral catheter. The fluorescence of ureters was visualized in the NIR mode of the camera system, localizing the ureters precisely and in real time.

#### RESULTS:

This technique was used to visualize ureters in 30 surgeries. Median age of the patients was 46.7 years with median body mass index of 23.2 kg/m<sup>2</sup>. Mean duration between administration of dye and insertion of trocar was 10 minutes. Mean duration for insertion of cystoscopically guided intraureteral ICG was 7 minutes. Ureteral fluorescence was visualized in all cases with some variation in intensity of the brightness perceived depending on surrounding fat. Duration of the lengthiest surgery was 240 minutes, and fluorescence was appreciated till the end. There were no intraoperative or postoperative complications attributed to ICG administration. In 10 patients (33%), there was difficulty in identifying the ureters on conventional white light mode, in which ICG localization was extremely helpful.

#### CONCLUSION:

ICG-stained ureteral visualization under NIR light is a safe and feasible method that provides real-time ureteral demarcation. This easily replicable, sensitive, and specific method of ureteral visualization can make complex laparoscopic pelvic surgeries safer.



<https://doi.org/10.1177/1553350619827152>

## INDOCYANINE GREEN FLUORESCENCE IMAGING FOR LAPAROSCOPIC COMPLEX UPPER URINARY TRACT RECONSTRUCTIONS: A COMPARATIVE STUDY

ABSTRACT

Zhu W., Xiong S., Wu Y., et al.

Translational Andrology and Urology, 2021, (comparative study/retrospective review)

### BACKGROUND/AIM:

To describe our technique for using an intraureteral injection of indocyanine green (ICG) and visualization under near-infrared fluorescence (NIRF) to facilitate challenging upper urinary tract reconstructions (UUTRs) and to present the comparative outcomes.

### PATIENTS AND METHODS:

We collected 36 patients who underwent laparoscopic UUTRs between April 2019 and March 2020, and we divided the patients into two groups based on the use of ICG (ICG group and non-ICG group). Demographic characteristics, perioperative outcomes, and functional outcomes were compared between the two groups.

### RESULTS:

There were 18 cases in the ICG group and 18 cases in the non-ICG group, respectively. There were no differences in the baseline characteristics between the two groups. The intraoperative time to identification of the ureter (TIU;  $20.9 \pm 11.7$  vs.  $30.0 \pm 14.6$  min,  $P=0.03$ ) and length of postoperative hospital stay (LPHS;  $11.1 \pm 3.0$  vs.  $16.6 \pm 10.0$  days,  $P=0.03$ ) were significantly shorter in the ICG group. There was also a trend for lesser time for locating the stricture ( $43.0 \pm 27.9$  vs.  $55.4 \pm 18.6$  min,  $P=0.14$ ) and lower estimated blood loss (EBL) in the ICG group patients ( $88.3 \pm 75.4$  vs.  $91.7 \pm 46.2$  mL,  $P=0.22$ ). During the mean 3.8-month follow-up for the ICG group and the 6.2-month for the non-ICG group, there was a trend for more severe complications in the non-ICG group.

### CONCLUSION:

Visualizing intraureteral ICG under NIRF is useful in challenging UUTRs, allows for rapid ureteral identification and accurate real-time delineation of the ureteral stricture margins, and provides encouraging follow-up outcomes compared with those in the non-ICG group.



DOI: 10.21037/tau-20-1261

# GYNECOLOGY

## URETER IDENTIFICATION

### ABSTRACT

#### INTRA-OPERATIVE IDENTIFICATION OF URETERS USING INDOCYANINE GREEN FOR GYNECOLOGICAL ONCOLOGY PROCEDURES

Cabanes M., Boria F., Gutiérrez A. H., et al.

International Journal of Gynecological Cancer, 2020, Video article

#### BACKGROUND/AIM:

It is well known that ureteral injury is a possible complication of gynecological surgery. The literature reports rates for ureteral injuries for pelvic surgery ranging from 1% to 10% as the complexity of the procedure increases. Many of these injuries remain unrecognized during the surgery. Patients with prior surgical procedures, endometriosis, inflammatory bowel disease, or gynecological cancers are more likely to present this complication. Different identification techniques have been described, such as regular ureteral stent placement, methylene blue injection, or illuminated ureteral catheter positioning. However, all of them are moderately expensive, time consuming, or with a lack of high-quality ureteral visualization.

#### PATIENTS AND METHODS:

We present a new ureteral visualization technique in order to avoid complications related to ureteral injury during gynecological oncologic surgeries (video). By using indocyanine green (ICG) injection in the ureters by cystoscopy, the fluorescent ureters can be easily identified to assess their location or facilitate their dissection. Ureteral visualization by ICG has been previously used experimentally in different medical areas such as colorectal surgery. Our simplification of the technique includes the following steps: (1) cystoscopy to place in the ureter 10 cm of a 6 Fr catheter; (2) ureteral injection of 8 mL ICG solution (concentration 1.25 mg/mL); (3) removal of ureteral catheters (full ureteral catheterization is not needed); (4) intra-operative identification using near infrared light at the locations needed (transperitoneally, infundibulopelvic area, lateral parametria, or ventral parametria). This technique may be used both in laparoscopic and open surgery by using a laparoscopic endoscope or a specific near infrared camera, respectively.

#### RESULTS:

We have carried out this technique in 16 patients to date with 100% success in ureteral identification. The equipment used was Olympus endoscopy tower Visera Elite II S200 with 0° infrared scope (OLYMPUS IBERIA S.A.U, Barcelona, Spain). The main advantage is a lower risk of ureteral injury due to real-time identification during the surgical procedure. Moreover, our technique is a cheaper option than others with high-quality visualization, is much less time-consuming (15 additional minutes to the procedure), and has a low adverse event profile.

## CONCLUSION:

We conclude that ureteral identification using ICG injection is a feasible option to facilitate ureteral dissection and assessment of its location during gynecological oncologic surgery, with a low cost and good safety profile that could prevent ureteral injury.

## ABSTRACT



# UROLOGY

## PARTIAL PROSTATECTOMY, PARTIAL NEPHRECTOMY, PYELOPLASTY AND OTHERS

### ABSTRACT

#### COULD FLUORESCENCE-GUIDED SURGERY BE AN EFFICIENT AND SUSTAINABLE OPTION? A SICE (ITALIAN SOCIETY OF ENDOSCOPIC SURGERY) HEALTH TECHNOLOGY ASSESSMENT SUMMARY

Vettoretto, N., Foglia, E., Ferrario, L. et al.

*Surgical Endoscopy*, 2020, (evaluation/comparative study)

#### BACKGROUND/AIM:

Indocyanine green fluorescence vision is an upcoming technology in surgery. It can be used in three ways: angiographic and biliary tree visualization and lymphatic spreading studies. The present paper shows the most outstanding results from a health technology assessment study design, conducted on fluorescence-guided compared with standard vision surgery.

#### PATIENTS AND METHODS:

A health technology assessment approach was implemented to investigate the economic, social, ethical, and organizational implications related to the adoption of the innovative fluorescence-guided view, with a focus on minimally invasive approach. With the support of a multidisciplinary team, qualitative and quantitative data were collected, by means of literature evidence, validated questionnaires and self-reported interviews, considering the dimensions resulting from the EUnetHTA Core Model.

#### RESULTS:

From a systematic search of literature, we retrieved the following studies: 6 on hepatic, 1 on pancreatic, 4 on biliary, 2 on bariatric, 4 on endocrine, 2 on thoracic, 11 on colorectal, 7 on urology, 11 on gynecology, 2 on gastric surgery. Fluorescence guide has shown advantages on the length of hospitalization particularly in colorectal surgery, with a reduction of the rate of leakages and re-do anastomoses, in spite of a slight increase in operating time, and is confirmed to be a safe, efficacious, and sustainable vision technology. Clinical applications are still presenting a low evidence in the literature.

#### CONCLUSION:

The present paper, under the patronage of Italian Society of Endoscopic Surgery, based on an HTA approach, sustains the use of fluorescence-guided vision in minimally invasive surgery, in the fields of general, gynecologic, urologic, and thoracic surgery, as an efficient and economically sustainable technology.



<https://doi.org/10.1007/s00464-020-07542-3>

## INDOCYANINE GREEN USE IN UROLOGY

## ABSTRACT

Petrut B., Bujoreanu C.E., Porav-Hodade D., et al.

JBUON, 2021, (controlled prospective study)

### BACKGROUND/AIM:

Indocyanine green (ICG) is being used more and more in Urology along with advances in minimal invasive surgery, guiding excision and reconstruction, highlighting anatomic structures and functional features with oncologic guidance still being debatable. The purpose of this paper was to explore ICG use in urologic procedures

### PATIENTS AND METHODS:

We present our experience (37 cases) of using ICG fluorescence guidance in urologic operations performed using 3D laparoscopy and FireFly® fluorescence imaging mode of Da Vinci X robot. The operations were the following: pelvic lymphadenectomy in radical prostatectomy, totally intracorporeal orthotopic ileal neobladder reconstruction, vesicovaginal fistula repair, partial nephrectomy and pyeloplasty. Barnard's test was used to compare postoperative complications (digestive fistula, ureteral stricture) for totally intracorporeal ileal neobladders performed with (group 1, 27 cases) vs. without (group 2, 28 cases) ICG guidance.

### RESULTS:

ICG under near-infrared fluorescence offered a precise identification of ischemic structures- vaginal wall, distal ureteral end, ileal loop, along with vascularized tissues allowing an optimal pyeloplasty and nephron sparing surgery with partial unclamping. It also allowed the identification of a lymph node during radical prostatectomy that otherwise would not have been excised during the routinely performed pelvic lymphadenectomy. There were no complications of ICG usage and the complication rate (digestive fistula, ureteral strictures) was significantly lower ( $p=0.002716$ ) for group 1 compared with group 2.

### CONCLUSION:

ICG facilitates the identification of key elements (anatomy and pathological structures) in the laparoscopic and robotic treatment of both malignant and benign urologic diseases, with possible impact on perioperative complications, along with oncologic and functional postoperative outcomes.



# UROLOGY

## PARTIAL PROSTATECTOMY, PARTIAL NEPHRECTOMY, PYELOPLASTY AND OTHERS

### ABSTRACT

#### ROBOT-ASSISTED NERVE-SPARING RADICAL PROSTATECTOMY USING NEAR-INFRARED FLUORESCENCE TECHNOLOGY AND INDOCYANINE GREEN: INITIAL EXPERIENCE

Mangano M.S., De Gobbi A., Beniamin F., et al.

Urologia Journal, 2017, (controlled prospective study)

#### BACKGROUND/AIM:

Indocyanine green (ICG) is a fluorescent molecule that provokes detectable photon emission. The use of ICG with near-infrared (NIR) imaging system has been described during robotic partial nephrectomy (RAPN) as an adjunctive means of identifying renal artery and parenchymal perfusion. We propose the use of the ICG with NIR fluorescence during laparoscopic robot-assisted radical prostatectomy (RARP), to identify the benchmark artery improving the preservation of neurovascular bundle and to improve the visualization of the vascularization and then the hemostasis.

#### PATIENTS AND METHODS:

From April 2015 to February 2016, 62 patients underwent to RARP in our Urology Unit. In 26 consecutive patients, in the attempt to have a better visualization of neurovascular bundles, we used to inject ICG during the procedure. We evaluated the percentage of identification of neurovascular bundles using NIR fluorescence. Then, we evaluated complications related to injection of ICG and operative time differences between RARP with and without ICG injection performed by the same surgeons.

#### RESULTS:

We identified prostatic arteries and neurovascular bundles using NIR fluorescence technology in all patients (100%). There was not any increase in the operative time compared with RARP without ICG injection performed by the same surgeons. Complications related to injection of ICG did not occur.

#### CONCLUSION:

In our experience, even if on a limited number of patients, the application of ICG with NIR fluorescence during RARP is helpful to identify the benchmark artery of neurovascular bundle.



<https://doi.org/10.5301/uj.5000244>



# UROLOGY

## URETER IDENTIFICATION

### ABSTRACT

### REAL-TIME VISUALIZATION OF URETERS USING INDOCYANINE GREEN DURING LAPAROSCOPIC SURGERIES: CAN WE MAKE SURGERY SAFER?

Mandovra P., Vishaka K., Roy V. P.

Surgical Innovation. 2019, (controlled prospective study)

#### BACKGROUND/AIM:

Intraoperative ureteral injury is rare, but a grave complication during laparoscopic surgery. Several methods for intraoperative localization of ureters are described with their own pitfalls. Intraoperative localization using near-infrared (NIR) fluorescence with indocyanine green (ICG) is an easier and assured method during laparoscopic pelvic surgeries.

#### PATIENTS AND METHODS:

From September 2017 to December 2017, patients undergoing laparoscopic pelvic surgeries were administered cystoscopic-guided intraureteral ICG immediately preoperatively with tip of a 6-Fr ureteral catheter. The fluorescence of ureters was visualized in the NIR mode of the camera system, localizing the ureters precisely and in real time.

#### RESULTS:

This technique was used to visualize ureters in 30 surgeries. Median age of the patients was 46.7 years with median body mass index of 23.2 kg/m<sup>2</sup>. Mean duration between administration of dye and insertion of trocar was 10 minutes. Mean duration for insertion of cystoscopically guided intraureteral ICG was 7 minutes. Ureteral fluorescence was visualized in all cases with some variation in intensity of the brightness perceived depending on surrounding fat. Duration of the lengthiest surgery was 240 minutes, and fluorescence was appreciated till the end. There were no intraoperative or postoperative complications attributed to ICG administration. In 10 patients (33%), there was difficulty in identifying the ureters on conventional white light mode, in which ICG localization was extremely helpful.

#### CONCLUSION:

ICG-stained ureteral visualization under NIR light is a safe and feasible method that provides real-time ureteral demarcation. This easily replicable, sensitive, and specific method of ureteral visualization can make complex laparoscopic pelvic surgeries safer.



<https://doi.org/10.1177/1553350619827152>

## INDOCYANINE GREEN FLUORESCENCE IMAGING FOR LAPAROSCOPIC COMPLEX UPPER URINARY TRACT RECONSTRUCTIONS: A COMPARATIVE STUDY

ABSTRACT

Zhu W., Xiong S., Wu Y., et al.

Translational Andrology and Urology, 2021, (comparative study/retrospective review)

### BACKGROUND/AIM:

To describe our technique for using an intraureteral injection of indocyanine green (ICG) and visualization under near-infrared fluorescence (NIRF) to facilitate challenging upper urinary tract reconstructions (UUTRs) and to present the comparative outcomes.

### PATIENTS AND METHODS:

We collected 36 patients who underwent laparoscopic UUTRs between April 2019 and March 2020, and we divided the patients into two groups based on the use of ICG (ICG group and non-ICG group). Demographic characteristics, perioperative outcomes, and functional outcomes were compared between the two groups.

### RESULTS:

There were 18 cases in the ICG group and 18 cases in the non-ICG group, respectively. There were no differences in the baseline characteristics between the two groups. The intraoperative time to identification of the ureter (TIU;  $20.9 \pm 11.7$  vs.  $30.0 \pm 14.6$  min,  $P=0.03$ ) and length of postoperative hospital stay (LPHS;  $11.1 \pm 3.0$  vs.  $16.6 \pm 10.0$  days,  $P=0.03$ ) were significantly shorter in the ICG group. There was also a trend for lesser time for locating the stricture ( $43.0 \pm 27.9$  vs.  $55.4 \pm 18.6$  min,  $P=0.14$ ) and lower estimated blood loss (EBL) in the ICG group patients ( $88.3 \pm 75.4$  vs.  $91.7 \pm 46.2$  mL,  $P=0.22$ ). During the mean 3.8-month follow-up for the ICG group and the 6.2-month for the non-ICG group, there was a trend for more severe complications in the non-ICG group.

### CONCLUSION:

Visualizing intraureteral ICG under NIRF is useful in challenging UUTRs, allows for rapid ureteral identification and accurate real-time delineation of the ureteral stricture margins, and provides encouraging follow-up outcomes compared with those in the non-ICG group.



DOI: 10.21037/tau-20-1261

# UROLOGY

## URETER IDENTIFICATION

### ABSTRACT

#### INTRA-OPERATIVE IDENTIFICATION OF URETERS USING INDOCYANINE GREEN FOR GYNECOLOGICAL ONCOLOGY PROCEDURES

Cabanés M., Boria F., Gutiérrez A. H., et al.

International Journal of Gynecological Cancer, 2020, Video article

#### BACKGROUND/AIM:

It is well known that ureteral injury is a possible complication of gynecological surgery. The literature reports rates for ureteral injuries for pelvic surgery ranging from 1% to 10% as the complexity of the procedure increases. Many of these injuries remain unrecognized during the surgery. Patients with prior surgical procedures, endometriosis, inflammatory bowel disease, or gynecological cancers are more likely to present this complication. Different identification techniques have been described, such as regular ureteral stent placement, methylene blue injection, or illuminated ureteral catheter positioning. However, all of them are moderately expensive, time consuming, or with a lack of high-quality ureteral visualization.

#### PATIENTS AND METHODS:

We present a new ureteral visualization technique in order to avoid complications related to ureteral injury during gynecological oncologic surgeries (video). By using indocyanine green (ICG) injection in the ureters by cystoscopy, the fluorescent ureters can be easily identified to assess their location or facilitate their dissection. Ureteral visualization by ICG has been previously used experimentally in different medical areas such as colorectal surgery. Our simplification of the technique includes the following steps: (1) cystoscopy to place in the ureter 10 cm of a 6 Fr catheter; (2) ureteral injection of 8 mL ICG solution (concentration 1.25 mg/mL); (3) removal of ureteral catheters (full ureteral catheterization is not needed); (4) intra-operative identification using near infrared light at the locations needed (transperitoneally, infundibulopelvic area, lateral parametria, or ventral parametria). This technique may be used both in laparoscopic and open surgery by using a laparoscopic endoscope or a specific near infrared camera, respectively.

#### RESULTS:

We have carried out this technique in 16 patients to date with 100% success in ureteral identification. The equipment used was Olympus endoscopy tower Visera Elite II S200 with 0° infrared scope (OLYMPUS IBERIA S.A.U, Barcelona, Spain). The main advantage is a lower risk of ureteral injury due to real-time identification during the surgical procedure. Moreover, our technique is a cheaper option than others with high-quality visualization, is much less time-consuming (15 additional minutes to the procedure), and has a low adverse event profile.

## CONCLUSION:

We conclude that ureteral identification using ICG injection is a feasible option to facilitate ureteral dissection and assessment of its location during gynecological oncologic surgery, with a low cost and good safety profile that could prevent ureteral injury.



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