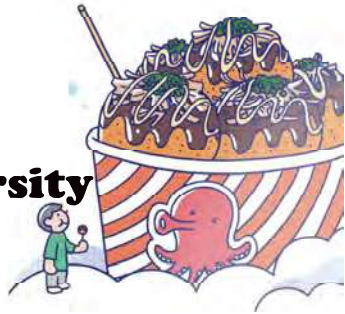
The 3rd Annual Meeting of International Society for Fluorescence Guided Surgery

Asia-Pacific Chapter

April 05-06 2024

@ABENO HARUKASU OSAKA Japan



Chair: Takeaki Ishizawa
Dept. HBP Surgery, Osaka Metropolitan University

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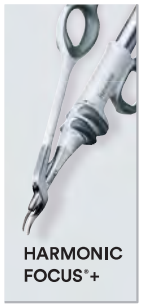

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Greeting Message

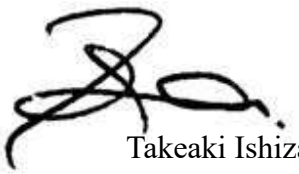
Welcome to the 3rd annual meeting of the AP-ISFGS!

First, I would like to thank everyone who has contributed to the organization of this event. Your enthusiastic support will allow us to share this memorable experience with surgeons, researchers, and industry partners joining us today from more than fifteen countries.

I still remember the day, when I first presented the clinical applications of fluorescence cholangiography using indocyanine green (ICG) at an international congress in 2010. At that time, few in the audience was paying attention to the utility of this technique. However, following the accumulation of evidences over the course of more than a decade, fluorescence imaging has become a standard navigation tool used during laparoscopic cholecystectomy in several countries. As in the case of fluorescence cholangiography, a dozen of fluorescence imaging technique has recently become used in a variety of surgical procedures, literally from head to toe. The primary aim of this meeting is to share our knowledge regarding standard-of-care techniques such as fluorescence cholangiography for delivering favorable outcomes to patients in the Asia–Pacific region using fluorescence-guided surgery.

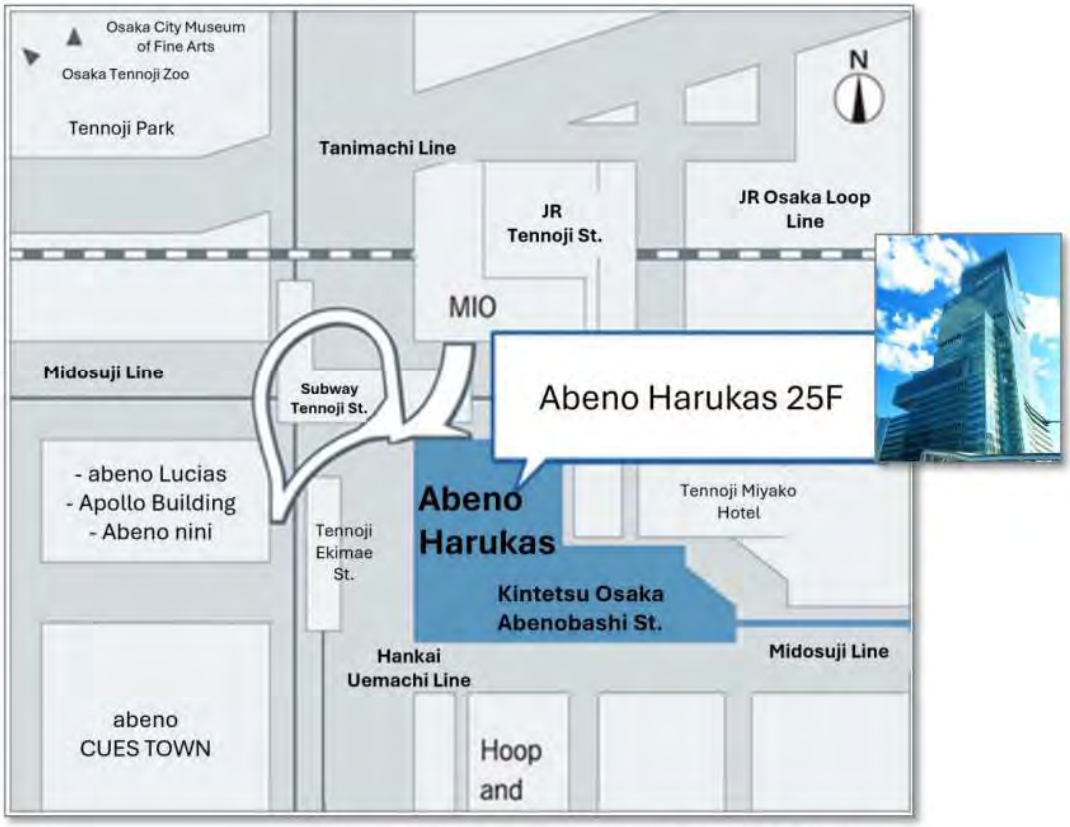
The other purpose for our gathering here is to become acquainted with the upcoming novel fluorophores and imaging technologies that may change fluorescence imaging from an intraoperative diagnostic tool to an actual treatment option. In other words, we are now facing the second phase of fluorescence-guided surgery on the hilltop of ICG-based technologies. I expect that the Asia–Pacific region will play a leading role in building evidence on the effective use of new technologies, contributing to improved surgical outcomes.

Finally, our most important goal is to deepen friendships beyond the boundaries of nations, surgical and research specialties, and professions. Please enjoy this event and your stay in Osaka, hopefully under the full bloom of cherry trees (SAKURA)!



Takeaki Ishizawa, MD, PhD, FACS
President of the AP-ISFGS
Professor, Department of Hepatobiliary-Pancreatic Surgery,
Graduate School of Medicine, Osaka Metropolitan University, Osaka.

Access



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- Subway Midosuji Line: Tennoji Station, West Exit
- Subway Tanimachi Line: Tennoji Station, South-West Exit / South-East Exit
- Hankai Uemachi Line: Tennoji Ekimae Station

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Umeda Station	Approx. 15min Osaka Metro Midosuji Line Umeda Station to Tennoji Station
Namba Station	Approx. 6min Osaka Metro Midosuji Line Namba Station to Tennoji Station

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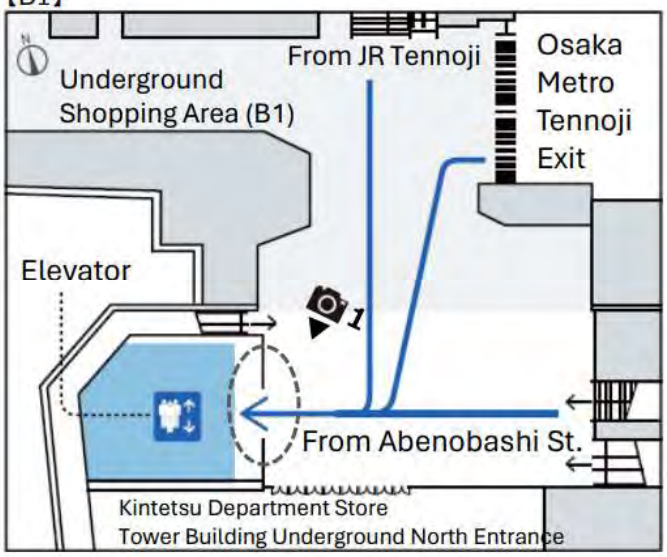
① Take the B1 elevator next to the North Entrance of Tower Building of Kintetsu Department Store to the 17th floor.

【B1】



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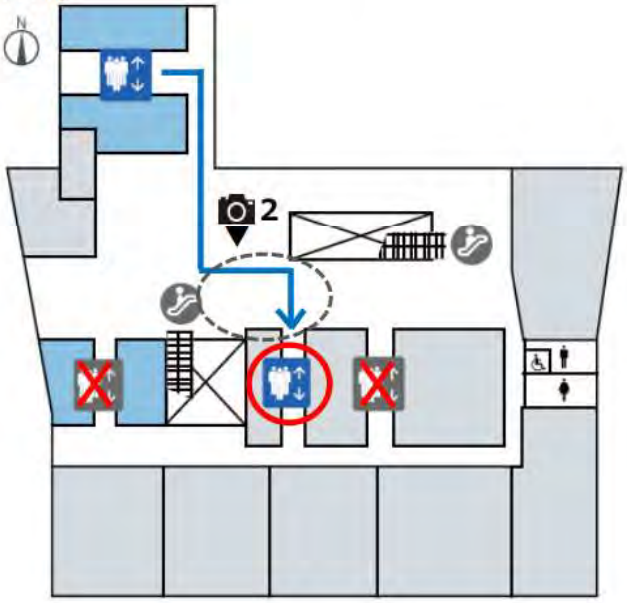
② Get off at the 17th floor and change elevators. Use the elevator in the middle.

【17F】



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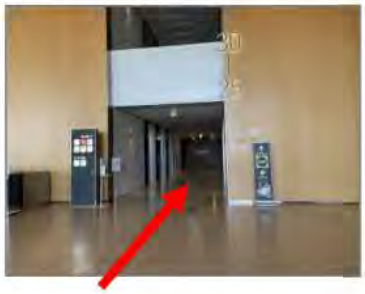

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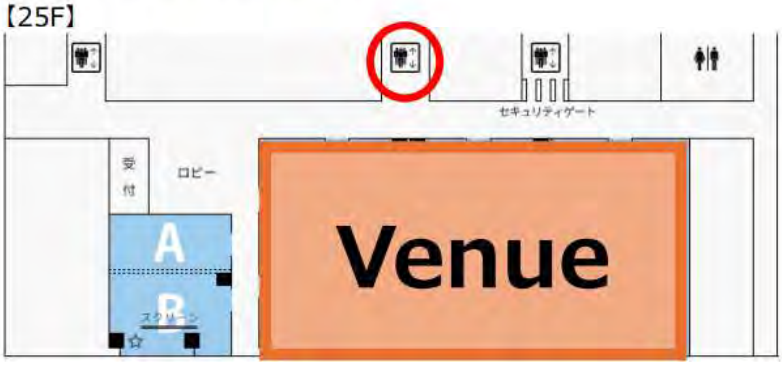

April 5 12:30-12:35 **Openeing remarks**				
	Takeaki Ishizawa	Osaka Metropolitan University	Japan	
April 5 12:35-13:55 **I. Toward standard-of-care 1 (GI tract and general surgery)**				
Chairpersons	**Toyofumi Chen-Yoshikawa**	Nagoya University	Japan	
	Ian Tan	University Surgical Cluster, NATIONAL UNIVERSITY HEALTH SYSTEM (NUHS)	Singapore	
Presenters				
101	**Naoto Takahashi**	The Jikei University Kashiwa Hospital	Japan	**Our experience of intraoperative ICG fluorescence-guided surgery in gastric cancer**
102	**Jane Chungyoon Kim**	Seoul National University College of Medicine	Korea	**Enhancing Laparoscopic Surgery for Remnant Gastric Cancer with Indocyanine Green Fluorescence: A Case Series from a Single Center**
103	**Kimiyasu Yamazaki**	School of Medicine, Showa University	Japan	**Fluorescence microscopy findings of ICG fluorescence localization at tumor marking site in laparoscopic surgery for gastric cancer**
104	**Hiroyuki Kitagawa**	Kochi Medical School	Japan	**Blood flow evaluation of reconstructed gastric tube in esophageal surgery using near-infrared imaging and retrospective time intensity curve analysis**
105	**Yusuke Matsune**	School of Medicine, Showa University	Japan	**Evaluation of blood flow with ICG fluorescent imaging for the preservation of ischemic intestine**
106	**Toshiaki Wada**	Kindai University Faculty of Medicine	Japan	**Laparoscopic colectomy with lymph node navigation and intracorporeal anastomosis using Double ICG technique**
107	**Junji Takahashi**	International University of Health and Welfare	Japan	**Introduction of Fluoroscopic Surgery: case reports of the cholecystectomy and appendectomy**
April 5 14:00-15:20 **II. Toward standard-of-care 2 (HBP surgery)**				
	Satoru Seo	Kochi medical school	Japan	
	Xiaoying Wang	Zhongshan Hospital, Fudan University	China	
Presenters				
201	**Shinichi Kinami**	Kanazawa Medical University Himi Municipal Hospital	Japan	**Optimal administration method and weak points of ICG fluorescence cholangiography in laparoscopic cholecystectomy**
202	**Vu Van Quang**	108 Military Central Hospital	Vietnam	**Early outcome of laparoscopic anatomical hepatectomy using Indocyanine Green in treatment of Hepatocellular carcinoma**
203	**Kenichiro Araki**	Gunma University Graduate School of Medicine	Japan	**Significance of laparoscopic segmentectomy of the liver using ICG fluorescent negative staining method: a comparative study with open procedure**
204	**Nobuyuki Takemura**	National Center for Global Health and Medicine	Japan	**A case of S4aS5 anatomical hepatectomy using ICG fluorescence positive and negative staining methods for advanced gallbladder cancer**
205	**Shuhei Kanda**	Graduate School of Medicine, Kyoto University, Kyoto, Japan	Japan	**The concentration gradient of fluorescence from multiple dosages of indocyanine green enables the identification of liver regions**
206	**Martin Huerta García**	Vall d'Hebron University Hospital	Spain	**Intraoperative Fluorescence Imaging with Preoperative ICG Administration for Liver Tumors Detection: Evaluating the Significance of ICG Retention in Resection Decision-Making**
207	**Jinpeng Tang**	Zhongshan Hospital, Fudan University	China	**Improving retention and specificity of fluorescence probe for hepatocellular carcinoma**
April 5 15:30-17:05 **III. New techniques 1**				
Chairpersons	**Masaki Kaibori**	Kansai Medical University	Japan	
	Katsuya Yamada	Hirosaki University	Japan	
Presenters				
301	**Takeshi Shinozaki**	National Cancer Center Hospital East	Japan	**Photoimmunotherapy**
302	**Hideo Fukuhara**	Kochi University	Japan	**5-aminolevulinic acid-based photodynamic diagnosis for non-muscle invasive bladder cancer**
303	**J.R. van der Vorst**	Leiden University Medical Center	The Netherlands	**CEA-targeted fluorescence-guided surgery using SGM-101, current status and future prospects**
304	**Eric Bensen**	Vergent Bioscience, Inc.	US	**VGT-309: A tumor targeted near-infrared imaging agent for intraoperative detection of cancer in the lung**
305	**Karina Juhl**	FluoGuide	Danmark	**Optical-Guided Surgery in High Grade Glioma and Oral and Oropharyngeal Squamous Cell Carcinoma Using a Novel uPAR-Targeted Near-Infrared Imaging Agent FG001 (AE105-Glu-Glu-ICG)**
306	**Gabriel P. Haas**	Astellas Pharma Global Development Inc.	US	**Clinical application of pudexacianinium chloride (ASP5354) for intraoperative and noninvasive visualization of ureters**
307	**Tommy Lee**	On Target Lab	US	**Pafolacianine for intraoperative molecular imaging of cancer in the lung: The ELUCIDATE trial**
April 5 17:10-17:50 **IV. Evening seminar**	**Fluorescence guided surgery from the basic to advanced approach - Japan to Global - (Sponsored by Stryker)**			
Chairperson	**Jun Watanabe**	Kansai Medical University	Japan	
Presenters				
E01	**Jun Watanabe**	Kansai Medical University	Japan	**Blood Perfusion Assessment by Indocyanine Green Fluorescence Imaging for Minimally Invasive Rectal Cancer Surgery**
E02	**Taiga Wakabayashi**	Ageo Central General Hospital	Japan	**Current roles of ICG fluorescent imaging systems in laparoscopic liver resection**
April 5 19:00-21:00 **Welcome dinner (Sponsored by Diagnostic Green)**				

April 6 8:00-8:45 **V. Morning seminar**	**HMRG: a possible main player in the future fluorescence-guided surgery (Sponsored by Goryo Chemical)**			
Chairperson	**Yasuteru Urano**	The University of Tokyo	Japan	
Presenters				
M01	**Shota Tanaka**	Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences	Japan	**New endeavor to photodynamic diagnosis for glioma**
M02	**Yosuke Tsuji**	Graduate School of Medicine, The University of Tokyo	Japan	**Illuminating Esophageal Cancer! Fluorescent Probes for Endoscopic Early Detection**
April 6 8:50-9:45 **VI. Fluorescence-guided surgery in the world**				
Chairpersons	**Takeaki Ishizawa**	Osaka Metropolitan University	Japan	
	Norihiro Kokudo	National Center for Global Health and Medicine	Japan	
Presenters				
601	**Raul J Rosenthal**	Cleveland Clinic Weston, Florida	US	**Message to the AP-ISFGS (Video)**
602	**Fernando Dip**	Hospital de Clinicas, University of Buenos Aires	Argentina	**ISFGS for the future (Video)**
603	**Masashi Yoshida**	International University of Health and Welfare	Japan	**Japanese Society for Fluorescence Guided Surgery, the path we have taken and the road ahead**
604	**Hiro Hasegawa**	National Cancer Center Hospital East	Japan	**Japanese consensus guideline on evaluation of blood flow using indocyanine green fluorescence imaging in colorectal surgery**
605	**Seong-Ho Kong**	Seoul National University Hospital	Korea	**Device and drug availability in Asia-Pacific regions for further development of fluorescence guided surgery**
April 6 9:50-11:25 **VII. Expanding field of fluorescence guided surgery 1**				
Chairpersons	**Yung-Chun Hsieh**	National Taiwan University College of Medicine	Taiwan	
	Han-Kwang Yang	Seoul National University College of Medicine	Korea	
Presenters				
701	**Catherine Teh**	Makati Medical Center	Philippines	**Clinical trials of fluorescence cholangiography targeting reduction of bile duct injury during laparoscopic cholecystectomy**
702	**Ian Wong**	Queen Mary Hospital	Hong Kong	**Roles of fluorescence imaging in upper GI surgery**
703	**Ian Tan**	University Surgical Cluster, NATIONAL UNIVERSITY HEALTH SYSTEM (NUHS)	Singapore	**The Role of ICG in Colorectal Surgery**
704	**Roderick Peul**	Leiden University Medical Center	The Netherlands	**The potential of fluorescence imaging in preventing anastomotic leakage during gastric conduit surgery**
705	**Kenshin Sai**	Minami-Osaka General Hospital	Japan	**Lymphatico-Venous Anastomosis for Lymphedema Cases introduced Fluorescence imaging system SPY-PHI ®-Taking advantage of our hospital-**
706	**Yung-Chun Hsieh**	National Taiwan University Hospital, National Taiwan University College of Medicine	Taiwan	**Optimized repetitive injection protocol using Voluven-assisted indocyanine green in breast cancer sentinel lymph node biopsy**
707	**Tamiko Kamimura**	Tokorozawa Chuo Hospital	Japan	**Indocyanine Green Fluorescence-Guided Knee Arthroscopy: Preliminary Results and Future Prospective**
April 6 11:30-11:55 **Exhibition Go-Round with coffee**				
April 6 12:00-13:00 **VIII. Luncheon seminar**	**The possibility and future of color coded surgery (Sponsored by Olympus)**			
Chairpersons	**G.V. Rao**	AIG Hospitals & Asian Institute of Gastroenterology	India	**Opening remarks**
Presenters				
L01	**Takashi Nonaka**	Nagasaki University Graduate School of Biological Science	Japan	**Color enhanced surgery for colorectal cancer**
L02	**Rawisak Chanwat**	National Cancer Institute	Thailand	**Advancements in Color Enhanced Surgery for Laparoscopic Liver Resection**
April 6 13:05-14:40 **IX. Expanding field of fluorescence guided surgery 2**				
Chairpersons	**Nguyen Anh Tuan**	108 Military Central Hospital	Vietnam	
	Nicholas O'Rourke	University of Queensland Brisbane	Australia	
Presenters				
901	**Xiaoying Wang**	Zhongshan Hospital, Fudan University	China	**Sentinel lymph node mapping of intrahepatic cholangiocarcinoma by ICG fluorescence**
902	**Nguyen Van Du**	108 Military Central Hospital	Vietnam	**Comparative Study of ICG and Non-ICG in Laparoscopic Gastrectomy for Gastric Cancer: A Propensity Score-Matched Analysis at a Single Center**
903	**Nicholas O'Rourke**	University of Queensland Brisbane	Australia	**ICG usage in spleen preserving distal pancreatectomy**
904	**Dhiresh Kumar Maharjan**	Kathmandu Medical College Teaching Hospital	Nepal	**Role of ICG to look for vascularity of the pancreatic stump after Whipples procedure**
905	**Stefan Koning**	Leiden University Medical Center	The Netherlands	**The FAFI-trial: NIRF perfusion assessment in reconstructive DIEP-flap surgery**
906	**Rajaie Kamarudin**	Selayang Hospital	Malaysia	**Luminescent Precision: Illuminating Hepatopancreatobiliary Surgery with ICG in Malaysia**
907	**Wifanto S Jeo**	Cipto Mangunkusumo Hospital Jakarta	Indonesia	**Efficacy and Safety of Near-Infrared Florescence Cholangiography Using Indocyanine Green**
April 6 14:45-16:05 **X. New techniques 2**				
Chairpersons	**Takeshi Aoki**	Showa University	Japan	
	Simon Low	The Univeristy of Hong Kong	Hong Kong	
Presenters				
1001	**Yoshihiko Tashiro**	School of Medicine, Showa University	Japan	**Development of A Fluorescent Surgical Gauze Stained with Indocyanine Green**
1002	**M. W. Kruiswijk**	Leiden University Medical Center	The Netherlands	**The use of near infrared fluorescence for understanding micro- and macrovascular pathology in vascular surgery patients**
1003	**Kodai Tomioka**	School of Medicine, Showa University	Japan	**Fusion of Indocyanine Green Fluorescence Imaging and Artificial Intelligence Navigation for Color-Coded Laparoscopic Liver Resection**
1004	**Shunjin Ryu**	Kawaguchi Municipal Medical Center	Japan	**Near-infrared fluorescence imaging, mixed reality and artificial intelligence assistance for anatomic visualization during colorectal cancer surgery**
1005	**Hyun-Koo Kim**	Korea University Guro Hospital	Korea	**Novel Fluorescent Imaging using Inhaled or Different Wavelength Fluorophores for Simultaneous Identification of Tumor Margin and Intersegmental Plane During Pulmonary Segmentectomy**
1006	**Hiroto Nishino**	Graduate School of Medicine, Kyoto University	Japan	**Real-time navigation liver resection with indocyanine green fluorescence projection onto the surgical field**
April 6 16:05-16:10 **Closing remarks**				
	Takeaki Ishizawa	Osaka Metropolitan University	Japan	

Day 1, April 5

12:30

Opening remarks

12:35-13:55

I: Toward standard-of-care 1 (GI tract and general surgery)

Chairpersons; Toyofumi Chen-Yoshikawa, Ian Tan

14:00-15:20

II: Toward standard-of-care 2 (HBP surgery)

Chairpersons; Satoru Seo, Xiaoying Wang

15:30-17:05

III: New techniques 1

Chairpersons; Masaki Kaibori, Katsuya Yamada

17:10-17:50

IV: Evening seminar (Sponsored by Stryker)

Chairperson; Jun Watanabe

Day 1, April 6

8:00-8:45

V: Morning seminar (Sponsored by Goryo Chemical)

Chairperson; Yasuteru Urano

8:50-9:45

VI: Fluorescence-guided surgery in the world

Chairpersons; Takeaki Ishizawa, Norihiro Kokudo

9:50-11:25

VII: Expanding field of fluorescence guided surgery 1

Chairpersons; Yung-Chun Hsieh, Han-Kwang Yang

11:30-11:55

Exhibition Go-Round with coffee

12:00-13:00

VIII: Luncheon seminar (Sponsored by Olympus)

Chairperson; G. V. Rao

13:05-14:40

IX: Expanding field of fluorescence guided surgery 2

Chairpersons; Nguyen Anh Tuan, Nicholas O'Rourke

14:45-16:05

X: New techniques 2

Chairpersons; Takeshi Aoki, Simon Low

16:05

Closing remarks

Acknowledgement

Organization committee
ISS, INC.

Miyuki Imai

Waka Yamaguchi

Azusa Hanazaki

Department of Hepatobiliary-Pancreatic Surgery
Graduate School of Medicine
Osaka Metropolitan University

Masahiko Kinoshita, MD, PhD

Takeaki Ishizawa, MD, PhD

Day 1

April 5 12:35-13:55

I: Toward standard-of-care 1
(GI tract and general surgery)

<Chairpersons>

Toyofumi Chen-Yoshikawa
Nagoya University, Japan

Ian Tan Jse-Wei
University Surgical Cluster, National University Health System, Singapore

Our experience of Intraoperative ICG fluorescence-guided surgery in gastric cancer

Naoto Takahashi[1], Kenji Takeshita[1], Ken Eto[2]

[1]Department of Surgery, The Jikei University Kashiwa Hospital, Japan
[2]Department of Surgery, The Jikei University School of Medicine, Japan

Introduction: Indocyanine green (ICG) is increasingly used in surgery, especially in gastric and esophageal cancer surgery. ICG fluorescence-guided surgery (IFGS) has potentially improved surgical outcomes because ICG fluorescence imaging can provide helpful surgical information through lymphangiography and perfusion. We have been studying sentinel node navigation surgery (SNNS) for early gastric cancer (EGC) to reduce unnecessary extensive lymphadenectomy and the amount of gastric resection, which can avoid post-gastrectomy syndromes such as poor oral intake and weight loss. In addition, we have been working on determining gastrectomy lines using fluorescent clips (FC). In this meeting, we will introduce our efforts.

Sentinel Node Navigation Surgery: Indications for SNNS for EGC are the following: tumor size is less than 4cm and clinical N0. 0.1mg/ml of ICG is injected intraoperatively into the submucosal layer by endoscopy, and SNs are explored at 20 min after ICG injection by Elite II (Olympus Tokyo). From 2010 to 2023, 107 cases were enrolled in this analysis. The detection rate for SNs was 100%. Metastatic lymph nodes were found in 6 patients with intraoperative rapid diagnosis. The false negative cases for lymph node metastasis were 2 of 101 patients with isolated tumor cells. When SNs were negative for lymph node metastasis, wedge resection or segmental gastrectomy were performed in 55 and 25 cases, respectively. Disease-specific death was not observed.

Fluorescent clips: The importance of preoperative tumor site marking has increased over the years, as the method of intraoperative primary lesion identification and determination of resection margins is one factor determining whether oncological safety and function-preserving gastrectomy are possible during surgery. We hypothesize that preoperative placement of the near-infrared fluorescent (NIRF) clip, ZEOCLIP FS, near the oral incision line of the gastric tumor will allow for Firefly recognition of the NIRF clip on da Vinci during surgery and easy determination of the tumor location and incision line. Five cases were enrolled from 2022 to 2023. In all 5 cases, Firefly detected fluorescence clips, and the resected stomach's proximal margin was negative.

Conclusion: ICG fluorescence-guided SNNS for EGC is a promising technique to reduce unnecessary extensive lymphadenectomy and the amount of gastric resection. FC is feasible and safe and can be used as a tumor-marking agent to determine accurate surgical resection lines.

Enhancing Laparoscopic Surgery for Remnant Gastric Cancer with Indocyanine Green Fluorescence: A Case Series from a Single Center

Jane Chungyoon Kim, Seong-Ho Kong, Do Joong Park, Hyuk-Joon Lee, Han-Kwang Yang

Department of Surgery, Seoul National University College of Medicine, Seoul, South Korea

Background: The introduction of indocyanine green (ICG) fluorescence imaging has been a pivotal advancement in gastric cancer surgeries, particularly for improving lymph node dissection. This technique's application becomes even more critical in cases of remnant gastric cancer, where post-gastrectomy anatomical changes alter lymphatic drainage pathways.

Materials and Methods: This study investigates the application of ICG during laparoscopic surgeries for remnant gastric cancer. The procedure involves circumferential injection of ICG around the cancer margins via intraoperative gastroscopy. This enables real-time visualization of ICG-fluorescence during surgery. The extent of lymph node dissection and gastrectomy is determined based on ICG uptake patterns.

Results: Our case series includes four patients with remnant gastric cancer who underwent ICG-guided laparoscopic surgery. Of these, three required total gastrectomies, and one underwent a distal gastrectomy. Consistent with existing literature, we observed frequent lymph node metastases along the splenic artery, splenic hilum, and jejunal mesentery. ICG uptake at these nodes dictated the surgical approach: total gastrectomy with splenic hilum lymph node dissection when fluorescence was noted at the splenic hilum or left cardiac lymph nodes, and distal gastrectomy with Roux-en-Y reconstruction in the absence of significant fluorescence. This method also facilitated the identification and dissection of jejunal mesenteric lymph nodes.

Conclusion: The intraoperative application of ICG in remnant gastric cancer surgeries has proven to be a valuable tool. It not only aids in surgical decision-making but also enhances the safety and precision of lymph node dissections. ICG fluorescence imaging emerges as a promising technology for laparoscopic interventions in remnant gastric cancer cases.

Fluorescence microscopy findings of ICG fluorescence localization at tumor marking site in laparoscopic surgery for gastric cancer

Kimiyasu Yamazaki, Kiyotaka Mochizuki, Tetsuya Kitajima, Kodai Tomioka, Yoshihiko Tashiro, Hiromi Date, Ryohei Watanabe, Kazuhiro Matsuda, Tomokazu Kusano, Yojiro Kato, Makoto Watanabe, Yuta Enami, Osamu Yoshitake, Takeshi Aoki

Division of General and Gastroenterological Surgery, Department of Surgery, School of Medicine, Showa University, Japan

Introduction: Indocyanine green (ICG) fluorescence imaging is widely applied in gastrointestinal and hepatobiliary surgery [1.2]. Preoperative fluorescent marking with ICG has been reported to be useful in laparoscopic surgery for gastrointestinal cancer [3]. In this study, we evaluate fluorescence microscopy findings of ICG fluorescence localization at tumor marking site in laparoscopic surgery for gastric cancer.

Methods: The study included 25 patients with gastric cancer who underwent laparoscopic or robotic gastrectomy using ICG fluorescence as a tumor marking at our institution. 0.5ml of ICG solution (0.05mg/ml) was injected into submucosal layer at four points around the tumor 1-3 days before surgery or intraoperatively under endoscopy. Intraoperative ICG fluorescence was observed using a laparoscopic near-infrared camera system. HE-stained specimens of the resected stomach were observed with a fluorescence microscope as we previously reported [4]. The procedures for this study were approved by the Ethics Committee of our institution, and informed consent was obtained from all patients.

Results: In one case of additional resection after endoscopic submucosal dissection (ESD), ICG fluorescence was not observed both intraoperatively and by fluorescence microscopy. Postoperative histopathologic resection margins were negative in all cases. ICG fluorescence by fluorescence microscopy was strongly observed in muscularis mucosa, upper part of muscularis propria and elastic fibers of vessels in the submucosa, but not in cancerous lesions or ESD scars with strong fibrosis.

Discussion: Tumor marking with ICG fluorescence is useful for intraoperative determination of the resection line, but it is important to inject the ICG solution accurately into the submucosal layer. Further study is needed to determine the amount and concentration of ICG to be injected.

Conclusion: Fluorescence microscopy confirmed that ICG fluorescence accumulates in the submucosa is visible as a tumor marking.

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Blood flow evaluation of reconstructed gastric tube in esophageal surgery using near-infrared imaging and retrospective time intensity curve analysis

Hiroyuki Kitagawa[1], Nao Yamamoto[2], Kazumasa Orihashi[3], Keiichiro Yokota[1], Tsutomu Namikawa[1], Satoru Seo[1]

[1]Department of Surgery, [2]Department of Clinical Engineering, [3]Section of Liaison Healthcare Engineering, Kochi Medical School, Kochi, Japan

Purpose: Near-infrared fluorescence imaging using indocyanine green (ICG-NIFI) can visualize a blood flow in reconstructed gastric tube, however it depends on surgeon's visual assessment. The aim of this study was to re-analyze the ICG-NIFI data by a rater independent from the surgeon and feasibility of creating the time intensity curve (TIC).
Methods: We retrospectively reviewed 73 patients who underwent esophageal surgery with gastric tube reconstruction between January 2017 and April 2021. From the stored ICG videos, fluorescence intensity was examined in the four regions of interest (ROIs), which was set around the planned anastomosis site on the elevated gastric tube. After creation the TICs using the OpenCV library, we measured the intensity starting point and the time constant, and assessed the correlation between the anastomotic leakage.
Results: Postoperative leakage occurred for 11 patients (15.1%). The leakage group had significantly lack of blood flow continuity between the right and left gastroepiploic arteries (63.6% vs. 12.9%; P=0.001) and slower ICG visualization time assessed by the surgeon's eyes (40 vs. 31 s; P=0.036). TIC could create in 46 cases. Intensity starting point at the all ROIs were faster than the surgeon's assessment. In the subset analysis of 64 patients who performed a circular stapler anastomosis, the leakage group had slower intensity starting point was in all ROIs, compared to without leakage group.
Conclusion: A TIC analysis of ICG-NIFI by a rater independent could detect a intensity change faster than surgeon's assessment.

Evaluation of blood flow with ICG fluorescent imaging for the preservation of ischemic intestine

Yusuke Matsune, Takeshi Aoki, Yoshihiko Tashiro, Kimiyasu Yamazaki, Yukari Shinohara, Ryo Katayama, Tetsuya Kitajima, Kazuhiro Matsuda, Tomokazu Kusano, Hiromi Date, Ryohei Watanabe, Makoto Watanabe

Division of Gastroenterological & General Surgery, Department of Surgery, School of Medicine, Showa University

Background: Several reports have shown that assessing intestinal blood flow using indocyanine green (ICG) fluorescence imaging is helpful in ischemic bowel disease because it makes blood flow visible. We report several cases of preservation of the ischemic intestine using

Patients and Methods: We evaluated 38 patients with ischemic intestine from November to June, 2023. They underwent laparotomy and laparoscopy under the ICG navigation system. ICG2.5mg/1 ml was injected intravenously to evaluate intestinal blood flow and observe ICG fluorescence during the operations.

Results: The mean age was 69 (26-95) years. Fifteen males and 23 females were included. The cause of intestinal ischemia included band formation in 15 cases, internal hernia in 7 cases, volvulus in 3 cases, strangulated hernia in 9 cases, Superior Mesenteric Artery (SMA) thrombosis in 2 cases, and trauma in 2 cases. The assessment of intestinal blood flow using ICG revealed intestinal ischemia in 22 cases. The average operating time was 114 (35-250) minutes, and the blood loss was 154 (6-450) ml. No intraoperative complications occurred. Several postoperative complications (Clavien-Dindo Grade III or higher) were observed in 1 case with paralytic ileus and 2 cases with anastomotic leakage. One of the two cases required vasopressors due to the postoperative persistent shock. The other was due to liver cirrhosis (Child-Pugh B). No complications of delayed necrosis was observed in cases without intestinal resection.

Discussion: We revealed the effectiveness of ICG fluorescence imaging in measuring intestinal perfusion intra-operatively to avoid unnecessary resections. The evaluation of various modalities and further studies are needed to establish more accurate criteria and algorithms for evaluating blood flow and bowel perfusion.

Laparoscopic colectomy with lymph node navigation and intracorporeal anastomosis using Double ICG technique

Toshiaki Wada, Yusuke Makutani, Ryotaro Ogawa, Yasumasa Yoshioka, Masayoshi Iwamoto, Koji Daito, Kazuki Ueda, Tadao Tokoro, Junichiro Kawamura

Division of Colorectal Surgery, Department of Surgery, Kindai University Faculty of Medicine, Japan

Purpose: In laparoscopic colectomy for colorectal cancer, appropriate lymph node dissection and prevention of anastomotic leak are very important. Indocyanine green (ICG) images obtain through the laparoscopic procedure helped visualize lymphatic drainage vessels and inform decision-making to determine the vessels. Intracorporeal anastomosis has the advantages such as earlier recovery of postoperative bowel function, shorter length of wound incision, reduction of intestinal mobilization range, and fewer incisional hernia. We report the surgical technique and short-term results of 48 patients who underwent laparoscopic colectomy and intracorporeal anastomosis using Double ICG fluorescence technique from July 2020 to September 2023.

Method: Two injections of ICG(0.75mg×2) into the proximal and distal subserosa of the tumor preceded the surgical procedure after pneumoperitoneum. Intraoperative lymph node mapping by the Stryker1588, 1688AIM camera imaging system was visualized. Laparoscopic colectomy was performed according to the CME and CVL concept. Complete intracorporeal anastomosis was performed by a functional end-to-end or Overlap or Delta anastomosis. After anastomosis, ICG (12.5 mg) was injected intravenously to check the intestinal blood perfusion at the anastomosis site.

Result: 48 patients (Sex; male: 23, female: 25) (Tumor location; C :20, A: 11, T: 8,D:7, S:2) (pStage0:2, I:15, II: 16, III:10 IV:5) were underwent. Median age was 74. Median BMI was 23. Median number of dissected lymph nodes was 18. The median operative time was 246 minutes. Median wound length was 3.5cm. The median postoperative hospital stay was 7days. Visualization of lymphatic flow was observable in 24 of 28 cases (85.7%). Transection line was changed in 2/48 cases (4.1%) after ICG fluorescence angiography. There were no intraoperative complications, and two patients had postoperative paralytic ileus.

Conclusion: ICG fluorescence lymphangiography in laparoscopic colectomy for colon cancer allows visualization of lymphatic flow and may complement more reliable lymph node dissection. In addition, the evaluation of intestinal perfusion using ICG contributes to the reduction of anastomotic leakage and enables safer intracorporeal anastomosis.

Introduction of Fluoroscopic Surgery: case reports of the cholecystectomy and appendectomy

Junji Takahashi, Masashi Yoshida, Teppei Kamada, Keigo Nakashima, Norihiko Suzuki, Hironori Ohdaira, Yutaka Suzuki

Department of Surgery, International University of Health and Welfare, Tochigi, Japan

Introduction: Development of bright field full color fluorescent laparoscopy made us possible to operate under fluorescent guidance without switching to white light mode. We have postulated that entire operative procedures can be performed under near-infrared fluorescence guidance in condition of optical indocyanine green (ICG) administrations. The surgery of which all processes are performed completely guided by fluorescence can be called the fluoroscopic surgery. Here, we present cases of the fluoroscopic surgery for cholecystectomy and appendectomy.

Case 1: The patient was an Asian woman in her fifties without history of abdominal surgery. She had several attacks of gallstones but no cholecystitis. We administered 25mg of ICG intravenously 16 hours before the start of surgery. The laparoscopic surgery was performed using VISION SENSE®. The entire laparoscopic procedure was performed under fluorescence guidance (fluoroscopic surgery).

The anatomy of the bile duct and Common bile duct (CBD) was clearly observed and we were able to confirm the border of bile duct and CBD, avoiding involvement of the CBD during clipping. When peeling the gallbladder bed, the layer was easy to be recognized.

Case 2: Following conservative treatment for appendicitis, this Asian male patient underwent an interval appendectomy. Laparoscopic surgery was performed using the VISIONSENSE® system. Diluted ICG (25 mg/15 mL) was administered intravenously at 1 ml/min using syringe pump.

The appendiceal artery was visualised in light green, and the intensity of the visualisation was defined relative to the tissue surrounding the dissected appendiceal artery. The superior rectal artery and vessels within the mesentery of the small intestine were confirmed to be continuously visualised throughout the surgery.

Therefore, continuous ICG angiography made it possible to operate while keeping the appendiceal artery visible in this case.

Discussion and Conclusion: Fluoroscopic surgery was feasible in these 2 cases. The advantages of the fluoroscopic surgery will be discussed.

April 5 14:00-15:20

II: Toward standard-of-care 2

(HBP surgery)

<Chairpersons>

Satoru Seo
Kochi Medical School, Japan

Xiaoying Wang
Zhongshan Hospital, Fudan University, China

Optimal administration method and weak points of ICG fluorescence cholangiography in laparoscopic cholecystectomy

Shinichi Kinami[1,2], Shota Motoyama[2], Hitoshi Saito[1], Hiroyuki Takamura[2]

[1]Department of General and Gastroenterologic Surgery, Kanazawa Medical University Himi Municipal Hospital, Japan

[2]Department of Surgical Oncology, Kanazawa Medical University, Japan

Background: Intraoperative ICG fluorescence cholangiography in laparoscopic cholecystectomy is an alternative to intraoperative contrast cholangiography and is considered beneficial to avoid common bile duct injury. We discussed the usefulness and problems of ICG fluorescence cholangiography.

Methods: PINPOINT and SPY-PHI (Stryker) were introduced in September 2020, and intraoperative ICG fluorescence cholangiography was attempted. Visualization was graded on a 3-point scale: good, poor, and failure. ICG was administered by trans-PTGBD biliary injection (T group) in patients with PTGBD insertion and by intravenous injection in other cases. Three times of intravenous administration were tried: immediately before surgery (VI group), on the morning of the day of surgery (VM group), and on the day before surgery (VY group).

Results: Among the 83 cases, 17 were VI, 14 were VM, 38 were VY, and the other 14 were T. There were 6 cases in which visualization of the cystic duct failed: four were post-ERBD, and 2 were cases with severe inflammation. On the other hand, in the T group, the cystic duct could be visualized in all cases, even with severe inflammation. Among the 63 cases of intravenous injection in which the cystic duct could be identified, the liver showed strong fluorescence in all cases in the VI group, and the objective identification of the cystic duct was poor in more than half of the cases. The liver fluorescence was also strong in the VM group, although the poor identification of the cystic duct was only 14% of the cases. On the other hand, in the VY group, the liver fluorescence was weak, and the fluorescence of the cystic duct and common bile duct was evident, and there were no cases in which it was difficult to identify the cystic duct due to poor signal/noise (S/N) ratio. The cystic duct was difficult to locate in 4 cases (13%), including 2 cases of incarcerated cystic duct due to cystic duct obstruction by stones and 2 cases of severe inflammation.

Conclusion: ICG fluorescence cholangiography performed by intravenous injection the day before surgery is an excellent method for easy and clear visualization of the cystic duct and common bile duct. The advantage over the immediate intravenous injection method is a low signal-to-noise ratio. On the other hand, it was difficult to visualize the cystic duct in cases of severe inflammation, post-ERBD, and cases with cystic duct stones.

Early outcome of laparoscopic anatomical hepatectomy using Indocyanine Green in treatment of Hepatocellular carcinoma

Vu Van Quang, Le Van Thanh, Vu Ngoc Tuan, Nguyen Hoang Ngọc Anh, Le Trung Hieu

Department of Hepatobiliary & Pancreas Surgery in 108 Military Central, Vietnam

Objective: To evaluate early results of laparoscopic anatomical hepatectomy using Indocyanine Green in treating Hepatocellular carcinoma.

Subject and method: This was a prospective study in treating Hepatocellular Carcinoma by laparoscopic anatomical hepatectomy using Indocyanine Green in 108 Military Central Hospital from July 2021 to June 2023. To visualize the demarcation line intraoperatively, patients were injected intravenously by negative staining using 2.5 mg ICG following clamping of the Glissonean pedicles.

Result: A total of 58 cases were collected. In 100% of cases, ICG fluorescent imaging clearly delineated the demarcation lines and allowed the identification of intersegmental planes; the tumor-bearing hepatic region became non-fluorescing during parenchymal transection. The average age was 55.2 ± 13.4 years. The male/female ratio was 50/8. The percentage of chronic Hepatitis B infection was 75,9%. The average AFP index was 168.6 ± 245.2 ng/ml. The average tumor size was 32.4 ± 12.2 mm. The major hepatectomy was 55.2%, and the average operation time and blood loss were 201.7 ± 35.6 minutes and 358.3 ± 225.6 ml, respectively. Intraoperative blood transfusion was performed for 01 (1.7%) cases. The negative margin of specimens was 100%. There was not any case need conversion to laparotomy. The good result was 96.6%. The proportion of complications was 02 (3.4%) cases. The average hospital stay after surgery was 8.2 ± 2.3 days.

Conclusion: Laparoscopic anatomical hepatectomy using Indocyanine Green in treating Hepatocellular carcinoma provide feasible result. It helps achieve an anatomical margin, which could result in a better prognosis.

Significance of laparoscopic segmentectomy of the liver using ICG fluorescent negative staining method: a comparative study with open procedure

Kenichiro Araki, Ryosuke Fukushima, Takayuki Okuyama, Takaomi Seki, Kouki Hoshino, Kei Hagiwara, Shunsuke Kawai, Norihiro Ishii, Mariko Tsukagoshi, Takamichi Igarashi, Norifumi Harimoto, and Ken Shirabe

Division of Hepatobiliary and Pancreatic Surgery, Gunma University Graduate School of Medicine, Japan

Background: Laparoscopic segmentectomy (LS) of the liver using indocyanine green (ICG) fluorescence navigation with a negative staining method has potential for performing accurate and safe anatomical excision. However, there are few reports on the clinical analysis about visualization of liver segmentation by ICG navigation in anatomical liver resection. We aimed to evaluate the significance of LS using ICG fluorescence navigation compared with open segmentectomy (OS).

Methods: Eighty-seven patients who underwent anatomical segmentectomies were evaluated for OS (n=44) and LS (n=43). The Glissonean pedicle approach was performed using either the extrahepatic or intrahepatic method, depending on the location of the segment in the LS. After clamping target Gissonean pedicle, the negative staining method was performed with intravenous injection of ICG (1.25-2.5mg). Liver parenchymal transection was done along intersegmental plane visualizing by overlay mode of ICG camera. Surgical outcomes were compared between the two groups. The correlation between the predicted resecting liver volume (PRLV) calculated using CT-volumetry and the actual resected liver volume (ARLV) was assessed in the two groups.

Results: Patients who underwent LS showed better outcomes in terms of operative time ($p=0.023$), blood loss ($p<0.001$), and length of hospital stay ($p<0.001$). There were significantly fewer Grade III or higher postoperative complications in the LS group ($p=0.007$). Both values of AST ($p<0.001$) and ALT ($p<0.001$) on postoperative day 1 were significantly lower in the LS group than in the OS group. PRLV and ARLV were more strongly correlated in LS ($r=0.896$) than in OS ($r=0.773$). The difference between PRLV and ARLV was significantly lower in the LS group than in the OS group ($p=0.022$), and this trend was particularly noticeable in the posterosuperior segment ($p=0.008$) than in the anterolateral segment ($p=0.811$).

Conclusion: LS using ICG navigation allows precise resection and may contribute to safer short-term outcomes than conventional OS, particularly in the posterosuperior segment.

A case of S4aS5 anatomical hepatectomy using ICG fluorescence positive and negative staining methods for advanced gallbladder cancer

Nobuyuki Takemura, Fuyuki Inagaki, Yuhi Yoshizaki, Fuminori Mihara, and Norihiro Kokudo

Hepato-Biliary Pancreatic Surgery Division, Department of Surgery, National Center for Global Health and Medicine, Japan

Introduction: Anatomical hepatectomy using ICG fluorescence technique can be performed by either positive staining or negative staining, the former can be performed without hilar dissection, but it is difficult to puncture thin portal vein branches. The latter can identify the perfusion area of a small portal vein branch, but requires hilar dissection from the hepatic pedicle to deeper Glisson's sheath. In this report, we describe a case in which S4aS5 was systematically resected using both the positive and negative ICG fluorescence staining methods.

Case report: A man in his 60s with advanced gall bladder carcinoma with hepatic invasion up to S4aS5 and intrahepatic metastasis at the same site, diagnosed by abdominal ultrasonography of a follow-up hemangioma, CA19-9 level as high as 568 U/ml. After laparotomy confirming there were no un-resectable factors, the lymph nodes of the hepatic hilum were first dissected and the cholecystectomy was performed. Then, the liver was dissected on the right side of the umbilical portion for negative staining, and two P4a were divided and dissected. P5 was then punctured and 5 ml of indigocarmine with 0.25 mg (1/100 V) of ICG was injected, and fluorescence was observed. The border of S5 was clearly drawn, and since it was thought that the negative staining of S4a could be clarified by reperfused ICG, the patient was observed for a while, but since it was not clearly drawn, ICG 1.25 mg (1/20V) was administered systemically, the negative staining of S4a was completed, and the demarcation line on the hepatic surface was confirmed. P5 root, MHV main trunk, and gall bladder plate were ligated and dissected. Operative time was 4 hours 12 minutes and total amount of blood loss was 570 ml without intraoperative blood transfusion. The patient had a good postoperative course with no major complications and was discharged 16 days after surgery.

Summary: P4a can be easily approached by hilar dissection on the right side of the umbilical portion, while P5 is more easily approached by puncture because of its deep branching. We present a case of cholecystic carcinoma with hepatic invasion in which S4aS5 was accurately resected. We believe that this is a very simple method and could become a standard procedure.

The concentration gradient of fluorescence from multiple dosages of indocyanine green enables the identification of liver regions

Shuhei Kanda, Hiroto Nishino, Takahiro Nishio, Tariq Awidah, Kentaro Chikamori , Tomoaki Yoh, Shoichi Kageyama, Takayuki Anazawa, Takamichi Ishii, Etsuro Hatano

Department of Surgery, Graduate School of Medicine, Kyoto University, Kyoto, Japan

In anatomic hepatectomy, the identification of liver regions is essential. The methods to change the color of liver surface by injecting dye or ischemia of the regions are commonly used. Since Aoki et al first reported that indocyanine green (ICG) can visualize liver regions, ICG has recently been used as the method. We developed the Medical Imaging Projection System (MIPS), a system that directly projects fluorescent images of ICG captured by a camera onto the patient's liver. MIPS was able to demonstrate the potential for real-time navigation in surgery. ICG is typically administered only once during 1 operation. We report a case of administering ICG twice with MIPS that was effective for anatomic liver resection.

A 73-year-old man had undergone 1 radiation therapy and 3 radiofrequency ablations for hepatocellular carcinoma over the past 4 years. Follow-up CT showed a low-density lesion in segment (Sg) 8 with portal vein tumor thrombus (PVTT). Following 4 courses of chemotherapy with Atezolizumab and Bevacizumab, we planned right anterior sectionectomy.

As PVTT extended to the right anterior sectional branch, we predicted that it was not possible to perform negative staining of Sg 8 and the positive staining was also ineffective or ambiguous. We planned to perform the staining twice by changing the concentrations of ICG and to achieve a 3-stage gradient of fluorescence. Firstly, we identified the pale fluorescent boundary between the right anterior and posterior sections by blocking the inflow of the Glissonean pedicle of the right posterior section (ICG dose: 0.25mg). Secondly, we identified the bright fluorescent boundary between the right anterior section and the left medial section by blocking the inflow of the Glissonean pedicle of the right lobe (ICG dose: 2.5mg). The fluorescence intensity distinguished between three regions. By adjusting threshold value, MIPS projected each section boundaries onto the liver surface. The right anterior sectionectomy was successful with no postoperative complications, and pathological examination showed negative surgical margin. We believe that this technique can be applied to other surgeries necessary to distinguish multiple boundaries.

Intraoperative Fluorescence Imaging with Preoperative ICG Administration for Liver Tumors Detection: Evaluating the Significance of ICG Retention in Resection Decision-Making

Martín Huerta Garcia, Concepción Gómez-Gavara, Cristina Dopazo, Mar Dalmau, Ernest Hidalgo, and Ramón Charco

HPB Surgery and Liver Transplant Department, Hospital Universitari Vall d'Hebron, Universitat Autònoma de Barcelona, Barcelona, Spain

Purpose: Indocyanine Green (ICG) has demonstrated to allow a better identification of liver tumors and might improve clinical outcomes in liver surgery. The aim of the study is to determine the effectiveness of ICG fluorescence in detecting liver tumors when used in combination with preoperatory Magnetic Resonance Imaging (MRI) and intraoperative ultrasonography (IOUS).

Methods: The study included adult patients who underwent minimally invasive liver resection for malignant tumors. All patients had a preoperative MRI and had ICG administered intravenously (0.2-0.5 mg/kg) 24 hours before surgery. Once in theatre, liver parenchyma was scanned with IOUS and ICG fluorescence. Tumors identified were resected and specimens sent for pathology assessment.

Results: 20 patients were included in the study. MRI reported 42 tumors, IOUS detected 46 and ICG identified 53. Combining MRI+ICG+IOUS, 62 lesions were identified and resected. From 42 tumors detected by MRI, 34 were histologically consistent with cancer. By adding IOUS+ICG, 20 extra lesions were resected and 10 of them were malignant. Accuracy, sensitivity (S) and specificity (E) for malignant tumor detection for MRI, IOUS and ICG was 70.9% (S 77.2%, E 55%), 74.1% (S 84%, E 50%), and 82.2% (S 97.7%, E 44%). ICG was the most sensitive tool, identifying more malignant tumors than MRI ($p=0.012$) and IOUS ($p=0.07$). Combination of ICG+IOUS showed the highest results when comparing the ROC curves.

Conclusions: ICG-guided surgery is a safe and useful tool for detecting more malignant tumors in liver surgery.

Keywords: indocyanine green, liver surgery, magnetic resonance imaging, intraoperative ultrasonography.

Improving retention and specificity of fluorescence probe for hepatocellular carcinoma

Jinpeng Tang, Jie Hu, Xiaoying Wang

Zhongshan Hospital, Fudan University, Shanghai, China

Despite the high sensitivity and positive predictive value, the false-positive rate of ICG fluorescence tumor imaging is reportedly high in liver surgery. Therefore, it is necessary to develop tumor specific fluorescent probes. SP94 peptide has demonstrated its ability to target HCC. Connecting SP94 to ICG may increase tumor specificity of ICG fluorescence probe which can be detected by existing fluorescent laparoscopic equipment. In this study, we designed and synthesized three novel compounds: SP94-ICG, ODDA-SP94-ICG, and cySP94-ICG, and assessed their effectiveness of targeting HCC in human HCC cell-bearing nude mice. These probes were administered separately via tail vein injections, and their biodistribution was monitored using a fluorescence laparoscopy at various time intervals (0h, 24h, 48h, 72h, 96h, 120h). All of three new probes showed prolonged retention times compared to ICG. Notably, ODDA-SP94-ICG and cySP94-ICG exhibited significantly prolonged retention times than SP94-ICG. In subcutaneous tumor-bearing nude mice models, the ODDA-SP94-ICG and cySP94-ICG probes displayed a remarkable fluorescence intensity peak at the tumor site 24 hours post-injection, with the signal persisting for over 100 hours thereafter. Interestingly, ICG was primarily excreted through the intestinal tract. Meanwhile, the SP94-ICG and cySP94-ICG probes were predominantly filtered through the kidneys. In contrast, the ODDA-SP94-ICG probe demonstrated exceptional retention capability, as evidenced by the absence of significant washout. The safety of all three probes has been proved by pathology of liver, kidney, lung, heart, brain and intestine. This study represents an advancement in improving the retention and specificity of new fluorescence probe for HCC, which pave the way for the future phase 1 clinical trial.

April 5 15:30-17:05

III: New techniques 1

<Chairpersons>

Masaki Kaibori
Kansai Medical University, Japan

Katsuya Yamada
Hirosaki University Graduate School of Medicine, Japan

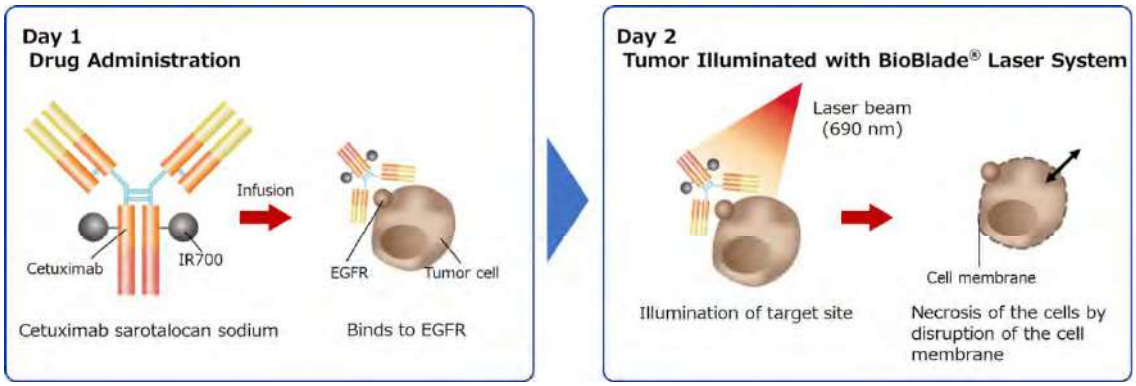
Photoimmunotherapy

Takeshi Shinozaki

Department of Head and Neck Surgery National Cancer Center Hospital East, Japan

Photoimmunotherapy utilizes an antibody–drug conjugate, cetuximab sarotalocan sodium, that consists of cetuximab, a chimeric anti-human epidermal growth factor receptor (EGFR) monoclonal antibody (IgG1), and a light-sensitive compound, the dye IRDye 700DX (IR700). The conjugate is highly selective for binding cells expressing EGFR, which is highly and strongly expressed in HNSCC. The dye is activated by illumination of a 690 nm (red) laser beam from the BioBlade® laser system and then rapidly kills only the cells to which the conjugate is bound. The mechanism of action is thought to be as follows: (i) activation of the antibody conjugate by laser illumination, (ii) which causes damage on the cell membrane, (iii) resulting in an increase in transmembrane water flux and (iv) leading to cell rupture and necrosis. This reaction is considered to occur within an extremely short period of time after laser illumination. Since January 2021, this treatment has been eligible for insurance coverage in Japan for unresectable locally advanced or locally recurrent head and neck cancers.

We treated 12 cases in which photoimmunotherapy was performed at the National Cancer Center Hospital East, Japan. Photoimmunotherapy was administered 27 times to 12 patients with recurrent and inoperable head and neck cancer. All of patients received their considerable definitive treatments such as surgery and CRT. We will present the effectiveness of the photoimmunotherapy. Clinical studies about PIT have been just getting started in Japan. We are currently conducting a prospective observational study evaluating the relationship between the effectiveness and the changing of the fluorescence intensity of tumors during photoimmunotherapy.



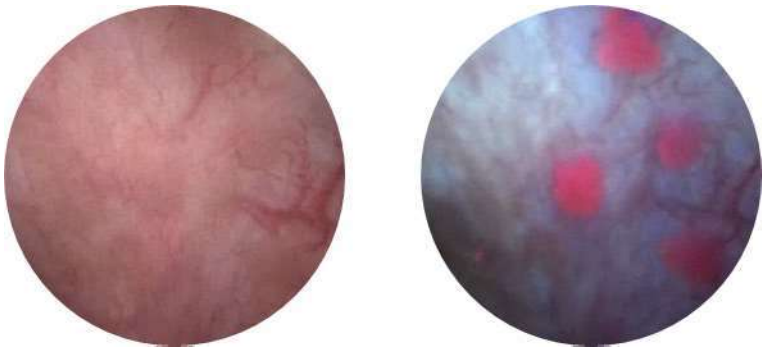
5-aminolevulinic acid-based photodynamic diagnosis for non-muscle invasive bladder cancer

Hideo Fukuhara, Ryu Shigehisa, Shinkuro Yamamoto, Keiji Inoue

Department of Urology, Kochi medical school, Japan

Photodynamic diagnosis (PDD) with 5-aminolevulinic acid (ALA) was covered by insurance in 2017 for bladder cancer as "visualization of muscle layer non-invasive bladder during transurethral bladder tumor resection," enabling its use in real-world clinical practice. ALA-PDD has not only improved diagnostic accuracy but also improved treatment outcomes. In our study, ALA-PDD not only reduced the postoperative recurrence rate, but also prolonged the time to recurrence by approximately 2.2-fold, even in cases of recurrence. However, with the widespread use of ALA-PDD in daily practice, hypotension or hypotension as a side effect has become an important problem. Occasionally, severe cases of hypotension are unresponsive to normal doses of pressor drugs during induction of anesthesia, requiring the use of large doses of pressor drugs and close management in the intensive care unit. To address this issue, we performed a retrospective analysis of all 245 patients from multiple centers who underwent ALA-PDD and performed multivariate logistic and decision tree analyses for factors related to hypotension. Multivariate logistic analysis revealed that history of hypertension, general anesthesia, and oral Ca antagonists were significant factors. Decision tree analysis also revealed a combination of factors that predisposed to hypotension. In this article, we will discuss the side effects of ALA-PDD in daily clinical practice, especially hypotension, with a review of the literature.

Figure; Bladder tumors show red fluorescence by ALA-PDD (multiple lesions).



CEA-targeted fluorescence-guided surgery using SGM-101, current status and future prospects

Joost van der Vorst[1], Mats Warmerdam[1], Francoise Cailler[2], Denise Hilling[1,3], Alexander Vahrmeijer[1]

[1]Department of Surgery, Leiden University Medical Center, Leiden, The Netherlands, [2]Surgimab, Montpellier, France, [3]Department of Surgical Oncology and Gastrointestinal Surgery, Erasmus MC Cancer Institute, Rotterdam University Medical Center, Rotterdam, The Netherlands

CEA is a well-known tumour marker, overexpressed in approximately 95% of colorectal adenocarcinomas and 80% of ductal pancreatic adenocarcinomas (PDAC), making it an ideal target for fluorescence guided surgery (FGS). SGM-101 is a CEA-targeted monoclonal antibody covalently bound to the fluorophore BM-104, that can be visualized with a dedicated 700nm camera system. Between 2016 and 2019 the SGM-clin02 trial was performed assessing feasibility, pharmacokinetics and pharmacodynamics in patients with colorectal cancer (n=60) and PDAC (n=15). The trial showed optimal intra-operative visualisation and accuracy, especially in the group receiving 10mg, 4 days before surgery. Most potential was seen in patients with locally advanced rectal cancer (LARC), locally recurrent rectal cancer (LRRC) and peritoneal metastasised colorectal cancer, with 22% (9/41) experiencing a fluorescence-based true positive change in treatment, leading to additional resections or treatment downgrades. In pancreas cancer patients, the study showed that despite the suboptimal intrinsic characteristics of pancreas cancer, SGM-101 can reach and bind to CEA-expressing tumor cells, with fluorescence detectable in both primary tumors and metastases.
These promising results led to the initiation of the phase 3 international multicentre, randomized, clinical study on the performance of SGM-101 in primary, recurrent and peritoneal metastasised colorectal cancer (NCT03659448). The primary endpoint of this trial is to detect additional malignant tissue, while the key secondary objective is to assess the use of SGM-101 to preserve non-cancer tissue during surgery. The trial is currently ongoing. Moreover, the SGM-LARRC-trial (NCT04642924), currently enrolling up to a total of 203 patients with LARC or LRRC, is powered to identify the surgical benefit of SGM-101 in terms of performing an R0 resection. Patient outcomes, including local tumor control and survival, will be assessed over a 2-year follow-up. Recently new trials have been initiated: 1) The SGM-CBM trial, assessing the feasibility of SGM-101 to visualize colorectal brain metastases in 10 patients (NCT04755920); 2) The SGM-T1 trial, evaluating whether SGM-101 is able to discriminate invasive T1/high-grade dysplasia (HGD) from low-grade dysplasia (LGD), supported by preclinical immunohistochemical analyses demonstrating elevated CEA expression in T1/HGD lesions in respect to LGD; 3) The Focus Green trial, combining indocyanine green (ICG) and SGM-101 to accentuate colorectal liver metastases (NCT05965817); 4) The FLUOPANC II trial, evaluating the feasibility of SGM-101 in ascertaining the local extent and resectability of neoadjuvant treated PDAC; and 5) The MIRCA and MIPAC trials, investigating the efficacy of multimodal imaging with radionuclide-conjugated SGM-101 for fluorescence and radio-guided resection of rectal cancer and PDAC. The results of these trials are eagerly awaited.

VGT-309: A tumor targeted near-infrared imaging agent for intraoperative detection of cancer in the lung

Eric Bensen

Vergent Bioscience, Inc
Minneapolis, Minnesota, USA

Curative cancer surgery depends on complete removal of malignant tissue. However, intraoperative differentiation of cancer from healthy tissue remains a surgical challenge. This is especially true for minimally invasive procedures where tactile and visual cues are reduced. Intraoperative molecular imaging (IMI) has emerged as a promising solution to these challenges by delivering real-time visual feedback to the surgeon, increasing the likelihood of complete tumor resection while reducing the unnecessary removal of healthy tissue. VGT-309 is an activatable IMI agent that targets cysteine cathepsins, a family of proteases enriched in a broad range of solid tumors. A targeted nucleophilic attack by an active cysteine cathepsin on the phenoxymethyl ketone electrophile of VGT-309 results in the covalent and irreversible labeling of the cathepsin with the near-infrared fluorophore ICG and the release of a quenching moiety, unmasking ICG fluorescence. Since all commercially available near-infrared imaging systems that support minimally invasive technologies can visualize ICG, VGT-309 is compatible with hardware currently available in most operating rooms. The clinical status of VGT-309 in ongoing and completed clinical trials for cancer in the lung will be presented.

Optical-Guided Surgery in High Grade Glioma and Oral and Oropharyngeal Squamous Cell Carcinoma Using a Novel uPAR-Targeted Near-Infrared Imaging Agent FG001 (AE105-Glu-Glu-ICG)

Karina Juhl[1,2], Jane Skjoeth-Rasmussen[3], Aleena Azam[3], Amanda Oester Andersen[4], Anders Christensen[4], Dorthe Groennegaard Mejer[2], Anne Poulsen[2], Morten Albrechtsen[2], Christian von Buchwald[4], Andreas Kjaer[1,2]

[1]Department of Clinical Physiology and Nuclear Medicine & Cluster for Molecular Imaging, Copenhagen University Hospital – Rigshospitalet & Department of Biomedical Sciences, University of Copenhagen, Denmark, [2]FluoGuide A/S, Copenhagen, Denmark, [3]Department of Neurosurgery, Neuroscience Center, Rigshospitalet, Copenhagen University Hospital, Copenhagen, Denmark, [4]Department of Otorhinolaryngology, Head & Neck Surgery and Audiology, Copenhagen University Hospital - Rigshospitalet, Denmark

Background: Identification and delineation of cancerous tissue is a key element in the surgical management of cancer. This review of trials aim to investigate a novel uPAR-targeted near-infrared (NIR) optical imaging agent, FG001 (ICG-Glu-Glu-AE105), for intraoperative tumor visualization in patients with High Grade Glioma (HGG) and oral and oropharyngeal squamous cell carcinoma (OSCC, OPSCC).

Methods: We conducted two clinical trials at Rigshospitalet, Copenhagen University Hospital; (1) An open-label, non-randomized, dose escalation, single-dose administration, multi-center phase I trial of FG001, in patients with malignant glioma scheduled for neurosurgery (2) An open-label, non-randomized, single center, single dose, exploratory phase II trial of FG001 for localization of oral and oropharyngeal squamous cell carcinoma. A total of 56 patients scheduled for primary surgical.

Dose escalation in the range of 1 mg to 48 mg was performed using near-infrared camera systems. During the trials, identification of the tumor, specificity and sensitivity was investigated. For oral cancer neck metastasis was also investigated for NIR signal. Tumor-specificity and signal intensity of FG001 was evaluated macroscopically by analysis of perioperative imaging and calculation of contrast expressed as tumor-to-background ratio (TBR). Microscopic tumor-specificity was accessed by analysis of correspondence of presence of tumor tissue and optical signal in resected tumor specimens. Blood samples were collected up to 44 hours post-surgery to further characterize the pharmacokinetic profile of FG001.

Results: In all patients with HGG or OSCC dosed at 8 mg FG001 or higher, specific tumor visualization was observed intraoperatively and by imaging of resected tumor specimen ex vivo on the back table.

In total 4 related AE have been reported in a total of 56 patients exposed to FG001, all mild (3 grade 1 and 1 grade 2)

Conclusion: The data indicates that FG001 is a promising novel image agent suitable for real-time intraoperative optical-guided visualization of imaging systems capable for ICG-spectral specifications to detect the primary tumor and metastases in OSCC and HGG. Further, FG001 was found to be safe and well tolerated.

Clinical application of pudexacianinium chloride (ASP5354) for intraoperative and noninvasive visualization of ureters

Gabriel P. Haas

Astellas Pharma Global Development Inc., Northbrook, IL 60062, USA

Identification of ureters during complex abdominal/retroperitoneal surgery is critical for preventing iatrogenic injury. Ureteral stenting or retrograde injection of materials is invasive and can increase risk of complications. Here we describe the clinical application of a novel, noninvasive, intravenously (IV) injected imaging agent, pudexacianinium chloride (ASP5354), to support visualization of ureters during laparoscopic and open procedures. ASP5354 is an iodine-free chemical entity with hydrophilic properties via conjugation with cyclodextrin. When administered IV, it is excreted into the urine through the kidneys. Photo-optically, ASP5354 is indistinguishable from indocyanine green (ICG), with absorption at 780 nm and emission at 820 nm, resulting in green luminescence when using a Near Infrared Fluorescence (NIR-F) detection device. Regulatory-cleared imaging devices approved for use with ICG for laparoscopic (Stryker 1688 Advanced Imaging Modalities) and open (Stryker SPY-PHI) procedures allow visualization under both white light (WL) and NIR-F imaging modes. Safety, tolerability, and pharmacokinetics (PK) of ASP5354 were evaluated in two phase 1 randomized, double-blind, placebo-controlled, sequential-ascending IV bolus dose, clinical trials in healthy adults: a first-in-human study in the United States (US) (NCT03698305) and a study of Japanese men (NCT04878471). Clinical evidence for intraoperative use of ASP5354 for visualizing ureters was first established in a phase 2 randomized, open-label, dose-ranging study in the US (NCT04238481), where adults undergoing laparoscopic colorectal surgery were randomized to receive ASP5354 in one IV dose at 0.3-, 1.0-, or 3.0-mg. Primary endpoint was ureteral fluorescence 30 min post-ASP5354 administration and at end of surgery. Safety and PK were also examined. WL/NIR-F image pairs of ureters were assessed in a retrospective study by surgeons who rated ureter conspicuity before, during, and after surgery using a 5-point Likert scale based on a single-item question, “How conspicuous is the ureter?” Two phase 3 randomized, investigator-blinded, open-label, single IV dose studies in the US are ongoing, with another study in the planning stage. The primary analysis will compare ureter conspicuity under WL vs NIR-F during abdominopelvic surgery in participants with normal renal function (NCT05754333) or mild renal impairment (NCT05999747), and in participants with moderate or severe renal impairment for secondary analysis. The primary endpoint will be ureter conspicuity for WL versus NIR-F scored using the 5-point Likert scale. ASP5354 clinical data and video examples of the utility of ASP5354 will be presented.

Pafolacianine for intraoperative molecular imaging of cancer in the lung: The ELUCIDATE trial

Inderpal S Sarkaria[1], Linda W Martin[2], David C Rice[3], Shanda H Blackmon[4], Herbert B Slade[5], Sunil Singhal[6]; ELUCIDATE Study Group

[1]University of Pittsburgh School of Medicine and University of Pittsburgh Medical Center, Pittsburgh, [2]University of Virginia Medical School, Charlottesville, [3]The University of Texas MD Anderson Cancer Center, Houston, [4]Mayo Clinic College of Medicine and Science, Rochester, [5]Deptartment of Pediatrics, University of North Texas Health Science Center, Fort Worth, [6]University of Pennsylvania Perelman School of Medicine, Philadelphia

Objective: The study objective was to determine the clinical utility of pafolacianine, a folate receptor-targeted fluorescent agent, in revealing by intraoperative molecular imaging folate receptor α positive cancers in the lung and narrow surgical margins that may otherwise be undetected with conventional visualization.
Methods: In this Phase 3, 12-center trial, 112 patients with suspected or biopsyconfirmed cancer in the lung scheduled for sublobar pulmonary resection were administered intravenous pafolacianine within 24 hours before surgery. Participants were randomly assigned to surgery with or without intraoperative molecular imaging (10:1 ratio). The primary end point was the proportion of participants with a clinically significant event, reflecting a meaningful change in the surgical operation.
Results: No drug-related serious adverse events occurred. One or more clinically significant event occurred in 53% of evaluated participants compared with a prespecified limit of 10% ($P < .0001$). In 38 participants, at least 1 event was a margin 10 mm or less from the resected primary nodule (38%, 95% confidence interval, 28.5-48.3), 32 being confirmed by histopathology. In 19 subjects (19%, 95% confidence interval, 11.8-28.1), intraoperative molecular imaging located the primary nodule that the surgeon could not locate with white light and palpation. Intraoperative molecular imaging revealed 10 occult synchronous malignant lesions in 8 subjects (8%, 95% confidence interval, 3.5-15.2) undetected using white light. Most (73%) intraoperative molecular imaging-discovered synchronous malignant lesions were outside the planned resection field. A change in the overall scope of surgical procedure occurred for 29 of the subjects (22 increase, 7 decrease).
Conclusions: Intraoperative molecular imaging with pafolacianine improves surgical outcomes by identifying occult tumors and close surgical margins

April 5 17:10-17:50

IV: Evening seminar (Stryker)
Fluorescence guided surgery from the basic to advanced approach - Japan to Global –

<Chairperson>

Jun Watanabe
Kansai Medical University, Japan

<Presenters>

Jun Watanabe
Kansai Medical University, Japan

Taiga Wakabayashi
Ageo Central General Hospital, Japan

Blood Perfusion Assessment by Indocyanine Green Fluorescence Imaging for Minimally Invasive Rectal Cancer Surgery

Jun Watanabe

Department of Lower Gastrointestinal and General Surgery,
Kansai Medical University, Japan

Objective: The aim of the present randomized controlled trial was to evaluate the superiority of indocyanine green fluorescence imaging (ICGFI) in reducing the rate of anastomotic leakage in minimally invasive rectal cancer surgery.

Background: The role of ICG-FI in anastomotic leakage in minimally invasive rectal cancer surgery is controversial according to the published literature.

Methods: This randomized, open-label, phase 3, trial was performed at 41 hospitals in Japan. Patients with clinically stage 0–III rectal carcinoma less than 12 cm from the anal verge, scheduled for minimally invasive sphincter-preserving surgery were preoperatively randomly assigned to receive a blood flow evaluation by ICG-FI (ICG+ group) or no blood flow evaluation by ICG-FI (ICG− group). The primary endpoint was the anastomotic leakage rate (grade A+B+C, expected reduction rate of 6%) analyzed in the modified intention-to-treat population.

Results: Between December 2018 and February 2021, a total of 850 patients were enrolled and randomized. After the exclusion of 11 patients, 839 were subject to the modified intention-to-treat population (422 in the ICG+ group and 417 in the ICG− group). The rate of anastomotic leakage (grade A+B+C) was significantly lower in the ICG+ group (7.6%) than in the ICG− group (11.8%) (relative risk, 0.645; 95% confidence interval 0.422–0.987; P= 0.041). The rate of anastomotic leakage (grade B+C) was 4.7% in the ICG+ group and 8.2% in the ICG−group (P=0.044), and the respective reoperation rates were 0.5% and 2.4% (P=0.021).

Conclusions: Although the actual reduction rate of anastomotic leakage in the ICG+ group was lower than the expected reduction rate, ICG-FI significantly reduced the anastomotic leakage rate by 4.2%.

Current roles of ICG fluorescent imaging systems in laparoscopic liver resection

Taiga Wakabayashi[1]

Center for Advanced Treatment of Hepatobiliary and Pancreatic Diseases, Ageo Central General Hospital, Saitama, Japan

Indocyanine green (ICG) fluorescence is a valuable tool in liver surgery, aiding in navigation. Its use has surged with the growth of minimally invasive techniques. ICG serves various functions in liver resection, including liver function testing, intraoperative cancer imaging, segmental staining, biliary imaging, and liver perfusion assessment. Despite its advantages, standardizing the optimal dose and timing of ICG remains challenging. A systematic review was conducted to address this, leading to recommendations: a dose of 0.5 mg/kg 14 days before surgery, with additional administration (0.02-0.5 mg/kg) for longer preoperative intervals. For segmental staining, doses range from 2.5 mg/body (negative staining) to 0.25 mg/body (positive staining). In laparoscopic liver resection (LLR), the integration of ICG fluorescence imaging with preoperative 3D reconstruction and IOUS enhances navigation. At our institution, we employ the Glissonean approach (GA) and indocyanine green negative staining (ICG-NS) for anatomical liver resection, based on the principle of parenchymal sparing. Analysis of LLR outcomes has demonstrated promising 5-year overall survival (OS) rates for hepatocellular carcinoma (HCC) and colorectal liver metastases (CRLM) with this laparoscopic limited anatomical resection (Lap-LAR). Its precise technique renders it a promising therapeutic option for liver malignancies. Further comparisons with conventional approaches are warranted.

Day 2

April 6 8:00-8:45

V: Morning seminar (Goryo Chemical)

HMRG: a possible main player in the future fluorescence-guided surgery

<Chairperson>

Yasuteru Urano
The University of Tokyo, Japan

<Presenters>

Shota Tanaka
Okayama University, Japan

Yosuke Tsuji
The University of Tokyo, Japan

April 6 8:50-9:45

VI: Fluorescence-guided surgery in the world

<Chairpersons>

Takeaki Ishizawa
Osaka Metropolitan University, Japan

Norihiro Kokudo
The University of Tokyo, Japan

Massage to AP-ISFGS (Video)

Raul J Rosenthal
Cleveland Clinic Weston, Florida, USA

ISFGS for the future (Video)

Fernando Dip
Hospital de Clinicas, University of Buenos Aires, Argentina

Japanese Society for Fluorescence Guided Surgery, the path we have taken and the road ahead

Masashi Yoshida

Department of Surgery, International University of Health and Welfare Hospital, Japan

Indocyanine green (ICG) fluorescence method for detecting sentinel lymph nodes in breast cancer (Kitai et al., 2005) and gastrointestinal cancer (Kusano et al., 2008), liver mapping using ICG fluorescence (Aoki et al., 2008), intraoperative fluorescent cholangiography using ICG (Ishizawa et al., 2009) and liver cancer fluorescence using ICG (Ishizawa et al. 2009) were first reported by Japanese institutes. The Japanese Society for Fluorescence Navigation Surgery (JSFNS) was established in 2008 and continued for 10 years. Moreover, international contribution of Dr. Ishizawa made him the founding president of the International Society for Fluorescence Guided Surgery (ISFGS). The camera used in the JSFNS was mainly monochrome. The first bright-field, full color camera, HyperEye Medical System (HEMS) was developed by Dr. Sato from Kochi University, Kochi, Japan. It was started in 2004 and has been commercially available since 2010. I have been involved in the experiments using HEMS since 2009. Medical Imaging Projection System (MIPS), the active projection mapping for ICG fluorescence was first reported by Nishino et al, from Kyoto University, Kyoto, Japan. These developments of fluorescent camera systems enable us to discuss wide variety of operations and the Japanese Society for Fluorescence Guided Surgery (JSFGS) was necessarily established in 2018. In addition to the fluorescent camera systems, the developments of the fluorescent probes are current topics in the JSFGS. Dr. Sato developed the near-infrared fluorescent resin and the near-infrared (NIR) fluorescent ureteral catheter and NIR fluorescent clip are used for laparoscopic (Narihiro et al.) and da Vinci assisted (Takahashi et al.) gastrointestinal operations. Tumor-fluorescence based on 5-aminolevulinic acid induced protoporphyrin IX has been applied to malignant glioma, bladder cancer and gastric cancers. Dr. Urano from Tokyo University, Tokyo, Japan established the showcase for variety of the fluorescent probes which are rapidly activated only in the cancer site.

Another important role of JSFGS is to distribute adequate information. We published the JSFGS guideline in 2023. Dr. Ishizawa in cooperate with JSFGS published guide book in 2020 (in Japanese) and in 2023 (English edition). We are planning to conduct multi-center studies on intestinal blood flow and fluorescent cholangiography. Because the aim of us is to create new, safer, faster, easier, clear and shine operations, we need to go on the road ahead.

Japanese consensus guideline on evaluation of blood flow using indocyanine green fluorescence imaging in colorectal surgery

Hiro Hasegawa[1, 2], Masaaki Ito[1, 2]

[1]Department of Colorectal Surgery, National Cancer Center Hospital East, Kashiwa, Japan

[2]Department for the Promotion of Medical Device Innovation, National Cancer Center Hospital East, Kashiwa, Japan

Evaluation of blood flow using indocyanine green fluorescence imaging in colorectal surgery has been increasing. However, some variability continues to exist in how to perform the fluorescence imaging. The Japanese consensus guideline was developed to identify areas of consensus and non-consensus regarding the assessment of blood flow using fluorescence imaging. A literature review was conducted, 8 clinical questions were set that were considered important in performing fluorescence imaging, and 12 statements were created for the survey. A two-round Delphi survey was conducted to assess the consensus, regarding the technical aspects and the expected effects. A total of 10 expert colorectal surgeons in Japan were involved in the survey. A consensus was reached for all 12 statements voted on in the first round, so the second round was not conducted. Although further research is required, fluorescence imaging appears to be a useful technique to assess blood flow in colorectal surgery, and we hope that this guideline can be used in clinical practice.

Device and drug availability in Asia-Pacific regions for further development of fluorescence guided surgery

Seong-Ho KONG

Department of Surgery, Seoul National University Hospital, Seoul, Korea
VITCAL, CO., Ltd.

For delicate fluorescence-guided surgery, high-performance fluorescence imaging equipment is crucial. Most devices are optimized for the wavelength of Indocyanine green (ICG), catering to various surgical procedures. Open equipment is utilized in both open and laparoscopic surgeries for macroscopic observations, particularly in plastic surgery for fine blood vessel and lymphatic observations. Open devices offer more flexibility in light delivery and obtaining high-sensitivity images, albeit being influenced by ambient light. Laparoscopic devices traditionally offer 4K resolution or 3D functionality, with preferences for overlaying or switching between fluorescence and white light modes.

For excitation, LEDs are commonly used due to safety certification ease, while lasers offer advantages in narrow excitation wavelength range, reducing energy requirements. Fluorescence signals, represented in near-infrared, are displayed using artificial colors. Several display methods exist, including black and white, monochromatic background, or overlay mode with white light images, each serving specific surgical needs. Gain control functions adjust fluorescence sensitivity, influenced by hardware and software changes.

Among robotic surgical systems, the da Vinci system is equipped with a fluorescence imaging system. Future systems are expected to incorporate fluorescence imaging capabilities. Additionally, high-performance microscopes aid in microsurgery by observing fluorescence signals.

ICG applications are expanding, with new indications emerging in various countries. In South Korea, new medical technologies allow for the usage of ICG for sentinel lymph node exploration in cervical and endometrial cancers, as well as lymphography in gastric cancer.

April 6 9:50-11:25

VII: Expanding field of fluorescence guided surgery 1

<Chairpersons>

Yung-Chun Hsieh
National Taiwan University Hospital, Taiwan

Han-Kwang Yang
Seoul National University College of Medicine, Korea

Clinical trials of fluorescence cholangiography targeting reduction of bile duct injury during laparoscopic cholecystectomy

Catherine Teh

Section of Hepatobiliary-Pancreatic Surgery, Department of Surgery, Makati Medical Center
Sections of Hepatobiliary-Pancreatic Surgery and Minimally Invasive Surgery, Department of Surgery, St Luke's Medical Center
Department of Surgery, National Kidney & Transplant Institute

Fluorescence cholangiography, particularly near-infrared fluorescence using indocyanine green (NIF-ICG), has emerged as a promising technique for enhancing the safety of laparoscopic cholecystectomy (LC) by facilitating the visualization of biliary structures. Clinical trials and systematic reviews have evaluated the efficacy and safety of this technique to reduce bile duct injury (BDI), a serious complication of LC with significant morbidity and potential for medico-legal consequences. Recent evidence suggests that fluorescence cholangiography can provide early real-time visualization of the biliary anatomy, potentially reducing operative times and the risk of conversion to open surgery, thus contributing to improved patient outcomes. The FALCON trial, largest randomized controlled clinical trial to date and other smaller studies, demonstrates the advantages of NIF-ICG LC over conventional LC in terms of critical view of safety achievement, successful identification of the cystic duct and common bile duct, and a reduction in operative time. These benefits underpin the importance of larger randomized clinical trials to substantiate these findings and potentially revise current surgical guidelines.

Roles of fluorescence imaging in upper GI surgery

Ian Wong[1], Simon Law[1]

[1]Department of Surgery, School of Clinical Medicine, LKS Faculty of Medicine, The University of Hong Kong

Indocyanine Green (ICG) has the ability to bind to albumin and is metabolized and eliminated by the liver. It can absorb near-infrared light and emit fluorescence. Approved by the FDA, ICG is considered a safe substance with diverse applications, including assessing liver function, cardiac output, ophthalmic angiography, and neurosurgical research. In recent years, it has gained significant popularity in various surgical fields due to its integration into high-definition imaging systems. In upper gastrointestinal surgery, its primary uses include evaluating tissue perfusion (angiography), visualizing anatomy, localizing tumors, and mapping lymph nodes (lymphography). In esophageal surgery specifically, its main indication is to assess the perfusion of the gastric conduit, as conduit ischemia and anastomosis leakage are closely related to the vascular supply. Extensive research has been dedicated to establishing a cutoff point for perfusion, and further investigation is needed to accurately quantify the speed and intensity of ICG perfusion and develop effective treatment strategies to optimize its utility. The concept of sentinel lymph node dissection in esophageal cancer surgery is relatively unexplored, primarily due to advanced disease presentation and extensive lymphatic drainage with skip lesions. However, lymph node mapping can potentially enhance the effectiveness and safety of lymph node dissection, particularly in the vicinity of the recurrent laryngeal nerve area.

Another area of interest in fluorescence-guided surgery is the use of different wavelengths to achieve deeper penetration, reduce noise signals, and provide sharper and more accurate images. The concept of Near Infrared II, which utilizes wavelengths between 1,000–1,700 nm, has shown promising results in preliminary bench and animal studies. Molecular imaging using probes other than ICG is also under intensive investigation. These probes have the potential to not only guide surgical resection but also aid in cancer staging and detecting recurrence. However, target markers are limited in upper gastrointestinal surgery, and the safety profiles of new probes or agents are questionable compared to the well-established safety of ICG in most scenarios. In conclusion, the development of fluorescence-guided upper gastrointestinal surgery is an exciting field with numerous potential areas for exploration and research.

The Role of ICG in Colorectal Surgery

Ian Tan Jse-Wei[1,2]

[1]Divison of Colorectal Surgery, University Surgical Cluster, National University Health System, Singapore

[2]Department of Surgery, Yong Loo Lin School of Medicine, National University of Singapore

Colorectal Cancer is the most common cancer worldwide. In patients who undergo major colorectal resections, anastomotic leaks remain to be the most challenging complication. Not only is it associated with significant perioperative morbidity and mortality, it is associated with delay in adjuvant systemic chemotherapy.

There are several key factors that are associated with creating a safe and healthy colorectal anastomosis, namely, good blood supply, absence of tension, tissue quality and meticulous technique.

Intraoperative fluorescence imaging using Indocyanine Green (ICG) is not only cheap, reliable and easy to use imaging modality, it is safe. Its use as an adjunct to the assessment of bowel perfusion prior to performing a colorectal anastomosis and may reduce anastomotic leak rate following colorectal surgery.

In addition to the assessment of blood perfusion, the real time visualization of biological structures has garnered potential uses in ureteral identification, lymphatic mapping as well as the assessment of hepatic and peritoneal metastases.

Although future research remains necessary, the potential use of ICG in colorectal surgery to enhance patient outcomes are promising.

The potential of fluorescence imaging in preventing anastomotic leakage during gastric conduit surgery

R C Peul[1], S Koning[1], F P Tange[1], M W Kruiswijk[1], P van den Hoven[1], R A Faber[1], H A Galema[2], B Zweedijk[2], S Keereweer[2], D E Hilling[3], A L Vahrmeijer[1], J R van der Vorst[1]

[1]Department of Surgery, Leiden University Medical Center, The Netherlands
[2]Department of Head and Neck Surgery, Erasmus Medical Center, The Netherlands
[3]Department of Surgery, Erasmus Medical Center, The Netherlands

Background: Anastomotic leakage is a severe complication after oesophageal resection with gastric conduit reconstruction due to oesophageal carcinoma. Poor perfusion of the gastric conduit plays an important role in the development of anastomotic leakage. Quantitative near-infrared (NIR) fluorescence angiography with indocyanine green (ICG-FA) is an objective technique that can be used for perfusion assessment. This study aims to assess the possibility of quantitative ICG-FA as a diagnostic tool in preventing anastomotic leakage in gastric conduit surgery.

Methods: In this study, patients undergoing esophagectomy with gastric conduit reconstruction in the LUMC and Erasmus MC are included. During surgery, a standardized NIR ICG-FA video of the gastric conduit is recorded with the Quest Spectrum 2.0 camera. Postoperatively, the videos are quantified. Primary outcomes are clinical outcomes such as anastomotic leakage and other postoperative complications in correlation with perfusion parameters of the time-intensity curves from selected Regions of Interest (ROI's) on the gastric conduit.

Results: The initial findings from an analysis of the first 50 patients show promising results in predicting anastomotic leakage using NIR fluorescence. However, to draw definitive conclusions, an analysis of a larger cohort is necessary. Currently, data collection for this expanded cohort is ongoing at both the Leiden University Medical Center and the Erasmus Medical Center.

Lymphatico-Venous Anastomosis for Lymphedema Cases introduced Fluorescence imaging system SPY-PHI ®-Taking advantage of our hospital-

Kenshin Sai[1], Kanoko Tanimoto[2], Kazuma Ogura[2], Kishi Marina[2], Takeshima Eriko[2], Motomura Hisashi[2]

Minami-Osaka General Hospital, Dept. of PRS[1], Osaka Metropolitan University, Dept. of PRS[2]

ICG fluorescence contrast is a method of irradiating the ICG taken up by the lymphatic vessels with near-infrared excitation light and imaging the near-infrared fluorescence generated from the ICG, thereby making it possible to dynamically observe the lymphatic vessels that are transporting lymphatic fluid before our eyes.
Lymphatic venous anastomosis (hereinafter LVA) using ICG fluorescence, the selection of viable lymphatic vessels is directly related to the success of surgery. This is the most important process.
Since March 2019, I have been performing lymphatic venous anastomosis nearly 50 cases using Stryker's SPY Portable Hand Held imager (hereinafter SPY-PHI ®).
I will report on some insights including the characteristics of our hospital.

Optimized repetitive injection protocol using Voluven-assisted indocyanine green in breast cancer sentinel lymph node biopsy

Yung-Chun Hsieh[1], Chiun-Sheng Huang[2]

[1]Department of Surgery, National Taiwan University Hospital Hsin-Chu Branch, Hsinchu, Taiwan

[2]Department of Surgery, National Taiwan University Hospital, Taipei, Taiwan

Our research team is privileged to present a comprehensive review of our novel surgical protocol, initially published in our paper earlier this year (https://doi.org/10.1245/s10434-023-14129-4). This paper investigates the use of Voluven® as a solvent for indocyanine green (ICG) fluorescence-guided sentinel lymph node biopsy (SLNB) in breast cancer patients. The study evaluated the photophysical properties of ICG in water and Voluven® through laboratory experiments and a mouse model, and clinically translated the formula into ICG-SLNB procedure in breast cancer patients using a repetitive injection-observation protocol, and concluded the use of ICG:Voluven® resulted in better transportation and more stable mapping quality for ICG-SLNB in breast cancer patients.

This presentation encompasses a detailed examination of the dose-adjustment trial results, a retrospective review of cases following the same injection protocol from August 2020 to August 2023, and an evaluation of the protocol's efficacy, safety, and oncological outcomes. This presentation will highlight the experiences gained from implementing this new protocol. Our review reveals promising reliability in terms of the successful rate of the protocol application. The high success rate and superior SLN detection sensitivity underscore the efficacy of our new injection protocol, demonstrating its potential as a standard procedure in the field. We also delve into the oncological outcomes resulting from the application of this novel surgical protocol. Our findings indicate promising results, with significantly increased detection sensitivity while avoiding extensive surgical exploration, improving patients' quality of life.

In conclusion, our presentation offers a holistic review of our novel injection protocol, encompassing the dose-adjustment trial results and retrospective case reviews. This comprehensive review serves as a testament to the potential of our novel injection protocol in revolutionizing cancer treatment, paving the way for future research and clinical applications.

Indocyanine Green Fluorescence-Guided Knee Arthroscopy: Preliminary Results and Future Prospective

Tamiko Kamimura

Department of Orthopaedic Surgery, Tokorozawa Chuo Hospital, Japan

Background: Meniscal vascularity plays a crucial role in meniscal tear healing. However, vascularization of the meniscus is limited to the red-red zone, an area constituting 10–25% of the meniscus. The author employed a laparoscopic procedure using indocyanine green (ICG) in knee arthroscopy to detect vascularization of knee structures in real time.

Objective: To evaluate the hemodynamics of the human meniscus using ICG fluorescence-guided knee arthroscopy and investigate the relationship between patient background and risk factors for meniscal repair.

Methods: In total, 37 patients who underwent meniscal repair and second-look surgery were administered 2.0 mL of ICG (2.5 mg/mL) intravenously. The time from fluorescence onset to its attenuation and the fluorescence intensity at the anterior, middle, and posterior segments of the medial and lateral meniscus (MM/LM) were evaluated on a 4-point scale, with scores ranging from 0 to 3. The time from ICG injection to fluorescence observation and fluorescence intensity were studied in two groups, which were categorized according to the patients' mean age (45 years) and smoking or non-smoking status. Fluorescence time was evaluated from the time of administration to the end of attenuation.

Results: On average, fluorescence was observed within 36.6 s of ICG administration, and the fluorescence was attenuated at 12 min and 33 s. The outcomes of onset and duration were comparable for those under 45 years and non-smokers and for those 46+ and smokers. Younger patients and non-smokers exhibited fluorescence with a slower onset and faster attenuation, while 46+ and smokers observed fluorescence at an earlier onset and later attenuation. Fluorescence intensities were 2.1, 1.6, and 1.4 for the anterior, middle, and posterior segments of the MM, and 2.1, 1.8, and 2.2 for the anterior, middle, and posterior segments in LM, respectively. There was no significant difference between MM and LM. However, the anterior segment was more fluorescent in the MM than the anterior and posterior segments of the LM. In addition, the LM was more fluorescent in individuals aged 45 years or younger. In smokers, fluorescence was lower in both LM and MM.

Discussion: Age and smoking history affected ICG fluorescence duration and fluorescence intensity. Considering the effects of age-related degeneration and load-induced congestion, real-time fluorescence imaging can be used to study specific blood-flow patterns within the meniscus during arthroscopic procedures. This is expected to contribute to meniscal repair outcomes in the next generation.

April 6 12:00-13:00

VIII: Luncheon seminar (Olympus)

The possibility and future of color coded surgery

<Chairperson>
G.V. Rao
AIG Hospitals & Asian Institute of Gastroenterology, India

<Presenters>
Takashi Nonaka
Nagasaki University Graduate School of Biological Science, Japan

Rawisak Chanwat
National Cancer Institute, Thailand

Color enhanced surgery for colorectal cancer

Takashi Nonaka

Department of Surgical oncology, Nagasaki University Graduate School of Biological Sciences.

With the development of endoscopic equipment, it has become easier to observe ICG fluorescence under laparoscopic surgery, so fluorescence-guided surgery has become popular. We collectively refer to surgeries that enable accurate surgery by emphasizing color tones that cannot be obtained with normal white light as color-guided surgery. Color guided surgery includes ICG-fluorescent guided surgery, 5-ALA fluorescent guided surgery, Color coded surgery using Cy5, AI guided surgery, etc. This time, we will introduce a new color-enhanced surgery that uses images obtained by emphasizing beta-carotene, a yellow component in fat tissue, using the yellow-enhancing mode of Olympus' VISERA ELITE III. The advantages of color enhanced surgery include the ability to clarify the boundaries between foam layers and fat tissue, and to highlight structures such as blood vessels within fat tissue. Particularly in the rectal surgery, it is possible to identify the boundary between the mesorectum and nerve tissue quickly, making it a useful method for performing accurate TME. In addition, blood vessels and nerves can be easily identified during lymph node dissection, and it can be used as a tool to perform safe surgery. This feature of color enhanced surgery is non-invasive and simple compared to the ICG fluorescence method, and it is thought that it can become a new color-guided surgery that is useful in the field of colorectal surgery.

Advancements in Color Enhanced Surgery for Laparoscopic Liver Resection

Rawisak Chanwat

Bumrungrad International Hospital, Bangkok, Thailand

Color enhanced surgery has emerged as a promising approach in hepatopancreatobiliary (HPB) procedures, revolutionizing the way surgeons visualize and navigate complex anatomical structures. This abstract highlights two key technologies contributing to this advancement: yellow enhancement technology and indocyanine green (ICG) fluorescence-guided resection.

Yellow enhancement technology offers improved visualization and delineation of critical structures, enhancing surgical precision and reducing the risk of intraoperative complications. Meanwhile, ICG-fluorescence guided resection provides real-time visualization of tissue perfusion and tumor margins, aiding in tumor detection and vascular identification.

This abstract explores the synergistic benefits of integrating these technologies, showcasing their potential to optimize surgical outcomes in laparoscopic liver surgery. Through illustrative case studies and clinical evidence, we demonstrate the transformative impact of colorenhanced surgery in improving patient care and advancing the field of laparoscopic liver surgery. We also discuss ongoing research and future directions aimed at further refining and expanding the application of these technologies. Overall, this abstract underscores the importance of continuous innovation and collaboration in harnessing the full potential of color-enhanced surgery for the benefit of liver surgery patients.

April 6 13:05-14:40

IX: Expanding field of fluorescence guided surgery 2

<Chairpersons>

Nguyen Anh Tuan
108 Military Central Hospital, Vietnam

Nicholas O'Rourke
University of Queensland Brisbane, Australia

Sentinel lymph node mapping of intrahepatic cholangiocarcinoma by ICG fluorescence

Xiaoying Wang

Zhongshan Hospital, Fudan University, Shanghai, China

Objectives: Lymphadenectomy is recommended for intrahepatic cholangiocarcinoma (ICC). However, the extension of lymphadenectomy is still controversial. Extended lymph node (LN) dissection can cause postoperative complications, such as lymphatic fistulae, tissue injury. Sentinel LN (SLN) biopsy provides precise nodal status intraoperatively and helps avoid unnecessary lymphadenectomy in breast and gastric cancer. There is no report of SLN biopsy in ICC. Therefore, we developed SLN mapping technique for ICC by ICG fluorescence.

Methods: As hepatic lymphatic vessel goes along with portal vein, hepatic artery, and bile duct in Glisson sheath, Glisson pedicle near the ICC was punctured with 21G PTCD needle by intraoperative ultrasound without injure PV, artery, or bile duct. 0.2ml ICG (2.5mg/ml) was slowly inject into Glisson sheath.

Results: After 1-2 minutes, ICG was going down though lymphatic chain and spread to LN, station by station, which observed by fluorescence laparoscopy. SLN can be clearly identified. LN dissected with ICG fluorescence, and lymphatic tissue can be easily identified from fat tissue, vessel, bile duct or pancreas. This technique has been proven to be reliable for ICC in different segments of both left and right liver. SLNs vary according the site of the tumors.

Conclusion: To our best knowledge, this is first report of SLN mapping of ICC by ICG fluorescence. By this novel technique, we can dynamically observe the lymphatic chain and drainage direction of ICC located in different segments, which guide the selective lymphadenectomy and individualized cleaning.

Comparative Study of ICG and non-ICG in Laparoscopic Gastrectomy for Gastric Cancer: A Propensity Score-Matched Analysis at a Single Center

Nguyen Van Du, Nguyen Anh Tuan

108 Military Central Hospital, Vietnam

Objective: To investigate efficacy of ICG fluorescence imaging-guided during laparoscopic lymphadenectomy for gastric cancer.Subjects and methods: We prospectively analyzed patients undergoing laparoscopic distal gastrectomy with D2 lymphadenectomy for gastric cancer. Patients were categorized into ICG (n = 80) or non-ICG (n = 160) groups. The surgical results between the two groups were compared based on the propensity score matching (PSM) method.

Results: In total, we included 160 patients pairing in two groups ICG and non-ICG after PSM. There were no significant differences in age, sex, and BMI between the two groups. There was a shorter procedure time in the ICG group compared to the non-ICG group (120.3 ± 19.3 vs 141.1 ± 26.3 mins). There was no difference in blood loss between the two groups. Regarding the effectiveness of lymph node (LN) dissection: The ICG group had a higher mean total number of lymph nodes retrieved than the non-ICG group (37.7 ± 11.8 vs 27.2 ± 10.4 LNs; $p < 0.001$). In the ICG group: the rate of fluorescent lymph nodes was 80.4%, the mean number of fluorescent lymph nodes was 30.3 ± 11.1 LNs; the rate of metastatic lymph nodes and fluorescent LN metastasis was 6.79%, 7.34%, respectively.

Conclusion: Indocyanine green fluorescence imaging can be performed for routine lymphatic mapping during laparoscopic gastrectomy and improve the number of lymph node dissections.

Keywords: Laparoscopic gastrectomy, Gastric cancer, Indocianine green

ICG usage in spleen preserving distal pancreatectomy

Nicholas O'Rourke

Royal Brisbane Hospital, Australia

Traditionally distal pancreatectomy/splenectomy can be performed in three ways: take the spleen and splenic vessels; take the spleen and leave the splenic vessels (Kimura); take the splenic vessels, but leave the spleen, now supplied by the short gastrics and the gastroepiploic (Warshaw). Variations can occur when the either just the splenic artery or vein are divided.

A fourth, new way has recently been described (1). This is distal pancreatectomy with partial splenectomy, where the splenic vessels are taken, and the spleen divided preserving the upper third on the short gastric vessels alone. This is useful for benign hilar lesions or small medial malignant lesions as lymph node clearance appears adequate.

ICG can be used to confirm splenic vascularity in situations of uncertainty, with either Warshaw or Kimura procedures. ICG can also be used to demonstrate that part of the spleen supplied by the short gastrics, prior to spleen division. The spleen is not like the liver with defined segments, and the hilar anatomy is quite variable. This presentation demonstrates the use of ICG in helping the surgeon decide on splenic vascularity, in several recent cases.

References:

1. Bell-Allen N, Macnamara A, Bull N, Lewin J, O'Rourke N. Laparoscopic partial splenectomy in distal pancreatectomy may preserve splenic function. ANZ J of Surgery. 2024 Jan. (E pub)

Role of Indocyanine Green (ICG) to look for vascularity of pancreatic stump during Whipple's procedure.

Maharjan DK, Limbu Y, Ghimire R, Thapa PB

Hepato-Biliary and Pancreatic Surgery Unit; Department of GI and HPB Surgery, Kathmandu Medical College Teaching Hospital, Kathmandu University. Kathmandu, Nepal

Introduction: Vascularity of pancreatic stump margin, post transection has been Achille's tendon for the pancreatic surgeon with dreaded post-operative pancreatic fistula (POPF) being the end result which might increase morbidity as well as mortality post Whipple's procedure.

Methods: With introduction of Indocyanine Green (ICG) dye (0.25mg per Kg body weight IV) after transection of pancreatic margin during Whipple's procedure, vascularity of the stump were assessed. Beside near infrared ICG mode, intensity mapping was used for final vascular perfusion assessment.

Results: This study took place from August 2022 to August 2023 in Department of GI and HPB Surgery and still ongoing. Total 43 Whipple's procedures were included during this period. ICG was given after removal of specimen and before pancreatic - jejunostomy anastomosis begin. Though, ICG shows vascular enhancement of the stump, with use of intensity mapping of ICG fluorescence indicated inhomogeneous vascularity at the pancreatic resection margin in 3 patients, thus necessitating revision of pancreatic margins before pancreatic-jejunostomy. Grade A POPF was noted in 3.44 % (n=8) of patients. Grade B POPF was noted in 1.29 % (n=3). None had grade C POPF.

Conclusion: Besides, pancreatic texture and duct size among others, being contributing factors for POPF, visualizing and objectifying the adequacy of vascularity at the pancreatic resection margin can potentially mitigate one of the risk factors of POPF. Moreover, use of intensity mapping during procedure would further help us to objectify the grade of micro perfusion of the pancreatic stump.

The FAFI-trial: NIRF perfusion assessment in reconstructive DIEP-flap surgery

S. Koning[1], F P Tange[1], P S Verduijn[2], B G Sibinga Mulder[2], L van Capelle[1] , M W Kruiswijk[1], R C Peul[1], C Driessen[3], M A M Mureau[4], A L Vahrmeijer[1], J R van der Vorst[1]

[1] Department of Surgery, Leiden University Medical Center, Albinusdreef 2, 2333 ZA, Leiden, the Netherlands
[2] Department of Plastic and Reconstructive Surgery, Leiden University Medical Center, Albinusdreef 2, 2333 ZA, Leiden, the Netherlands
[3] Department of Plastic and Reconstructive Surgery, Amsterdam University Medical Center, Meibergdreef 9, 1105 AZ, Amsterdam, the Netherlands
[4] Department of Plastic and Reconstructive Surgery, Erasmus MC Cancer Institute, University Medical Center Rotterdam, Doctor Molewaterplein 40, 3015GD, Rotterdam, the Netherlands

Introduction: In 2022, nearly 18,000 Dutch women received the diagnosis of breast cancer, reaffirming its status as the most prevalent cancer among women, with one in seven facing this diagnosis in their lifetime. Surgical intervention is necessary for approximately 90% of these cases, with 30% requiring mastectomy. Autologous breast reconstruction, particularly utilizing the deep inferior epigastric artery (DIEP) flap, is a common procedure following mastectomy. However, between 10-35% of patients undergoing this reconstruction experience fat necrosis in the transplanted tissue, often due to perfusion issues leading to ischemia or ischemia-reperfusion injuries.

Fat necrosis ranges from cosmetic concerns to severe complications necessitating further interventions. Near-infrared fluorescence (NIR) imaging with indocyanine green (ICG) during surgery offers a promising approach to identify ischemic areas within the DIEP flap, potentially mitigating fat necrosis risk.

Methods: The ongoing randomized controlled trial aims to assess whether intraoperative ICG NIR fluorescence imaging reduces fat necrosis incidence. The trial includes 280 female patients undergoing autologous breast reconstruction, divided equally between standard clinical assessment and assessment augmented by ICG NIR fluorescence imaging.

Primary outcomes focus on clinically significant fat necrosis rates at two weeks and three months post-reconstruction. Quantification software analyzes intraoperative images to correlate perfusion parameters with post-operative complications.

Conclusion: The FAFI-trial, conducted across multiple Dutch centers, seeks to determine the clinical utility of ICG NIR fluorescence imaging in reducing fat necrosis and improving patient outcomes and well-being following DIEP/msTRAM flap reconstruction. This study aims to optimize surgical techniques and enhance patient care in breast cancer treatment.

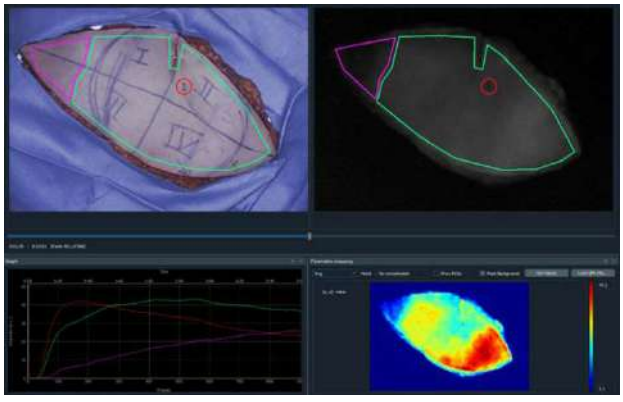


Figure 1 Regions of interest selected in a DIEP-flap with corresponding ICG signal displayed per region in a time-intensity curve.

Luminescent Precision: Illuminating Hepatopancreatobiliary Surgery with ICG in Malaysia

Rajaie K, Suryati M, Mohanasundram P, Balraj S

Department of Hepatobiliary-Pancreatic Surgery and Liver Transplant, Selayang Hospital, Malaysia

Abstract: Hepatopancreatobiliary (HPB) surgery demands meticulous attention to detail, necessitating both experience and specialized training to navigate the complex hepatobiliary anatomy. In Malaysia, a country with a population of 32 million, the field of HPB surgery has seen significant advancements, particularly with the introduction of indocyanine green (ICG) as an intraoperative adjunct. This paper presents an overview of the Malaysian experience with ICG in hepatobiliary surgery, highlighting its role as a valuable tool in enhancing surgical precision and improving outcomes. With approximately less than 50 practicing HPB surgeons in Malaysia, the adoption of ICG has become increasingly prominent over the past three years. Notably, its utilization has been particularly impactful in the training of young surgeons for laparoscopic cholecystectomy, aligning with our strategic objective of achieving zero bile duct injuries post-cholecystectomy. While its application in laparoscopic or open liver surgeries remains relatively limited in Malaysia, tertiary referral centers such as Selayang Hospital have embraced its potential.

Conclusion: The integration of ICG represents a paradigm shift for HPB surgeons in Malaysia, offering promising avenues for enhanced surgical efficacy and training opportunities for the next generation of Malaysian general surgeons.

Efficacy and Safety of Near-Infrared Florescence Cholangiography Using Indocyanine Green

Wifanto S Jeo[1], Hendry Lie[2], Andry Irawan[2], Taufik Sudirman[2], Bernardus Paris Budiono[3], Timotius Ivan Hariyanto[2]

1Department of Surgery, University of Indonesia, Cipto Mangunkusumo Hospital, Jakarta, Indonesia

2Department of Surgery, Pelita Harapan University, Siloam General Hospital, Tangerang, Indonesia

3Department of Surgery, Diponegoro University, Kariadi General Hospital, Semarang, Indonesia

Making sure surgeries are safe is extremely important, especially for laparoscopic cholecystectomy (LC), which is a key operation to remove the gallbladder. In LC surgery, near-infrared fluorescence cholangiography with indocyanine green (NIF-ICG) has become a remarkable tool and is accepted as a useful tool to visualize extrahepatic biliary structures intraoperatively. It helps surgeons see extra biliary structures more clearly by making them light up with fluorescent light. Many studies had already done to analyze how safe and effective NIF-ICG is, and how it could improve surgery in the future.

We conducted systematic review and analyzed data from twenty-two studies involving 3457 patients who underwent laparoscopic cholecystectomy (LC). Our meta-analysis showed that using near-infrared fluorescence with indocyanine green (NIF-ICG) during LC had several benefits. Firstly, it reduced the time of the operation, meaning surgeries were quicker when NIF-ICG was used. Secondly, the likelihood of needing to convert to open surgery was lower with NIF-ICG. Next, NIF-ICG also made it easier to find important structures like the cystic duct and common bile duct, compared to surgeries without NIF-ICG. Lastly, it took less time to find these structures when NIF-ICG was used. Using the NIF-ICG technique offers exciting advantages, including the ability to visualize biliary structures in real-time early on, reducing surgery time, and decreasing the chances of needing to convert during LC. For other procedures NIF-ICG seem have same benefits too. However, to fully validate these findings, larger randomized clinical trials are required.

April 6 14:45-16:05

X: New techniques 2

<Chairpersons>

Takeshi Aoki
School of Medicine, Showa University, Japan

Simon Low
The University of Hong Kong, Hong Kong

Development of A Fluorescent Surgical Gauze Dyed with Indocyanine Green

Yoshihiko Tashiro[1], Shinji Ando[2], Hidekazu Yasunaga[3], Takeshi Aoki[1]

[1]Division of Gastroenterological and General Surgery, Department of Surgery, School of Medicine, Showa University, Japan
[2]Department of Chemical Science & Engineering, Tokyo Institute of Technology, Japan
[3]Faculty of Fiber Science and Engineering, Kyoto Institute of Technology, Japan

Background: Surgical gauze is one of the must-have items during surgery and is also used to stop bleeding, protect organs, and guide the direction of surgery. However, surgical gauze is occasionally retained in the body, which causes a serious problem. We developed a novel fluorescent surgical gauze using indocyanine green (ICG) to prevent gauze remnants and to use for navigation surgery.
Method: We examined the optimal treating conditions for ICG. After immersing a piece of cotton gauze, which is frequently used in surgery, in an ICG aqueous solution (5.0×10-4 mol/l) with a liquor ratio of 50:1 at room temperature, it was heated up to 80 °C and kept for 60, 120, and 240 min, followed by washing with distilled water and autoclaving at 132 °C for 8 min. Fluorescent intensity was examined with SPY PHI (Stryker) system before and after autoclaving.
Results: Bright fluorescence from ICG was observed in the near-IR region for all dyed gauzes. The gauze with the shortest dyeing time (60 min) with autoclaving showed the strongest fluorescence intensity, and its fluorescence was clearly observed by transmitting through tissues such as mesentery and stomach with a thickness of about 10 mm.
Conclusion: ICG-dyed gauze emits bright fluorescence by transmitting through tissues. We will pursue the optimal treating conditions of ICG and develop more versatile fluorescent gauzes for navigation surgery and preventing gauze remnants.

The use of near-infrared fluorescence for understanding micro- and macrovascular pathology in vascular surgery patients

M.W. Kruiswijk[1], S.A. Willems[1], S. Koning[1], F.P. Tange[1], J.J.W.M. Brouwers[1], R. Peul[1], J. van Schaik[1], A. Schepers[1], J.F. Hamming[1], K.E.A. van der Bogt[3], C.S.P. van Rijswijk[2], P. van den Hoven[1] and J.R. van der Vorst[1]

[1]Department of Surgery, Leiden University Medical Center, the Netherlands
[2]Department of Interventional Radiology, Leiden University Medical Center, the Netherlands
[3]Department of Surgery, Haaglanden Medical Center, the Netherlands

Background: Diabetes mellitus (DM) is the leading cause of arterial diseases in the lower extremity and is known for microvascular dysfunction. The primary aim of this study is to investigate the potential of near-infrared (NIR) fluorescence with indocyanine green (ICG) to assess diabetic vascularity and consequently determine the relation with macrovascular assessment using duplex ultrasound (DUS).

Methods: This retrospective study collected pre- and postinterventional NIR fluorescence and duplex ultrasound measurements from PAD patients undergoing lower extremity revascularization. Maximal systolic acceleration (ACCmax) was measured by DUS and multiple perfusion parameters were calculated by ICG NIR fluorescence imaging. The effect of diabetes in improvement of basal perfusion patterns and parameters was investigated. The correlation between delta (Δ) ACCmax and Δ ICG NIR fluorescence parameters was determined.

Results: 81 PAD patients and 16 control patients underwent successful ICG NIR fluorescence measurements, analyzing 124 limbs, of which 36 were diabetic. Before and after revascularization, 5/10 parameters improved significantly in diabetic patients, compared with 9/10 in non-diabetic patients. ACCmax and ICG NIR fluorescence perfusion parameters improved significantly after revascularization. Both modalities assess either macro- or microvasculature, as no correlation in improvement between ACCmax and Normalized slope was observed. Within patients with a successful or unsuccessful clinical outcome, multiple non-congruent improvements of macro- and microvascular perfusion were seen.

Conclusion: ICG NIR fluorescence is able to quantify differences in tissue perfusion in patients with and without DM. Duplex ultrasound and ICG NIR fluorescence imaging assess different facets of the vasculature. Therefore, evaluation of both macrovascular flow and microvascular perfusion following lower extremity revascularization is essential.

Fusion of Indocyanine Green Fluorescence Imaging and Artificial Intelligence Navigation for Color-Coded Laparoscopic Liver Resection

Kodai Tomioka[1], Aoki Takeshi[1], Yoshihiko Tashiro[1], Nao Kobayashi[2], Yuta Kumazu[2], Kazuhiro Matsuda[1], Tomokazu Kusano[1], Akira Fujimori[1], Yuta Enami[1]

[1]Division of Gastroenterological and General Surgery, Department of Surgery, School of Medicine, Showa University, Shinagawa, Tokyo, Japan
[2]Anaut Inc., Tokyo, Japan

Background: Indocyanine green (ICG) is useful in laparoscopic liver resection (LLR) for liver segment staining, tumor identification and determination of resection margins. Furthermore, surgical AI system Eureka® (Anaut Inc., Tokyo, Japan) can be used to colorize and display tubular structures such as hepatic veins and Glissonean pedicles in real time. Here, we describe the realization of color-coded LLR using the ICG fluorescence imaging and AI.
Methods: We analyzed videos of LLRs with ICG performed at our hospital. ICG was administered intravenously 2-14 days prior to surgery. Positive and negative staining methods were used for liver segment staining.
Results: Eureka® was capable of coloring and displaying the tubular structures on the liver transection plane within 0.1 second once they were delineated; it recognized and clearly displayed hepatic vein are in blue and Glisonnean pedicle are in blue even in the presence of ICG fluorescence (Intersection over union is over 0.42, Dice coefficients was over 0.53).
Conclusion: The feasibility of color-coded LLR using the ICG fluorescence imaging and AI was suggested. The present technology would help to accurately perform LH and even might reduce complications.

Near-infrared fluorescence imaging, mixed reality and artificial intelligence assistance for anatomic visualization during colorectal cancer surgery

Shunjin Ryu, Yuta Imaizumi, Keisuke Goto, Sotaro Iwauchi, Takehiro Kobayashi, Ryusuke Ito, Yukio Nakabayashi

Department of Digestive Surgery, Kawaguchi Municipal Medical Center, Japan

We present the integration of three surgical navigation technologies in colorectal surgery. Near-infrared fluorescence imaging (IR) employing indocyanine-green dye, and fluorescent ureteral catheter enable visualization of blood vessels, ureter, and urethra. While IR is the primary technology used in colorectal surgeries, we propose combining it with the latest technology to yield better results.

The first such technology is “Mixed reality.” Employing the Holoeyes MD system (Holoeyes), three-dimensional (3D) images of the vascular anatomy obtained from the CT scans can be downloaded to HoloLens2 (transmissive glasses; Microsoft, Inc.). While preserving sterility, the surgeon can visualize the 3D hologram mid-surgery and manipulate the image, such as magnifying and changing angles. Moreover, a 3D hologram is more informative than a 3D image on a two-dimensional monitor. We performed a lymph node dissection and blood vessel resection while visualizing a 3D hologram resembling a heads-up display system.

IR can penetrate 5mm to 10 mm of fat due to the intravital transmission of near-infrared light, and a 3D hologram is more beneficial for obtaining information on deep-seated anatomy. Therefore, the combination of IR and mixed reality enable identification of superficial blood vessel run and ureter while simultaneously viewing the 3D hologram of deep- seated anatomy.

The second technology is artificial intelligence. Eureka (a surgical artificial intelligence system) enables intraoperative assessment of nerves, pancreas, and dissection layers. We use Eureka for educational purposes in colorectal surgery. It has not yet been certified as a medical device. However, intraoperative anatomical imaging on the monitor, employing both IR and AI assistance during colorectal surgery is expected in the near future.

This study aims to use color coding to identify the blood vessels, ureters, nerves, and dissection layers within the surgical field and to obtain images comparable to those in anatomy textbooks. New advances in surgical navigation technologies are expected to improve intraoperative anatomical recognition, reduce surgical difficulties, and reinforce surgical education.

Novel Fluorescent Imaging using Inhaled or Different Wavelength Fluorophores for Simultaneous Identification of Tumor Margin and Intersegmental Plane During Pulmonary Segmentectomy

Hyun-Koo Kim

Korea University Guro Hospital, Korea

Background: Segmentectomy is recommended as a limited resection procedure for patients with early-stage lung cancer or compromised lung function because it improves the patient's quality of life by minimizing the removal of normal tissue. Accurate tumor detection and identification of the intersegment plane of the lung at the same time are critical for the success of segmentectomy.

OBJECTIVE: The first method is to develop and evaluate the feasibility of a lung-specific local delivery method utilizing nebulization of low-dose indocyanine green (ICG) to resected lung segments for simultaneous detection of lung tumor margins and intersegmental planes in various animal models. The second method is to report dual-channel image-guided lung cancer surgery using renally clearable and physiochemically stable targeted fluorophores to visualize the tumor and intersegmental plane distinctly with different colors: cRGD-ZW800 (800 nm channel) targets tumors specifically, and ZW700 (700 nm channel) simultaneously helps discriminate segmental planes.

Method: Optimization of the local delivery of nebulized ICG to resected lung lobes for lung tumor margin identification was performed in rabbit lung tumor models. Subsequently, the feasibility of utilizing optimal low-dose ICG via local nebulization in resected lung segments for simultaneous detection of lung tumor margins and intersegmental planes in canine lung pseudotumor model models. The NIR fluorophores with 700 nm and with 800 nm channel were developed and evaluated the feasibility of dual-channel fluorescence imaging of lung tumors and intersegmental lines simultaneously in mouse, rabbit and canine animal models. Expression levels of integrin αvβ3, which is targeted by cRGD-ZW800-PEG, were retrospectively studied in lung tissue of 61 patients who underwent lung cancer surgery.

Results: Near-infrared fluorescence imaging demonstrated clear visualization of the lung tumor margins in a rabbit lung tumor model, using local nebulization of 0.1 mg/kg ICG. In a canine model, local nebulization of 0.05 mg/kg of ICG into the target segment enabled clear visualization of lung tumor margins and facilitated the detection of intersegmental planes for 30 min.

cRGD-ZW800-PEG has clinically useful optical properties and outperforms the FDA-approved NIR fluorophore ICG and serum unstable cRGD-ZW800-1 in multiple animal models of lung cancer. Combined with the blood-pooling agent ZW700-1C, cRGD-ZW800-PEG permits dual-channel NIR fluorescence imaging for intraoperative identification of lung segment lines and tumor margins with different colors simultaneously and accurately.

Conclusions: Lung-specific delivery of ICG is a method with high clinical practicality, because this method can effectively provide visualization of tumor margins and intersegmental plane simultaneously, and also reduce potential systemic side effects by reducing the dose of ICG. And, the dual-channel image-guided surgery enables complete tumor resection with adequate negative margins that can reduce the recurrence rate and increase the survival rate of lung cancer patients.

Real-time navigation liver resection with indocyanine green fluorescence projection onto the surgical field

Hiroto Nishino, Shuhei Kanda, Tomoaki Yoh, Takahiro Nishio, Satoshi Ogiso, Takashi Ito, Takamichi Ishii, Satoru Seo, Etsuro Hatano

Department of Surgery, Graduate School of Medicine, Kyoto University

Liver resection is the mainstay curative treatment for liver tumors with anatomic hepatectomy recommended for the treatment of hepatocellular carcinoma and some metastatic liver cancers. As surgeons cannot completely view the intra-parenchymal structure, only the hepatic veins are available as landmarks to perform liver parenchymal dissection in many cases.

Preoperative simulation has already become an essential part of hepatectomy, and intraoperative navigation has been steadily advancing over the past few years. Intraoperative navigation is expected to be enhanced by extended reality (XR) technologies, as well as artificial intelligence (AI) technologies. However, at present, XR cannot handle intraoperative movements and deformations of the liver, and AI can only use information from the surgical field.

Currently, the most frequently used method for intraoperative navigation is ICG fluorescence technique, which is useful for visualization of the liver segment and identification of liver tumors. Although continuous ICG fluorescence is impractical with conventional methods using handheld cameras, the Medical Imaging Projection System (MIPS) we have developed and ICG fluorescence labeling laparoscopic systems developed by various companies allow ICG fluorescence images to be displayed directly on the patient organ in real time during the procedure, thus enabling real-time intraoperative navigation.

In our department, we have been working to achieve more precise liver resection using MIPS in open surgery and overlay images using ICG fluorescence labeling-compatible laparoscopic systems in laparoscopic surgery. Further development of this technology may enable surgeons to perform liver resections more comfortably than they have performed on the basis of experience using preoperative simulation and intraoperative ultrasonography. The use of the MIPS or fluorescent-labeled laparoscopic systems may further expand the use of color-coded surgery, in which the surgeon follows the boundaries of the ICG fluorescent image with or without color. In the near future, we would like to accumulate experience at many institutions and continue to aim to realize not only safer and more effective liver resection for patients, but also more comfortable surgery for surgeons.

In this presentation, we will introduce these approaches.

蛍光イメージングの機器の導入法から最新の応用法までを解説!

術中 蛍光イメージング実践ガイド

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術中の蛍光イメージング技術について, ①初めて機器を導入する方法, ②各診療科での基本的活用法, ③応用的活用法とその開発, の3部構成で詳しく解説。活用法の解説では, 癌・血流・リンパ節・臓器を光らせて評価する4つの手法について, 各診療科の第一人者が具体的症例を提示しながら紹介している。また, 実際に蛍光イメージングを臨床に用いている映像をWeb動画で視聴可能。

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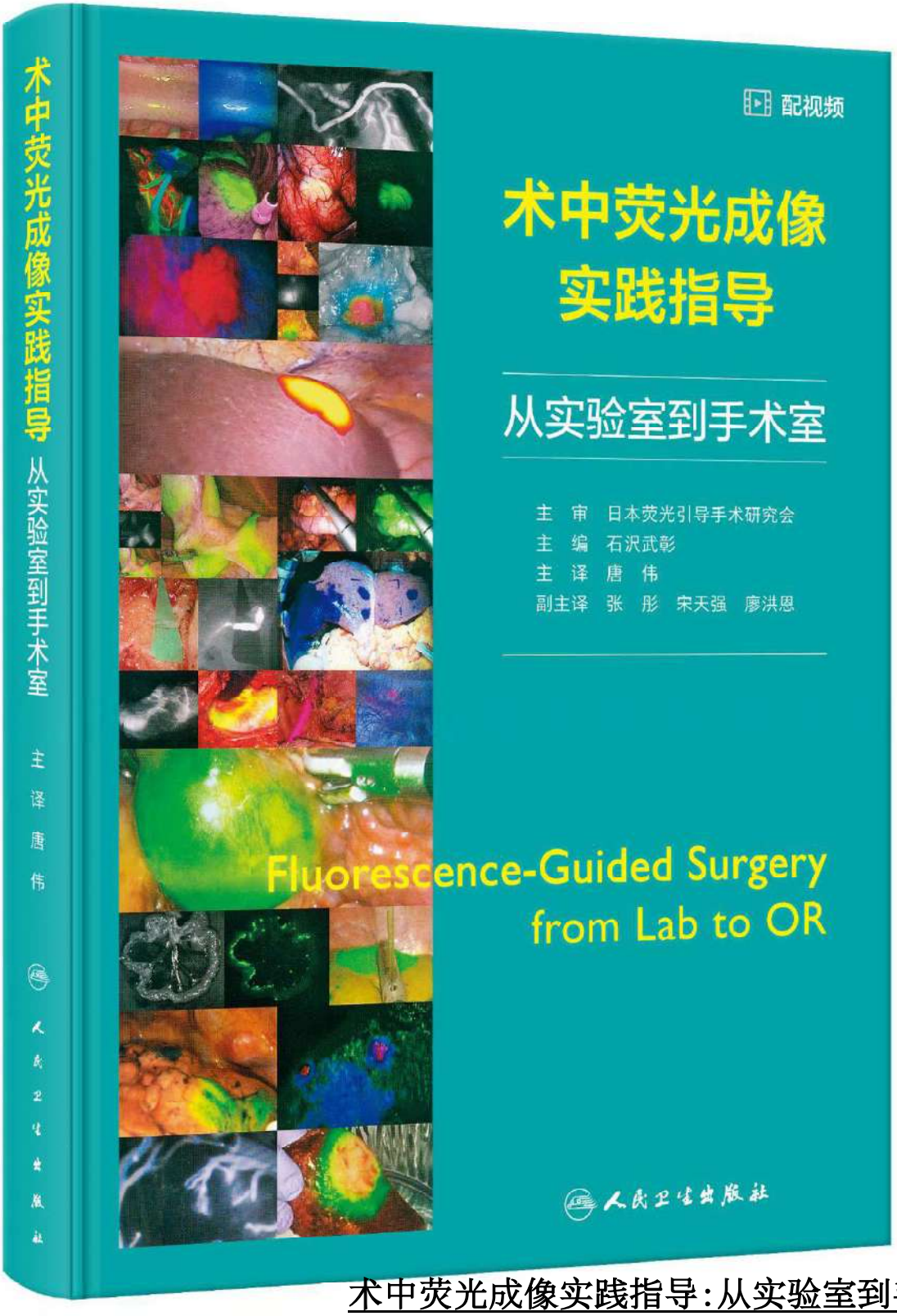
スマートフォンで書籍の内容紹介や目次がご覧いただけます。

本书作为一本由"知"到"行"的实践汇编，从实验设计到实际应用，从多维视角介绍了利用荧光技术在各个外科领域进行引导手术的方式方法、实践及未来前景，重点以图文并茂的方式介绍了许多临床实例。



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主　审：日本荧光引导手术研究会

主　编：石沢　武彰，主　译：唐　伟

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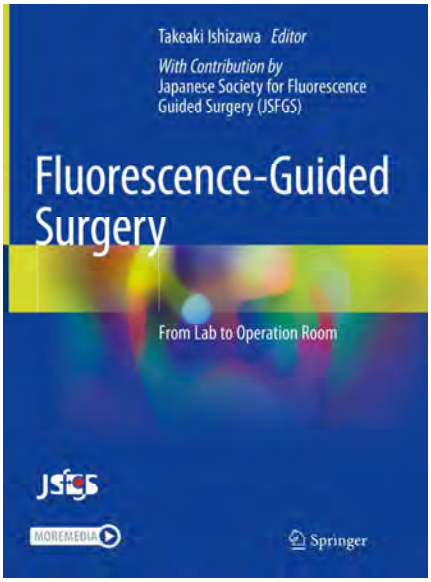

2023. XIX, 263 p. 184 illus., 177 illus. in color.

T. Ishizawa

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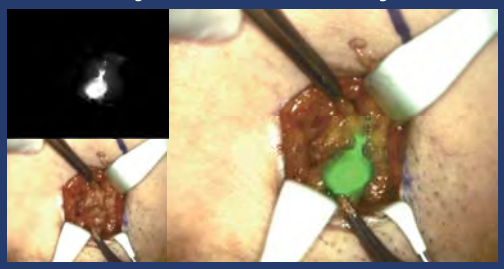

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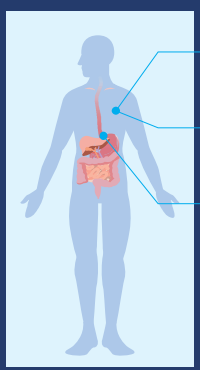

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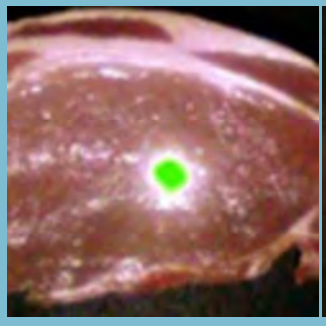

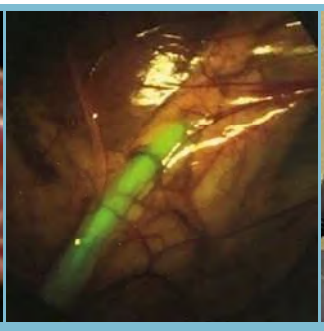

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