



Contents lists available at ScienceDirect

## Surgery

journal homepage: [www.elsevier.com/locate/surg](http://www.elsevier.com/locate/surg)

## Characterization of fluorescence patterns exhibited by different adrenal tumors: Determining the indications for indocyanine green use in adrenalectomy<sup>☆</sup>

Bora Kahramangil, MD, Emin Kose, MD, Eren Berber, MD\*

Department of Endocrine Surgery, Cleveland Clinic, OH

## ARTICLE INFO

## Article history:

Accepted 7 June 2018

Available online xxx

## ABSTRACT

**Background:** A number of small studies have reported the use of indocyanine green imaging during adrenalectomy. Nevertheless, imaging properties of different tumors and the indications for indocyanine green imaging use in adrenalectomy have not been defined.

**Methods:** This is an Institutional Review Board–approved retrospective review of a prospectively maintained database. Consenting patients underwent indocyanine green imaging fluorescence–guided robotic adrenalectomy. Fluorescence patterns of adrenal tumors were assessed. Multivariate logistic regression was performed to determine the best clinical applications.

**Results:** One hundred patients with Cushing syndrome ( $n=29$ ), pheochromocytoma ( $n=24$ ), primary hyperaldosteronism ( $n=23$ ), nonsecreting adrenocortical adenoma ( $n=9$ ), and other tumors ( $n=15$ ) underwent robotic adrenalectomy through lateral transabdominal ( $n=77$ ) and posterior retroperitoneal ( $n=23$ ) approaches. Mean tumor size was 3.6 cm and mean body mass index 33. A total of 74% of the tumors were hyperfluorescent compared with the surrounding retroperitoneal tissues, whereas the remaining 26% were nonfluorescent. Hyperfluorescence was predicted by adrenocortical tissue origin but not by demographic characteristics or tumor size. The contrast distinction between the tumor and the retroperitoneum was better, similar, or inferior on indocyanine green fluoresced compared with the nonfluoresced view in 41%, 27%, and 32% of patients, respectively. The utility was best for adrenocortical adenomas removed through a lateral transabdominal approach. Indocyanine green fluorescence imaging was used to confirm remnant viability in all 4 patients undergoing cortical-sparing adrenalectomy for pheochromocytoma ( $n=2$ ), adrenal cyst ( $n=1$ ), and lymphatic malformation ( $n=1$ ).

**Conclusion:** Adrenal tumors have different patterns of indocyanine green fluorescence based on histologic origin. Indocyanine green confers the highest utility for adrenocortical tumors removed through a lateral transabdominal approach and cortical-sparing adrenalectomy.

© 2018 Elsevier Inc. All rights reserved.

## Introduction

Indocyanine green (ICG) is an amphiphilic tricarboyanine intravenous dye, which exhibits fluorescence when excited by ~800 nm wavelength of near-infrared light. It has been in use in cardiology, hepatology, and ophthalmology since the 1950s.<sup>1</sup> With the advances in near-infrared fluorescence imaging systems, ICG has been introduced into various general surgical procedures to provide a visual assessment of tissue perfusion.<sup>2–4</sup> Endocrine organs have abundant blood supply to preferentially concentrate ICG

compared with surrounding tissues.<sup>1</sup> This physiology has inspired the design of several studies to assess the utility of ICG fluorescence imaging in endocrine surgery.<sup>5,6</sup>

The adrenal glands are highly vascular organs with multiple feeding arteries and collecting veins. With a mean organ blood flow of 1.87 mL/g per minute, the adrenal glands receive the third highest blood supply among the intra-abdominal organs after the renal cortex and the spleen.<sup>7</sup> ICG fluorescence from the adrenal glands was reported in pigs in 2015<sup>8</sup> and subsequently in humans during laparoscopic<sup>9</sup> and robotic<sup>10</sup> procedures. In a previous study our group compared the contrast distinction achieved with ICG fluorescence imaging with the nonfluoresced robotic view and reported that the ICG fluoresced view was superior than the nonfluoresced view 46.5% of the time.<sup>11</sup>

<sup>☆</sup> This study was given as an oral presentation at the American College of Surgeons Clinical Congress 2017, San Diego, CA, October 26, 2017.

\* Corresponding author: 9500 Euclid Ave/F20 Cleveland, OH 44195.

E-mail address: [berbere@ccf.org](mailto:berbere@ccf.org) (E. Berber).

<https://doi.org/10.1016/j.surg.2018.06.012>

0039-6060/© 2018 Elsevier Inc. All rights reserved.

Despite the documentation of its safety profile in previous studies, the indications for ICG use during adrenalectomy need to be defined to optimize its use. However, this requires the characterization of fluorescence patterns exhibited by different tumors, which has not been possible before because of small sample sizes. For the first time in the literature, this study analyzes the fluorescence characteristics of different adrenal pathologic conditions and attempts to define the best clinical indications for ICG use.

## Methods

### Study design

This was an Institutional Review Board–approved retrospective review of a prospectively maintained database. Between July 2014 and August 2017, patients underwent robotic adrenalectomy with ICG fluorescence imaging after informed consent. Patients with known iodine allergy, previous anaphylactic reaction to a dye injection, chronic kidney disease, chronic liver disease, and pregnant patients were not eligible for enrollment. All procedures were performed by a single surgeon (EB). The data from the initial 40 patients were partially reported in a previous study, which compared ICG-fluoresced to nonfluoresced robotic views.<sup>11</sup> The present study analyzes the fluorescent characteristics of different adrenal tumors to define the best clinical indications of this technology.

### Operative technique

Patients were assigned to a posterior retroperitoneal (PR) or lateral transabdominal (LT) approach based on a previously reported algorithm for laparoscopic adrenalectomy.<sup>12</sup> The LT approach was preferred in tumors larger than 6 cm and in patients with a measured distance of more than 7 cm between the skin and the Gerota fascia. The PR approach was used in nonobese patients with tumors smaller than 6 cm and when 1 of the following applied: (1) the patient was predicted to have adhesions because of a previous abdominal surgery; (2) the tumor was away from the renal hilum. Standard robotic surgical techniques were used as previously described.<sup>13</sup>

### Indocyanine green fluorescence imaging

ICG solution was prepared at a final concentration of 2.5 mg/mL by mixing 25 mg ICG (Akron Inc., Lake Forrest, IL) in 10 mL of distilled water. A 5 mg (2 mL) dose was administered intravenously after the exposure of the retroperitoneum. Robotic Firefly technology (Intuitive Surgical, Inc., Sunnyvale, CA) was used for fluorescence imaging. We previously reported on the pharmacokinetics and administration details of ICG.<sup>11</sup> Briefly, fluorescence was detected in the adrenal gland and the retroperitoneal tissues within 30 to 60 seconds of ICG administration. Optimal contrast was achieved after the retroperitoneal tissues released the dye at about 5 minutes. ICG fluorescence persisted in the adrenal gland for up to 20 minutes. To maintain contrast distinction, ICG injections could be repeated as deemed necessary by the operating surgeon.

### Assessment of fluorescence

Intraoperatively the pattern of fluorescence was assessed as a consensus between the operating surgeon, first assistant, and a research fellow not scrubbed in for surgery. The degree of fluorescence exhibited by the adrenal glands was graded as hyperfluorescent when the adrenal gland appeared brighter green on fluorescence imaging compared with the surrounding retroperitoneal fatty tissues. The adrenal was scored as nonfluorescent

**Table 1**  
Demographic and clinical details.

Parameter	All tumors (n = 100)
Age, y, mean (SD)	51.2 (14.1)
Sex, n (%)	
Female	67 (67)
Male	33 (33)
BMI, kg/m <sup>2</sup> , mean (SD)	33.1 (13.0)
Tumor size, cm, mean (SD)	3.6 (2.0)
Tumor side, n (%)	
Left	52 (52)
Right	48 (48)
Approach, n (%)	
Lateral transabdominal	77 (77)
Posterior retroperitoneal	23 (23)
Fluorescence on ICG administration, n (%)	
Hyperfluorescent	74 (74)
Nonfluorescent	26 (26)
Tissue distinction with ICG fluorescence, n (%)	
Superior to nonfluoresced view	41 (41)
Similar to nonfluoresced view	27 (27)
Inferior to nonfluoresced view	32 (32)

BMI, body mass index; SD, standard deviation.

when no fluorescence was detected from the tumor on excitation with near-infrared light. The degree of contrast distinction between the adrenal gland and the surrounding retroperitoneal fat identified on ICG fluorescence imaging was likewise quantified as a consensus by the same team to be either superior, similar, or inferior to the nonfluoresced view. Intraoperative and clinical data were collected prospectively and recorded into an Institutional Review Board–approved database.

### Statistical analysis

Statistical analysis was performed using JMP Version 13.1 (SAS Institute, Inc, Cary, NC). Continuous variables were analyzed using *t* test, Wilcoxon rank sum test, or analysis of variance and categorical data with  $\chi^2$  or Fisher exact test, as appropriate. Multivariate logistic regression was performed to determine the factors associated with hyperfluorescence on ICG administration and the best clinical indications of ICG. Parameters with a *P* value < .1 on the univariate analysis were included in the multivariate model. A *P* value < .05 was considered statistically significant. Continuous variables were presented as mean  $\pm$  standard deviation.

## Results

### Description of study cohort and perioperative outcomes

Table 1 summarizes the details of the study patients. An LT approach was used in 77% of patients. Adrenalectomy took an average of 148 minutes (LT: 155 minutes, PR: 127 minutes). Three cases were converted to open and 1 to hand-assisted laparoscopic technique because of local tissue invasion. Converted cases included 2 metastatic lesions, 1 adrenocortical carcinoma, and 1 pheochromocytoma located in close proximity to the renal hilum. A total of 96 patients underwent complete and 4 patients cortical-preserving adrenalectomy. Median length of stay was 1 day (range: 1–7) with a 90-day complication rate of 5% (pancreatic leak, atelectasis, urinary tract infection, pulmonary edema, and intraabdominal abscess; *n* = 1 each) with no ICG-related complications.

### Pattern of Indocyanine green fluorescence in different adrenal pathologic conditions

Patients received a median of 2 (range: 1–4) injections of ICG at a dose of 5 mg per injection. No tissue fluoresced before ICG

Download English Version:

<https://daneshyari.com/en/article/11013212>

Download Persian Version:

<https://daneshyari.com/article/11013212>

[Daneshyari.com](https://daneshyari.com)