

# The use of Indocyanine green in laparoscopic and robotic visceral surgery

R. Pater, Tutor: Dr. hab. n. med. Aebischer, Prof.UR.

## What is ICG used for in laparoscopic visceral surgery?

- Visualization of blood flow
- Bile visualization
- Visualization of liver carcinomas and metastases
- Visualization of the lymphatic system

## Visualization of blood flow

### Application examples:

- Rapid assessment of blood flow to a planned resection zone and subsequent anastomosis, e.g., colon or esophageal resections and gastric bypass.
- Visualization of the cystic artery during cholangiography.

## Bile visualization

### Application examples:

Due to hepato-biliary excretion, ICG accumulates in the gallbladder and bile ducts. This makes it quicker and easier to identify the biliary anatomy during cholecystectomy.

## Visualization of liver carcinomas and metastases

An intravenous injection of 0.4 mg/kg ICG solution is administered 36 hours before surgery.

After this time, the normal liver parenchyma has excreted most of the injected dye, while it is retained in the neighboring non-diseased cells around the metastatic lesion, which lack normal bile secretion.

## Visualization of the lymphatic system.

In oncological interventions, the reliable identification of the lymphatic system or the sentinel lymph node poses a challenge. Here, by using ICG, the entire lymphatic system in the tumor outflow area can be visually visualized in real time intraoperatively.

## Costs

The cost of one ampoule of ICG is approximately 60\$. Since most newer laparoscopy towers already have the necessary equipment, no further investment is required.

## Conclusion:

From both a toxicity and an economic standpoint, there is relatively little to be said against the use of ICG. There are already studies with significances regarding superiority. However, further research is needed here.

## How does ICG work?

Indocyanine green absorbs and fluoresces in the visible and near-infrared range. Both absorption and fluorescence are strongly dependent on the solvent and concentration used.

ICG absorbs mainly between 600 nm and 900 nm and emits fluorescence between 750 nm and 950 nm. The large overlap of the absorption and fluorescence spectra leads to a strong reabsorption of fluorescence by ICG itself.

The light needed to excite fluorescence is generated by a near-infrared light source mounted directly on a camera. A digital video camera allows ICG fluorescence to be recorded in real time, allowing perfusion to be assessed and documented.

## Toxicity and side effects

Indocyanine green is microsomally metabolized in the liver and excreted only via the liver and bile ducts<sup>1</sup>; since it is not absorbed by the intestinal mucosa, its toxicity is to be classified as low<sup>2</sup>.

In pregnancy, administration is not without risk<sup>1</sup>.

Since September 2007, it has been known that ICG decomposes into toxic waste products when exposed to UV light.

Several, as yet unknown, substances are formed in the process. However, a study published in February 2008 shows that ICG (the substance without UV exposure) is basically only slightly toxic as such<sup>3,4</sup>. Intravenous LD50 values measured in animals are 60 mg/kg in mice and 87 mg/kg in rats<sup>5,6,7</sup>.

Rarely - in one in 42,000 cases - mild side effects such as sore throat and flushing occur in humans. Effects such as anaphylactic shock, hypotension, tachycardia, dyspnea, and urticaria have been found only in isolated cases; the risk of severe side effects increases in patients with chronic renal failure.<sup>4,8</sup> The frequencies of mild, moderate, and severe side effects are only 0.15%, 0.2%, and 0.05%, respectively; the fatality rate is 1:333,333.<sup>2</sup>

For the competitor substance fluorescein, the proportion of people with side effects is 4.8% and the fatality rate is 1:222,222.

Because the preparation contains sodium iodide, testing for iodine intolerance is required. Because about 5% iodide is added, the iodine content of a 25 mg ampoule is 0.93 mg. In comparison, preparations for a KM-CT (140 ml) contain 300 mg/ml or for a corona angiography (200 ml) 350 mg/ml iodine.

1. Manfred J. Müller: *Ernährungsmedizinische Praxis: Methoden – Prävention – Behandlung*. 2. Auflage, Springer, Kiel 2007, ISBN 978-3-540-38230-0, S. 76.

2. A. J. Augustin, G. K. Kriegelstein in: *Augenheilkunde*. Springer-Verlag, 2001, ISBN 3-540-65947-1.

3. J. Hillenkamp: *Investigation of Indocyanine Green Toxicity in vitro*. DGG, Band 09, 2007, Universität Regensburg.

4. S. H. Wipper: *Validierung der Fluoreszenzangiographie zur intraoperativen Beurteilung und Quantifizierung der Myokardperfusion*.

5. United States National Library of Medicine (NLM)

6. *Toxicology and Applied Pharmacology*. Band 44, 1978, S. 225.

7. *Drugs in Japan*, 1995, S. 189.

8. R. Benya, J. Quintana, B. Brundage: *Adverse reactions to indocyanine green: A case report and a review of the literature*. In: *Cathet and Cardio Diagnosis* Band 17, 1989, S. 231–233.