



Is the Fascination and Publication Flood of ICG Fluorescence in General Surgery Justified?

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Editorial

Indocyanin green (ICG) evolved during World War II as a dye for photography and was first introduced in medicine at the Mayo clinic in 1957 [1]. Two years later ICG gained the FDA approval and was initially applied as a diagnostic modality in liver function tests and later in cardiology. During the last years, a major progress has been made in the field of artificial imaging to support the ICG use in surgery. This technical support has opened new horizons for fluoroscopy and has regenerated the interest of surgeons in the application of ICG [2-4]. The hype of ICG fluorescence however needs to be critically appraised in several points, as quality of studies performed, the comparability between systems and dosages of ICG used. This manuscript shall give some basic information on the fields of ICG fluorescence in general surgery and some background information on available systems and their technologies.

ICG is an amphiphilic, water soluble fluorophore with an excellent tissue penetration and a high binding affinity to plasma proteins, globulins and albumin [2,3]. Administered intravenously ICG is used in a dosage of 0.01-0.5 mg/kg and has a half-time of 150-180 seconds and is metabolized by the liver [4]. The use of ICG for diagnostic is regarded clinically safe as anaphylactic reactions only occur in very rare cases. After intravenous administration ICG binds rapidly to plasma proteins. After local injection ICG fluorescence can be used to show tumors, lymphatic drainage and sentinel nodes. The spectral absorption of ICG in blood is at about 780 nm and emission at about 830 nm [2]. The images can be obtained using a charge coupled device near-infrared video camera.

ICG tissue angiography can offer a real-time assessment of the tissue blood perfusion, thus providing the surgeon with helpful information when critical decisions concerning the adequacy of the blood perfusion have to be made. Perfusion assessment can help in the placement of critical anastomoses like in gastroesophageal surgery [5] and colorectal surgery [6,7]. It helps in decision making processes in cases of mesenteric ischemia [8] and liver resections [9]. Prospective randomized trials in all of these fields are currently on the way to gather a higher level of evidence of ICG fluorescence in these fields. One of the main critical points is the qualitative assessment character of ICG perfusion assessment. A reproducible perfusion threshold still remains something a surgeon could dream of regarding all systems currently on the market.

ICG fluorescence for sentinel node detection is a hot topic in several fields of surgery, urology, gynecology and general surgery [10,11]. ICG has been shown to be comparable to blue dye and radioactive markers in several studies of breast cancer and the future will show whether it is safe to rely solely on ICG as a dye.

ICG fluorescence of metastases/liver tumours after systemic injection of ICG has been reported to increase detection rates of colorectal liver metastases and hepatocellular carcinomas within several series, hence sensitivity and specificity differ [9,12,13]. Further limitations are the maximal infiltration depth of 10 mm.

Several imaging systems are currently commercially available for fluorescence angiography working with distinctive different technologies both in terms of light sources, optics and for excitation (laser, filters). Over the last years new imaging devices for intraoperative fluorescence illustration fascinated surgeons all around the world. The latest systems have high resolution cameras for open and laparoscopic situations. Moreover some platforms offer fused imaging enabling fluoroscopy while operating under white light. At a closer sight however: Differences in the quality of images, noise ratio and image fusion seem evident by the eye. Moreover most of the systems however don't offer a quantification tool yet. Until now it is unknown in how far these systems deliver comparable results between each other in the estimation of e.g. tissue perfusion. Auto-adjustment software

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Received Date: 31 May 2017

Accepted Date: 02 Jun 2017

Published Date: 12 Jun 2017

Citation:

Nowak K. Is the Fascination and
Publication Flood of ICG Fluorescence
in General Surgery Justified?. *Remed
Open Access*. 2017; 2: 1066.

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within some of the systems might even hamper clinical comparability of the systems.

A rising amount of clinical reports and studies are published. However the amount of high quality studies to gather evidence still is low in most fields of general surgery. The new field offers exciting new possibilities to the surgeon with possibly positive impact on our patients. However both from a clinical and technological perspective above mentioned challenges need to be overcome mainly by the medical device developers. The future of fluorescent imaging in surgery is bright. The technical possibilities are further emerging quickly. Supposable specific dyes for tumors and nerves together with fused imaging modalities might significantly help the surgeon intraoperatively in the close future.

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