

Overview of surgical application of ICG fluorescence navigation

(by Dr Toshiyuki Kitai, formally of Kyoto University currently Kishiwada City Hospital)

I would like to present an overview of surgical application of ICG fluorescence imaging. This technique is not new, but the surgical application started ten years ago, and the field is rapidly extended.

(Slide1)

Indocyanine green (ICG) is a popular diagnostic reagent clinically available for liver function test. The solution has green color and gives fluorescence around 800 nm. MW is 776, but once injected in the tissue, ICG bound to albumin and transported in the lymphatic vessels. It likely remains in the blood vessels and exclusively metabolized by the liver.

(Slide2)

The near infrared (NIR) wavelengths between 700 nm and 900 nm are called as optical window, where the absorption of hemoglobin and water is small. NIR light can penetrate deep into the tissue as compared with other lights. ICG has the excitation and emission spectra in the optical window. It is clinically beneficial, because the ICG at the depth of 1 cm can be detected. In contrast, other dye detection by visible light is limited in less than 1 mm.

(Slide3)

Surgical application of ICG fluorescence imaging started ten years ago for vascular surgery. Since then, application for sentinel node biopsy and hepatic imaging was added.

(Slide4)

First report was intraoperative quality assessment in off-pump coronary artery bypass grafting by Reuthebuch in 2004. Left panel: arrows show the stenotic portion of coronary branch. Right panel: laser angiography showed the patency of venous graft.

(Slide5)

Several NIR fluorescence imaging systems are commercially available. 760 nm of excitation is for ICG. Some of them use methylene blue as contract agent, with the wavelength of 670 or 690 nm. Light source is LED or laser. In recent models, we can enjoy color video as well for helping the dissection procedures.

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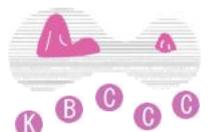
#7 1F, Kyoto Technoscience Center, 14 Yoshida Kawara-cho Sakyo-ku, Kyoto 606-8305, Japan

Telephone: +81-75-761-5751

Fax: +81-75-761-5718

Email: info@kyoto-breast-cancer.org

Website: www.kyoto-breast-cancer.org



(Slide6)

Microvascular surgery is one of the most useful areas of ICG fluorescence imaging. The patency of vascular anastomosis is demonstrated ICG signal. The fluorescence imaging system is incorporated in the surgical microscope for this purpose.

(Slide7)

Assessment of the tissue perfusion of skin flap is another application.

(Slide8)

The application for sentinel node biopsy in breast cancer was first reported in 2005. This technique is becoming popular especially in Japan.

(Slide9)

The application for sentinel node biopsy is extended to other types of cancer. Skin cancer, gastric cancer, colorectal cancer, lung cancer, and prostate cancer. In gastric cancer, lymphatic vessels and sentinel nodes embedded in the fatty tissue is clearly observed.

(Slide10)

According to the recent development of laparoscopic surgery, laparoscopic SNB is also reported.

(Slide11)

Although the application was extended to various kinds of cancer, SNB is not a standard of care in cancer other than breast and skin. There are several reasons why it is not generally accepted.

(Slide12)

Finally, hepatic imaging is based on the ICG metabolism. ICG is taken up exclusively by the hepatocytes and excreted to the bile. The slide is the intraoperative cholangiography in laparoscopic cholecystectomy.

(Slide13)

HCC and metastatic liver tumor can be sensitively detected by ICG fluorescence. This is a very clever application. The mechanism is that ICG is taken up but not secreted to the bile in the pathological tissue.

(Slide14)

Future perspective is tumor imaging by molecular manipulation.
Present research is promising but still limited in the laboratory use.

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