

Surgery

Recommendation of ICG Fluorescence Imaging in Hand Surgery Facilities



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1. Introduction

Saitama Jikei Hospital, located in Kumagaya City, Saitama Prefecture, is a 160-bed secondary emergency hospital with a history of 120 years, including its predecessor, Nishida Clinic. The hand surgery department was established in 2019 as the Saitama Hand & Microsurgery Institute. Currently, it consists of total four staff members, of which three are plastic surgeons and one is orthopedic surgeon, along with one fellow, one part-time member, and one international trainee. Our department actively employs ICG Fluorescence Angiography, but it has not been widely adopted in hand surgery facilities. One reason is that orthopedic surgeons, who make up a large part of hand surgeons, have fewer opportunities to encounter ICG Fluorescence Angiography, unlike plastic surgeons who perform joint operations with general surgeons or neurosurgeons. Therefore, aiming to promote the adoption of the Near-Infrared Fluorescence Imaging System in hand surgery facilities, I briefly introduce ICG Fluorescence Angiography in this document.

2. What is ICG Fluorescence Angiography?

ICG Fluorescence Angiography requires Indocyanine Green (ICG) and a Near-Infrared Fluorescence Imaging System. ICG, a dark green dye for injection, was originally used for liver function tests. The Near-Infrared Fluorescence Imaging System visualizes the weak near-infrared fluorescence emitted by ICG when excited by near-infrared light. To evaluate the blood flow of flaps, while aligning the camera with the flap, the staining of the flap can be confirmed in a few seconds after injection of ICG in peripheral vein. If the entire flap is poorly stained, it suggests a problem with the nutrient vessels, necessitating verification of the vessels. If there is poor stained areas in the flap, it suggests issues in the local blood

flow, therefore it becomes necessary to excise the poorly stained areas or adopt vascular anastomosis.

3. ICG Indications

Diagnogreen For Injection 25mg, an Indocyanine Green injectable, was initially approved for "liver function tests, circulatory function tests, cerebral vascular imaging during neurosurgery, and identification of sentinel lymph nodes in breast cancer and malignant melanoma." In 2018, "evaluation of vascular and tissue blood flow" was added as an indication.

4. Applicability of ICG Fluorescence Angiography

In the Japanese Medical Fee Points, as of 2023, the additional charge of intraoperative vascular imaging (K939-2) is permissible in specific procedures such as "neurosurgery, coronary artery bypass grafting, free flap and arterialized flap breast reconstruction, liver resection or laparoscopic liver resection, bladder cancer surgery, and when confirming gastrointestinal blood flow during surgery." Future expansions of indications to include lymphaticovenous anastomosis and other flap surgeries beyond breast reconstruction are anticipated.

5. Challenges in Promoting ICG Fluorescence Angiography in Hand Surgery

In hand surgery, ICG Fluorescence Angiography is used for revascularization in cases of amputated fingers or crush injuries, and for tissue transplantation in limb tissue loss. Although the drug is indicated for "evaluation of vascular and tissue blood flow,"

the lack of medical fees for the examination makes it challenging to introduce expensive Near-Infrared Fluorescence Imaging Systems into hospitals.

6. Types of Near-Infrared Fluorescence Imaging Systems

There are varieties in Near-Infrared Fluorescence Imaging Systems, such as microscope-integrated type, arm type, and handheld type. The microscope-integrated type, often an optional feature of surgical microscopes, is relatively affordable. We have utilized the microscope-integrated type since the establishment of our facility, however, its small field of view poses difficulties in evaluating large flaps.

Also, despite turning off the room lights as per the instructions, the resolution was still poor, and the confirmation of the staining was inadequate. Therefore, we decided to introduce the specialized equipment. Handheld types are useful in outpatient lymphedema treatment but require constant handling during imaging. The arm-type LIGHTVISION2 can simultaneously display visible image, near-infrared fluorescence image, and a combination of both. In the combination image, the color of ICG image can be chosen from white, green, or blue. The display of visible image makes it easier to mark the area with adequate blood flow, therefore, our facility introduced LIGHTVISION2 in 2023. Despite its high cost, LIGHTVISION2 is considered to be very useful for hand surgery facilities.

7. Usage Examples of LIGHTVISION2

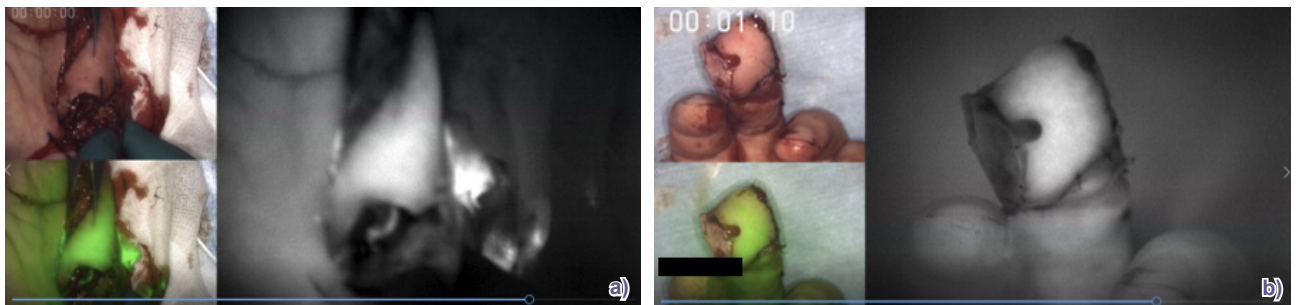


Fig.1 Case of a Free Hypothenar Flap

- a) During flap elevation, ICG Fluorescence Angiography showed complete staining across the flap, with the vascular pedicle also well-stained (slightly below the center of the screen).
- b) Upon transplantation to the middle finger tip, the entire flap was well-stained. The flap successfully survived.

Upper left is the visible image, right is the near-infrared fluorescence image, lower left is the visible + near-infrared fluorescence image. Our facility uses green as the fluorescence image color for the visible + near-infrared fluorescence image.



Fig.2 Case of an Antegrade Digital Island Flap from Another Finger

- a) The flap showed poor staining during the flap elevation.
- b) After transplantation to the thumb, the recipient site seemed to be slightly congested. The procedure was completed due to refill, resulting in partial necrosis.

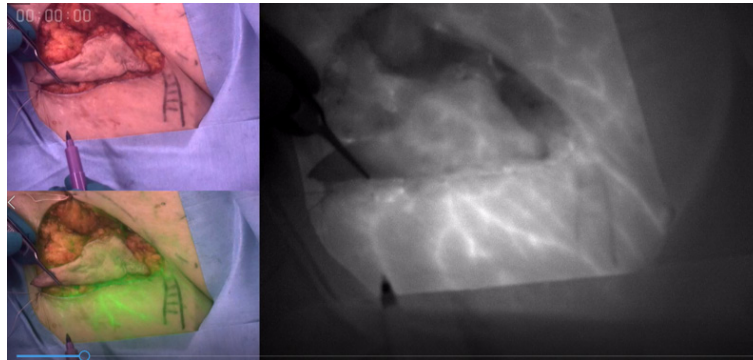


Fig.3 Case of a Free SCIP Flap
During elevation, a 15mm border of the flap showed no staining. Excision and reconstruction of this area prevented postoperative complications. By using the near-infrared fluorescence image and the visible + near-infrared fluorescence image together, evaluation of staining becomes easier. LIGHTVISION2 has wide field of view, making it suitable for large flaps.

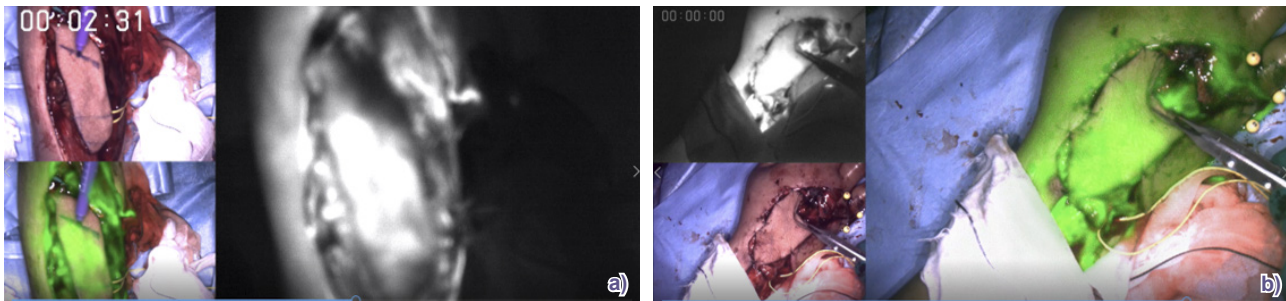


Fig.4 Case of a Reverse Posterior Interosseous Artery Perforator Flap
a) During elevation, a 20mm edge of the flap showed poor staining.
b) After transferring the flap to the dorsum of the hand and adding venous anastomosis, the entire flap well stained. The flap was successfully attached.

The flexibility to rearrange the three display images makes marking the blood flow region of the flap easier.