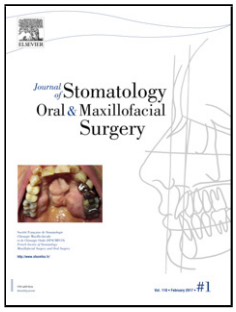

Title: Fluorescent indocyanine green angiography: preliminary results in microsurgery monitoring

Author: Vivien Moris Sarra Cristofari Alessio Stivala Barbara Lehre Charline Gengler Valentin Rabuel Alexandre Srouji Narcisse Zwetyenga David Guilier

PII: S2468-7855(19)30171-5
DOI: https://doi.org/doi:10.1016/j.jormas.2019.07.006
Reference: JORMAS 721

To appear in:

Received date: 23 June 2019
Accepted date: 8 July 2019

Please cite this article as: Moris V, Cristofari S, Stivala A, Lehre B, Gengler C, Rabuel V, Srouji A, Zwetyenga N, Guilier D, Fluorescent indocyanine green angiography: preliminary results in microsurgery monitoring, *Journal of Stomatology oral and Maxillofacial Surgery* (2019), https://doi.org/10.1016/j.jormas.2019.07.006

Fluorescent indocyanine green angiography: preliminary results in microsurgery monitoring

Vivien MORIS[1], Sarra CRISTOFARI[2], Alessio STIVALA[1], Barbara Lehre[1], Charline GENGLER[1], Valentin RABUEL[1], Alexandre SROUJI[1], Narcisse ZWETYENGA[1], David GUILIER[1]

Vivien MORIS :
14 rue Paul Gaffarel
21000 Dijon
morisvivien@gmail.com
Sarra CRISTOFARI
1 avenue Claude Vellefaux
75010 PARIS
sarra.cristofari@aphp.fr
Alessio STIVALA
14 rue Paul Gaffarel
21000 Dijon
alessiostivala@gmail.com
Barbara LEHRE
14 rue Paul Gaffarel
21000 DIJON
barbara.lerhe-pinto@chu-dijon.fr
Charline GENGLER
14 rue Paul Gaffarel
21000 Dijon
charline.gengler@chu-dijon.fr
Valentin RABUEL
14 rue Paul Gaffarel
21000 Dijon
valentin.rabuel@chu-dijon.fr
Alexandre SROUJI
14 rue Paul Gaffarel
21000 Dijon
alexandre.srouji@chu-dijon.fr
Narcisse ZWETYENGA
14 rue Paul Gaffarel
21000 DIJON
nzwetyenga@gmail.com
David GUILLIER
14 rue Paul Gaffarel
21000 Dijon
docteurguillierdavid@gmail.com

[1] *: Service de chirurgie plastique , CHU de Dijon, 14 rue Paul Gaffarel 21000 DIJON*

[2] *:Service de chirurgie plastique, CHU Tenon, 4 Rue de la Chine, 75020 Paris*

Introduction

Pedicled flaps and free-tissue transfer flaps are used routinely to reconstruct head and neck, limb, hand, thoracic and abdominopelvic hard and soft tissue defects. But failure remains a constant concern.

Usually failure is due to blood supply compromise. To detect vascular complication clinical monitoring, based on subjective criteria, remains the gold-standard. Clinical monitoring can be improved by many intraoperative and postoperative monitoring devices. These noninvasive and invasive devices help prevent and identify vascular occlusion, with varying degrees of success. None of these devices are universally adopted (1). Noninvasive techniques include hand-held Doppler ultrasound, infrared thermography, polarized spectral imaging, and laser Doppler perfusion imaging (2).

Indocyanine green (ICG), a fluorescent dye, has been used for more than 40 years for cardiac output, liver function, neurosurgery, ophthalmology and digestive surgery (3–5). ICG is a water-soluble dye that absorbs light in the near-infrared spectral range, with a peak at 805 nm, and emits fluorescence at 835 nm. ICG completely binds to plasma proteins after intravenous injection, and is exclusively distributed in the intravascular space (6). ICG has a short plasma half-life of 3.4 minutes. That allows repeated injections without reaching toxic levels. IGC is cleared from blood by the liver and excreted into the bile (7). Adverse effects are rare (anaphylactic shock, hypotension, dyspnea, nausea, exanthema, and pruritus) (8). These properties make it a suitable tracer for vessel perfusion.

The fluorescent indocyanine green angiography (FA ICG) has been used in thyroid surgery, in sentinel node procedure (breast cancer).

The objective of this study is to evaluate preliminary the results of the fluorescent indocyanine green angiography in free flaps procedures.

Materiel and methods

Patients who had microsurgical flap reconstruction were included during the study period in a single center.

The FA ICG was used at specific times. Intra-veinous injections of 0.1 mg/kg of INFRACYANINE® (concentration 2.5 mg/mL) were done intraoperatively. The Fluobeam® device (figure 1), programmed on sensitivity and mapping to interpret the data, was used.

Peroperative

The first injection was done during the beginning of the flap harvesting. Skin paddle perforators vessels were checked (size, path) to identify and spare the vessels and to adapt the skin paddle's shape to avoid necrosis (figure 2).

If it is necessary to perform osteotomies, another injection has been performed to check the osseous perforators vessels and to adapt the sites of osteotomies (fibula or radius) (figure 3).

Another injection was performed at the end of vascular anastomosis to visualize the arterial and venous patency (figure 4).

A final peroperative injection, was performed after the modeling, positioning and suture of the flap. Cutaneous, muscular and osseous perfusion were checked. Attention was payed to skin paddle edges because of malposition and/or hard suture (figure 5).

Time of FA ICG procedure was measured.

Postoperative

Clinical features of the flap (color, time of recoloration, temperature, etc.) were assessed every two hours.

Every eight hours, for practical reasons, FA ICG was used to monitor the flap during 3 days.

Results

Twelve patients enrolled were 9 males and 3 females. Their mean age was 54.5 years (range 25 – 75 years). Details of the results are shown in the Table 1.

Eight patients had free flaps: 4 fibular flaps (3 for mandibular reconstruction and 1 femur reconstruction), 2 radial forearm flaps (maxillary reconstruction), 1 latissimus free flap (tibia soft-tissue coverage) and 1 retroauricular fasciocutaneous free flap (thumb soft-tissue coverage).

Four flaps were pedicled flaps: 2 saphenous flaps for tibia soft-tissue coverage and 2 local flaps (Antia-Buch and frontal flaps) were realized for nose and ear defects respectively.

Eight patients had peroperative modifications to avoid potential complications: design modification of the skin paddle was made in 3 cases, tension stitches release was made in 2 cases, site of the osteotomy modification was made in 2 patients, surgical reexplorations was made in 2 patients and pivot point modification was made in 1 patient. Therefore, several modifications could have been made to one patient. In one case, the FA ICG showed hypoperfusion of the skin paddle allowing a precocious salvage reintervention. Peroperative exploration showed arterial and venous thrombosis due to a compressive hematoma in the pedicle area. For another patient, failure occurred despite vascular revision (Table 1). Every eight hours, FA ICG was used to monitor the flap. The follow-up did not show particular event.

The average time of FA ICG added to the surgical time was 10 minutes.

Discussion

FA ICG could be a reliable method for monitoring free-tissue transfers.

Evaluation of microvascular flap perfusion is still based on subjective clinical features (9). Clinical monitoring is observer-dependent and does not allow information sharing, test reproducibility, and consistent postoperative follow-up.

Free flap failure remains a difficul event for both patient and surgeon. The successful of salvage rate is linked to the delay between the onset of ischemia and its clinical assessment.

Various instrumental methods have been described, such as implantable doppler probe (10), color duplex ultrasound (11), near-infrared spectroscopy (NIRS) (12) and laser Doppler flowmetry (13). Fluorescence angiography with indocyanine green (FA ICG) is a relatively new method for evaluating tissue perfusion for flaps.

FA ICG was performed every 8 hours for practical reasons (lack of specialized personnel). With experience, FA ICG monitoring should be done at the same time as the clinical examination.

FA ICG has several advantages:

- Noninvasive procedure.
- During operation, the possibility of identifying the correct position of the perforator vessels to allow the design of the skin paddle to maximize the perfusion and to plan osteotomies sites.
- Facilitate harversting and modelling the flap for the young surgeon.
- Clinical patency test has a low sensitivity in the diagnosis of intravascular luminal obstruction (11), especially when the vascular flow is low. FA ICG is able to make difference between low flow and vascular thrombosis. Precocious diagnosis and salvage therapeutic of the flap can be realized (1,2).

Conclusion

FA ICG procedure can help in monitoring of free-flaps to improve success rate. In, perspective FA ICG may be used in monitoring of local and regional flaps.

This technique may be used such a pedagogical tool for young practitioners in their first microsurgery procedures.

Bibliographie

1. Yeoh MS, Kim DD, Ghali GE. Fluorescence angiography in the assessment of flap perfusion and vitality. Oral Maxillofac Surg Clin N Am. févr 2013;25(1):61‑6, vi.

2. Cornelissen AJM, van Mulken TJM, Graupner C, Qiu SS, Keuter XHA, van der Hulst RRWJ, et al. Near-infrared fluorescence image-guidance in plastic surgery: A systematic review. Eur J Plast Surg. 1 juin 2018;41(3):269‑78.

3. Levesque E, Hoti E, Azoulay D, Adam R, Samuel D, Castaing D, et al. Non-invasive ICG-clearance: a useful tool for the management of hepatic artery thrombosis following liver transplantation. Clin Transplant. avr 2011;25(2):297‑301.

4. Killory BD, Nakaji P, Gonzales LF, Ponce FA, Wait SD, Spetzler RF. Prospective evaluation of surgical microscope-integrated intraoperative near-infrared indocyanine green angiography during cerebral arteriovenous malformation surgery. Neurosurgery. sept 2009;65(3):456‑62; discussion 462.

5. Diana M, Noll E, Diemunsch P, Dallemagne B, Benahmed MA, Agnus V, et al. Enhanced-reality video fluorescence: a real-time assessment of intestinal viability. Ann Surg. avr 2014;259(4):700‑7.

6. Muckle TJ. Plasma proteins binding of indocyanine green. Biochem Med. févr 1976;15(1):17‑21.

7. Hitier M, Cracowski J-L, Hamou C, Righini C, Bettega G. Indocyanine green fluorescence angiography for free flap monitoring: A pilot study. J Cranio-Maxillo-fac Surg Off Publ Eur Assoc Cranio-Maxillo-fac Surg. nov 2016;44(11):1833‑41.

8. Obana A, Miki T, Hayashi K, Takeda M, Kawamura A, Mutoh T, et al. Survey of complications of indocyanine green angiography in Japan. Am J Ophthalmol. 15 déc 1994;118(6):749‑53.

9. Jones I, Kelly M, Percival N. Clinical monitoring of free flaps in the UK. Br J Plast Surg. janv 1999;52(1):78‑9.

10. Clert V, Guédon C, Cristofari J-P, Halimi C, Barry B, Albert S. [Implantable doppler probe for microsurgical free flap monitoring in cervico-facial reconstructive surgery]. Ann Chir Plast Esthet. avr 2013;58(2):82‑8.

11. Few JW, Corral CJ, Fine NA, Dumanian GA. Monitoring buried head and neck free flaps with high-resolution color-duplex ultrasound. Plast Reconstr Surg. 1 sept 2001;108(3):709‑12.

12. Repez A, Oroszy D, Arnez ZM. Continuous postoperative monitoring of cutaneous free flaps using near infrared spectroscopy. J Plast Reconstr Aesthetic Surg JPRAS. 2008;61(1):71‑7.

13. Yuen JC, Feng Z. Monitoring free flaps using the laser Doppler flowmeter: five-year experience. Plast Reconstr Surg. janv 2000;105(1):55‑61.

FIGURES:

Figure 1: Fluobeam device

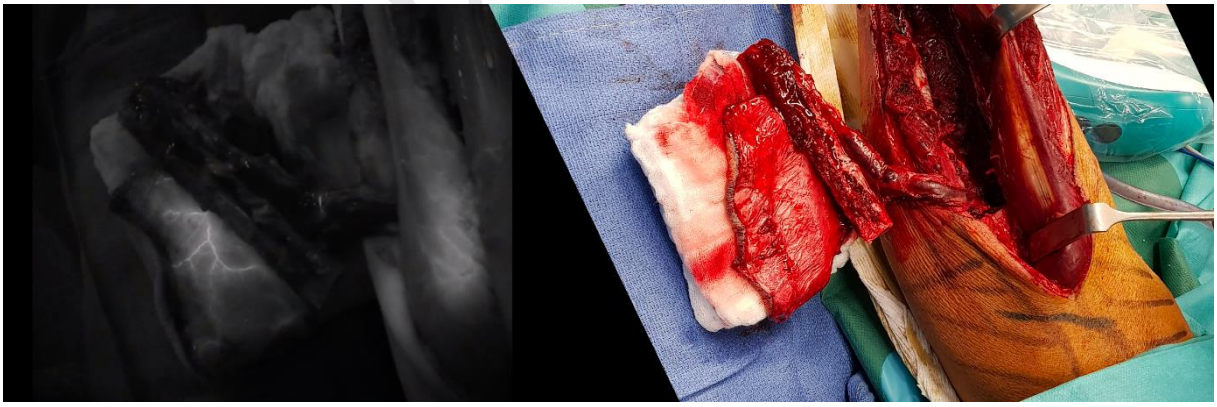

Figure 2: Skin paddle perforator vessel during a fibula flap harvesting

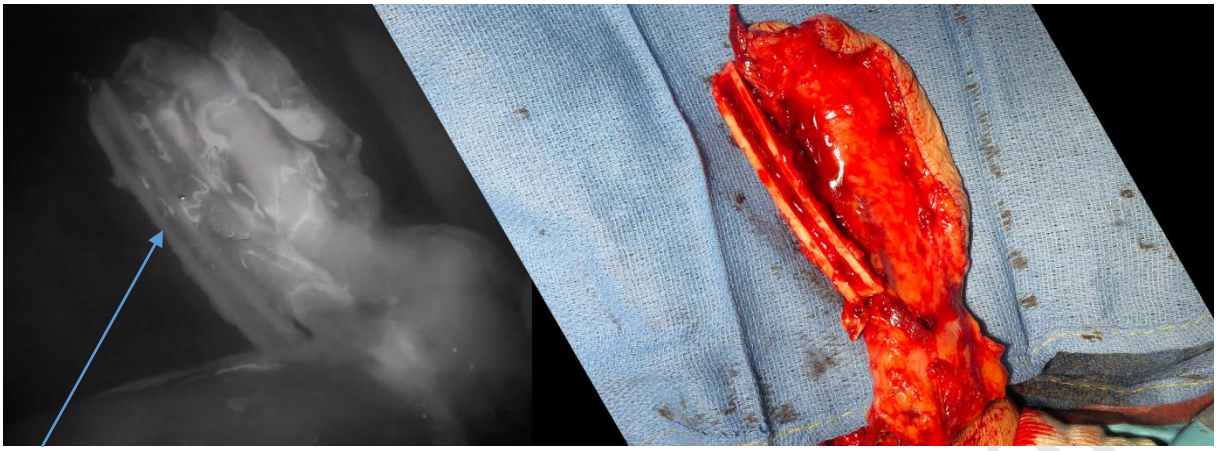

Figure 3: Osseous perforator vessel for this composite Chinese flap

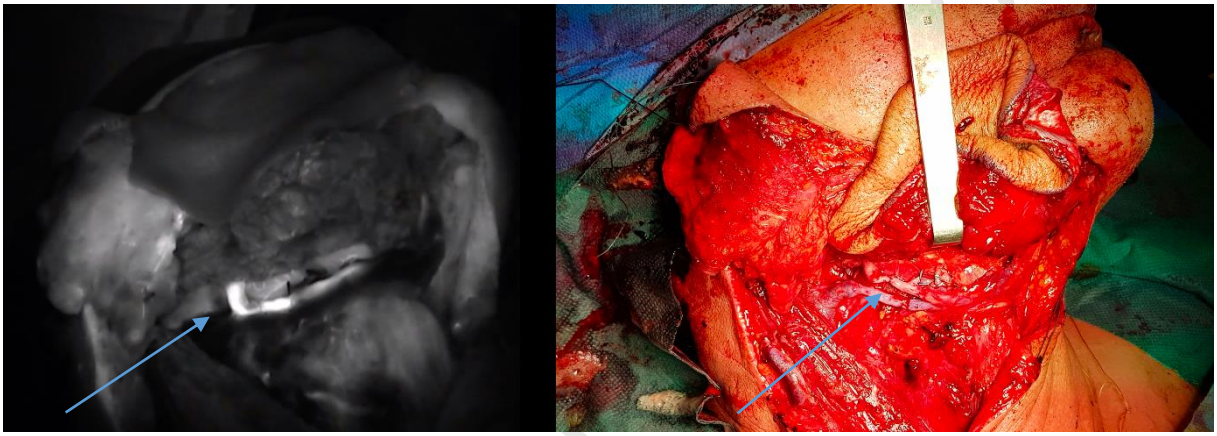

Figure 4: Fluorescence arterial patency: free fibula flap for mandibular reconstruction

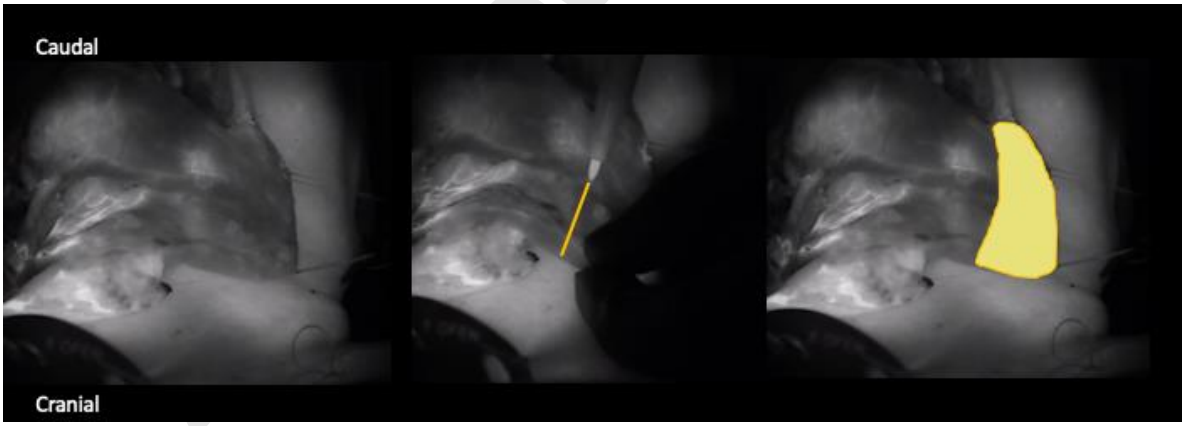

Figure 5: Hypoperfusion of the skin paddle