Use of Indocyanine green angiography for DIEP flap on breast reconstruction: A case report

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Case Report

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Background

After a mastectomy, the breast may be managed in a number of ways, including with implants or autologous tissue flaps taken from a variety of donor locations. About 7.5% of women who have had a mastectomy choose for breast reconstruction. However, that worth is growing as surgical oncologists are increasingly teaming together with reconstructive surgeons to improve outcomes in both areas (patient satisfaction and psychological effects). The transverse rectus abdominis musculocutaneous (TRAM) flap and the deep inferior epigastric perforator (DIEP) flap are the two most common autogenous reconstructive procedures used today. Despite being a significant improvement in breast reconstruction, the deep inferior epigastric perforator (DIEP) flap is often avoided by surgeons because of fears of a greater flap loss rate compared to free or muscle-sparing transverse rectus abdominis myocutaneous (TRAM) flaps. Smoking, chemotherapy, prereconstruction radiation, postreconstruction radiotherapy, hypertension, diabetes mellitus, abdominal scarring, obesity, age, flap size, number of venous anastomoses, and number of perforators were all factors associated with greater flap morbidity. Fat necrosis, partial flap loss, complete flap loss, arterial thrombosis, venous congestion, postoperative hernia, infection, seroma, and hematoma are some of the issues associated with breast reconstruction. The tricarbocyanine dye indocyanine green (ICG) fluoresces upon near-infrared stimulation and strongly binds to plasma proteins that have not left the intravascular space. It has been utilized for some time now in the examination of vascularization; it tells us about the perfusion of the flap's cutaneous island.

Keywords: Breast reconstruction, Postmastectomy reconstrctuction, Indocyanine green angiography, DIEP flap.

Plastic surgeons in the United States use tissue expanders and implants for 79% of breast reconstructions, whereas 14% use pedicled TRAM flaps, 9% use latissimus dorsi flaps, 3% use free TRAM flaps, and 3% use perforator flaps. Only one-fifth as many doctors undertake microsurgical procedures for restoring breast tissue. Microsurgical breast reconstruction is becoming less common as a consequence of the rising use of acellular dermal matrices as an adjuvant to implant-based reconstruction, which enables surgeons to obtain better outcomes with implants. One of the most significant developments in autologous tissue breast restoration is the deep inferior epigastric perforator (DIEP) flap. The DIEP flap offers all the benefits of the free transverse rectus abdominis myocutaneous (TRAM) flap while minimizing its downsides by retaining the rectus abdominis muscle and fascia. TRAM and DIEP flaps are similar in that they both have a direct blood supply, a natural form, a pliable consistency, and a durable cosmetic outcome. Breast mound cutaneous feeling may be restored with either the free TRAM or DIEP flap by reestablishing the connection between the sensory branch of the tenth or eleventh intercostal nerve and the anterior ramus of the lateral branch of the fourth intercostal nerve. Necrosis of adipose tissue is a common adverse effect. There is a large discrepancy of up to 62.5% in the reported incidence of fat necrosis after the surgery. Fat necrosis is a common condition that is commonly overlooked since it is seen as a minor surgical consequence. It degrades the final aesthetic outcome, increases the need for extra imaging tests and reoperation, and may even lead to the complete failure of the reconstructive aim, all of which induce pain. Patients undergoing oncologic breast surgery frequently experience psychological distress due to fat necrosis since the indurated nodular lesion it forms might seem like cancer at first glance. A firm and permanent lump, fat necrosis is a surgical consequence. Not all lesions are perceptible, particularly tiny and deep fat necrosis in big flaps, therefore it might be difficult to make a correct diagnosis. Fat necrosis has been called "the great mimicker" because of its similarity to other lesions,

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Figure 1. Pre-Surgical Marking / Abdominal perforating vessels previously marked by US

both benign and malignant. The tricarbocyanine dye indocyanine green (ICG) has several applications in medicine and surgery and has been shown to be safe. It allows for intraoperative vessel evaluation through ICG angiography (ICGA) due to its high affinity for

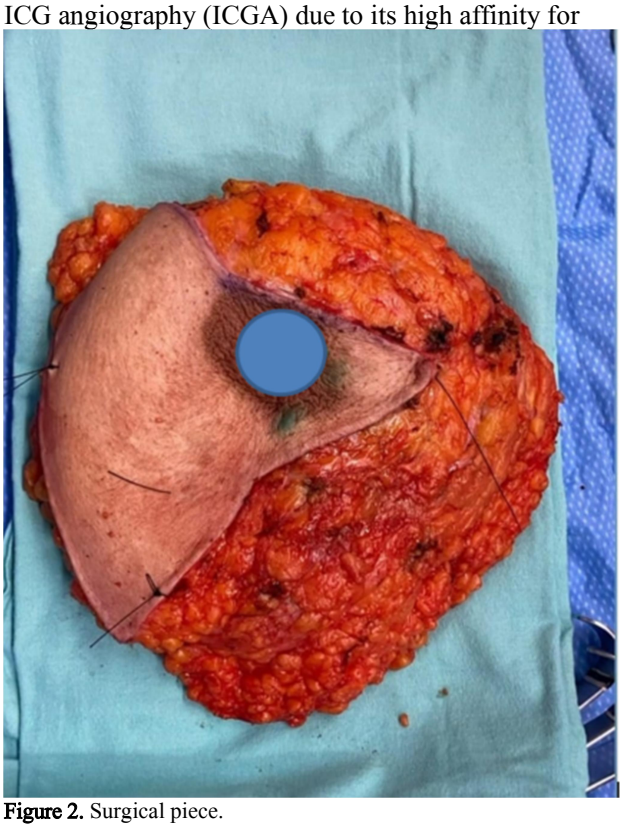

Figure 2. Surgical piece.

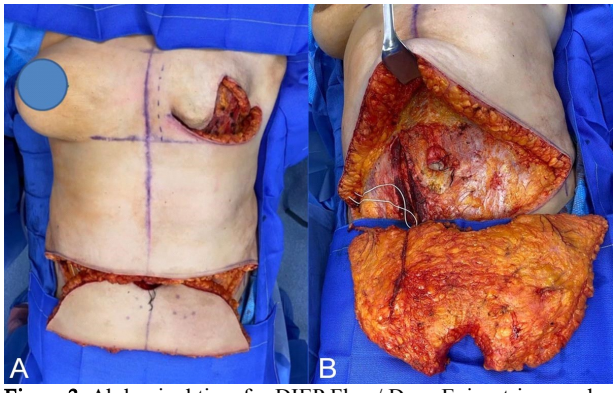

Figure 3. Abdominal time for DIEP Flap / Deep Epigastric vessels.

plasma proteins still present inside the intravascular space and extremely little extravascular fluorescence. Several benefits have been seen when ICGA is performed at the donor site to evaluate DIEP flap perfusion.

Surgical technique

Patients are marked before surgery while they are both standing and lying down. The top edge of the flap is moved just a little bit above the umbilicus so that the periumbilical perforator can be seen. The flap's vertical size rarely goes over 12 cm, which lets it close with little force. The inframammary crease is marked so that you can find it again. During the mastectomy, the DIEP flaps are lifted with the help of two teams. Doppler, preoperative computed tomography angiography (CT angiography), and direct viewing during surgery are all ways to find perforators. The best vessels to use are the ones inside the breast at the level of the third rib. The pectoralis major muscle is cut down the middle so that the costal cartilage can be seen. The perichondrium is raised so that 2 cm of cartilage can be taken out. The back part of the perichondrium is cut open so that the internal mammary veins can be seen. The DIEP flap is lifted from the side to the middle in a plane above the fascia. It is still possible to see the shallow inferior epigastric vein (SIEV). Once the lateral perforators are found, or if two or more perforators have similar features, we clamp them one at a time and do an ICGA on each one

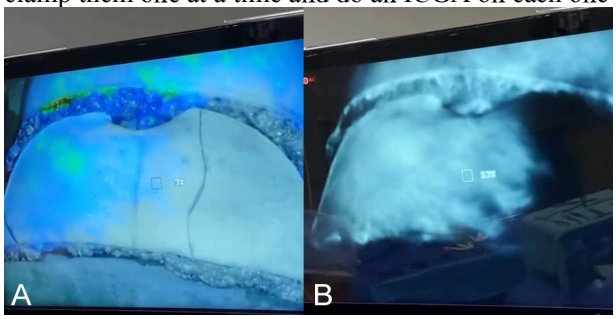

Figure 4. Indocyanine green angiography for DIEP flap final design and Proper perfusion

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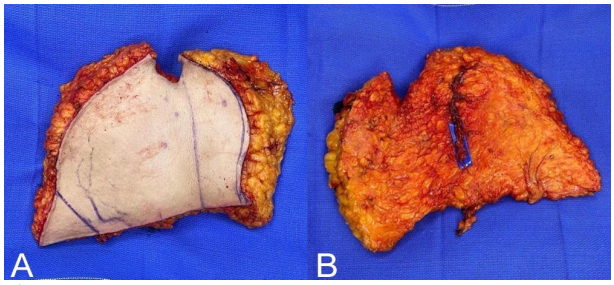

Figure 5. DIEP Flap final design according to the best blood perfusion corroborated by green of indocyanine / Deep Epigastric Vessels

to see how well they can perfuse the flap. Laser-assisted indocyanine green angiography (ICGA) was used to measure the flap's blood flow during surgery. A bolus of 1 ml of an ICG solution with 2.5 mg/ml of clean water was injected through the peripheral venous line. The edges of the areas where there was no fluorescence or a very weak fluorescence signal (ischemic areas) were marked, and the areas with the most blood flow were kept so that the final flap design would be correct. Skin and fat are raised until the perforators in the middle row can be seen. The anterior rectus sheath is opened around the perforating vascular bundle. This lets the perforators be followed to the deep inferior epigastric veins. For flap innervation, sensory nerves can be cut apart. After separating the pedicle, the flap is weighed and brought to the chest so it can be joined to the internal mammary veins. 9–0 nylon is used to join two vessels together. Between the flap nerve and the fourth intercostal nerve, a neurorrhaphy can be done. The flaps are made to fit the shape and curve of the breasts. Each hole in the rectus sheath is closed without pulling or pushing. The belly apron is moved forward and then closed in a normal way.

Indocyanine green

Indocyanine green (ICG), a moderately harmless fluorescent iodide dye with rapid hepatic clearance, has been employed in medicinal applications since the mid-1950s. In the 1970s, research into the fluorescent characteristics of ICG expanded its use to ophthalmology. Because of technological limitations at the time, extensive development of ICG fluorescent angiography did not begin until the mid-1990s, and widespread acceptance of the technique did not occur until the early 2000s, when improved digital imaging resolution provided a satisfactory alternative to film-based photography. Indocyanine green is a tricarbocyanine iodide dye that is amphiphilic. Intravascularly, the chemical binds to plasma proteins, containing the majority of the bolus until hepatic pickup and excretion into bile. The injected ICG is attached to plasma proteins 98% of the

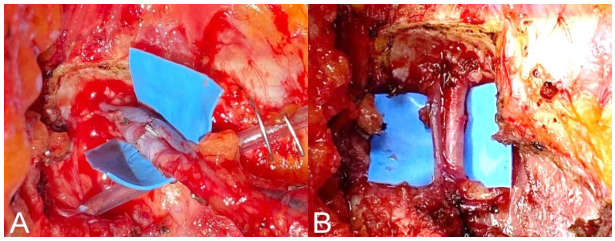

Figure 6. Anastomosis to Mammary Internal Artery.

time, while the remaining 2% is free in the serum. The evolution of the ICG breakdown reaction produces singlet oxygen molecules, which thermally disintegrate into low-toxicity carbonyl compounds. The dye has an LD50 (lethal dosage) of 50 to 80 mg/kg because the singlet oxygen persists within the ICG system. ICG is practically harmless at a normal dose of less than 2 mg/kg, providing the patient does not have an iodine allergy. In the first 10 to 20 minutes after administration, the dye is eliminated from the system exponentially, with a half-life of 3 to 4 minutes depending on the vascularization of the organ of interest. Because the near-infrared light used to quantify fluorescence makes tissues look more translucent, it probes several millimeters further into the tissue than other wavelengths. Fluorescence is observed around the greatest peak of 832 nm, and the molecule is generally stimulated between 750 and 800 nm. Since the early 2000s, the focus of ICGA in surgery has shifted to the evaluation of skin flap viability in general surgery and plastic and reconstructive surgery. The camera's images reveal real-time perfusion in the skin by assessing dye fluorescence and then providing objective information about which places have the highest blood flow and are at the lowest risk for wound consequences. The images are displayed in real time, allowing the surgeon to make judgments without the need for extra research or external interpretation. Skin necrosis occurs in 10% to 30% of mastectomies, although the use of ICGA in mastectomies has improved skin necrosis forecasts. Using a Gaussian model to describe flap viability, it was discovered that less than 25% perfusion was indicative of nonviable skin 90% of the time, whereas regions greater than or equal to 45% perfusion were most frequently viable (98% frequency).

Discussion

The ICGA is a useful intraoperative test that have been used for many years in reconstructive surgery. It provides information about the perfusion of the flap; its safety has been demonstrated and there is no significant increase in the surgical time, In addition, new applications are being investigated. Deep inferior epigastric artery perforator (DIEP) flap breast reconstruction has been repeatedly shown to result in

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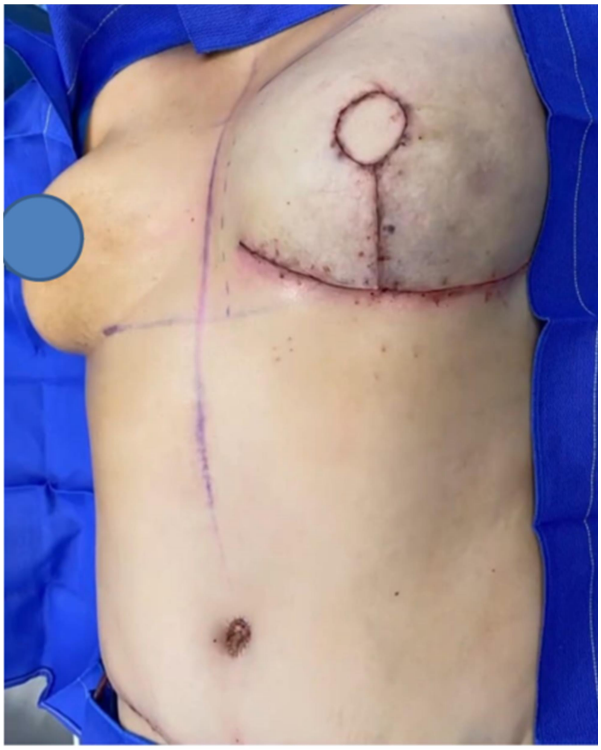

Figure 7. Final DIEP Flap reconstruction with appropriate thoracic and abdominal symmetry.

increased patient satisfaction over implant reconstruction, however, the ratio of this technique among breast reconstruction cases is exceedingly low, and only 7.1% of all breast reconstructions, performed in 2012 were DIEP flap reconstructions. The fear of encountering setbacks, such as increased operating time (leading potentially to increased vascular complications, flap loss, or increased fat necrosis), difficulty in identifying perforators (risk of pedicle trauma), or technical difficulties with anastomosis may lead young surgeons to forego performing a DIEP flap for breast reconstruction altogether. Because of the complexity and steep learning curve of DIEP flap, most of the plastic surgeons without a formal microsurgical training opt to use simpler methods for breast reconstruction, such as breast implants or pedicled flaps. The main concern for reconstructive surgeons performing microsurgical breast reconstruction is total loss of flap, which can be traumatizing to patients who are already emotionally compromised because of the nature of their underlying disease

Conclusion

With minimal morbidity at the donor site, microsurgical breast reconstruction utilizing the DIEP flap yields excellent esthetic results, and its use should be increased with appropriate training during plastic surgery residency. The advantage of conducting the ICGA on the donor site is that it is also useful for selecting the best perforator vessel on the donor site, which allows for optimal flap perfusion and a successful surgical result.

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Conflicts of interest

The authors have reported no conflicts of interest.

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