

Smartphone Dynamic Infrared Thermography for Harvesting AICAP Flap in a Large Breast-conservative Surgery

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Summary: Flaps based on perforators of the intercostal arteries have been described for the reconstruction of defects resulting from partial mastectomies. Dynamic infrared thermography (DIRT) identifies hot spots that accurately correspond to and evaluate perforator vessels toward the skin. The new generation of portable thermal cameras has become smaller, less expensive, more sensitive, and compatible with common smartphones. One option is the FLIR ONE system (FLIR Systems, Inc., Wilsonville, OR), a smartphone-compatible thermal camera. Despite its lower resolution, compared with the larger infrared camera models, it represents a viable option for thermal skin mapping, and its compact nature allows for easy portable use. The purpose of this article is to report a case of a preoperative study with smartphone DIRT used in the preparation of an anterior intercostal artery perforator-based flap for breast reconstruction after a wide resection at the level of the right infer-internal breast region, including a skin excision. Our study documents how smartphone DIRT is a rapid, sensitive, easily accessible and cost-effective diagnostic method for the topographical identification of intercostal artery perforators. It can be used as a rescue method at any stage of the intervention if it differs from the preoperative planning. It also confirms the proven usefulness of this flap for the reconstruction of partial defects in the breast and thoracic region. (*Plast Reconstr Surg Glob Open* 2023; 11:e4951; doi: 10.1097/GOX.0000000000004951; Published online 27 April 2023.)

Flaps based on perforators of the intercostal arteries have been described for the reconstruction of defects resulting from partial mastectomies.¹ Adipofascial flaps, de-epithelialized or not, can be sculpted based on the anterior or lateral perforators of these arteries.

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Received for publication September 26, 2022; accepted March 3, 2023.

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DOI: 10.1097/GOX.0000000000004951

Because the design of these flaps requires high surgical expertise and results in more use of preoperative examinations capable of detecting the reference perforators, often it is opted for random flaps with uncertainties related to the actual perfusion pattern of the flap set up.

Dynamic infrared thermography (DIRT) is a means of identifying hot spots that accurately correspond to and evaluate perforator vessels towards the skin²⁻⁴

DIRT detects the infrared radiation emitted inside the skin areas with variable perfusion of the tissue. It is known that areas with higher thermal radiation or “hot spots” correspond to increased local vascularization of tissues.⁵ Initially, with the advent of this technology, thermal imagers were relatively inaccurate and expensive. However, the next-generation portable thermal cameras have become smaller, less expensive, and increasingly sensitive. Although high-resolution cameras typically cost thousands of dollars, in recent years inexpensive and portable camera models, compatible with common smartphones, have been brought to the market.⁶ The FLIR ONE system (FLIR Systems, Inc., Wilsonville, Ore.), a smartphone-compatible thermal camera, is one of these

Disclosure statements are at the end of this article, following the correspondence information.

options. The camera uses infrared sensors of long wavelength (8–14 μm) and has a temperature ratio protection range of 0–100°C. Despite its lower resolution compared with the larger infrared camera models, it represents a viable option for thermal skin mapping, and its compact nature allows for easy portable use. A visible light camera is used to obtain an image that is subsequently digitally fused with the infrared thermal image.

For that reason, the use of such devices is much more suitable for daily clinical and surgical practice. In our institute, they have already started to be used for many purposes, including the design of flaps in anticipation of reconstructive interventions.

The purpose of this work is to report a case of a preoperative study with smartphone DIRT used in the preparation of an anterior intercostal artery perforator (AICAP)-based flap for breast reconstruction following a wide resection at the level of the right infer-internal breast region, including a skin excision (Fig. 1).

CASE PRESENTATION

A 70-year-old White woman presented to our clinic in 2022 with lobular breast cancer located at the right inferior-inner pole with T4N0M0 staging, that required extensive skin breast resection extended to the superficial and deep planes (Fig. 2). The tissue defect measured in the medialized breast was 9 cm \times 6 cm and extended in depth to the sternal periosteal and perichondrial plane costal.

Our group has extensive experience in using the peri-areolar approach to all breast resection in oncoplastic surgery, but in this case, with the need to lose a large area of skin at the inferior-inner pole, it would not have been applicable.^{7,8} We opted for the setting up of a flap based on the AICAP with the maintenance of medial fasciocutaneous continuity.

This decision was made to have lower morbidity of the donor site, easier healing of the surgical wound, and to allow a postoperative course as safe and quick as possible, to enable the necessary adjuvant therapies to be started without delay.

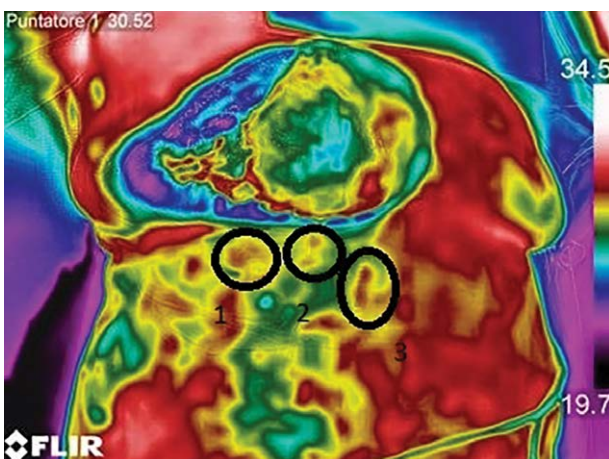


Fig. 1. Preoperative study: hot spots detection.



Fig. 2. Intraoperative photograph: AICAP piercing localization and tissue deficiency.

PREOPERATIVE ASSESSMENT

The patient was positioned supine. We performed a smartphone DIRT study of the donor site. Handheld acoustic Doppler assessments were undertaken to confirm adequate perforators. We have marked three hot spots at the level of the medial region of the thorax at a height between the fifth and seventh intercostal space, numbered as described in Figures 1 and 2.

OPERATIVE TECHNIQUE

During the careful dissection from the lateral to medial flap, the perforators corresponding to hot spot 1 were identified and compromised by ligatures, since its position entailed a restriction of the degree of freedom of the flap, causing incorrect inseting at the receiving site. The correctly identified hot spot 2 was selected as the main vascular pedicle of the flap due to its good position and its appropriate gauge (about 0.4 mm). We have therefore finished the preparation of a fasciocutaneous flap transposition to a medial pedicle based on the AICAP. The flap has been transposed by 90 degrees.

The viability of the flap was confirmed with intraoperative smartphone DIRT. To avoid inadequate perfusion of the apex of the sculpted flap, intraoperative DIRT was used again. The detection of a hyporadiant area about 1-cm long in the most distal region of the flap has allowed the selective review, minimizing the possibility of necrosis of the apex. The donor site was closed for the first intention by the advancement of an abdominal fasciocutaneous flap from the lower region of the donor site to obtain the closure line along the inframammary fold with good aesthetic satisfaction (Fig. 3). This case series has been reported in line with the PROCESS Guideline.⁹

RESULTS

The length of the follow-up was 9 months. The patient had a postoperative course without complications. No areas of partial or complete necrosis were detected. As planned, this smooth course allowed for quickly undertaking the adjuvant oncological therapies.



Fig. 3. Immediate postoperative image of the patient.

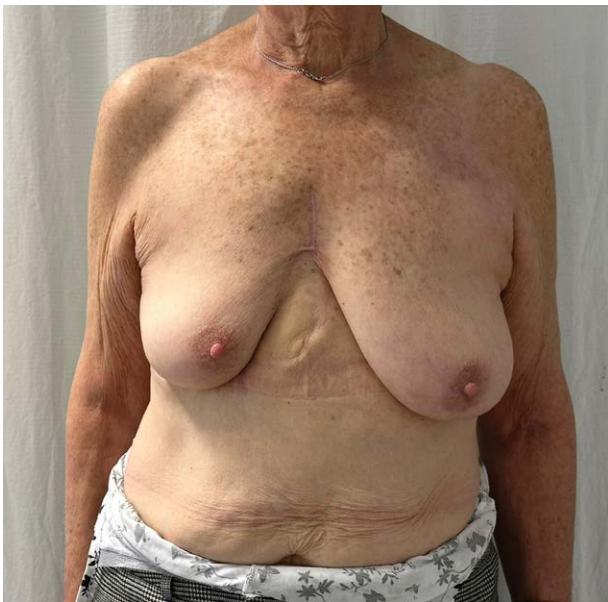


Fig. 4. Patient photograph 9 months after surgery.

The patient experienced weight loss of 16kg from surgery. Currently, she has completed chemotherapy and radiotherapy, and is in good general condition (Fig. 4).

DISCUSSION

According to anatomical studies on cadavers, the perforators that originate from the intercostal arteries are divided into anterior, lateral, and dorsal (AICAP, LICAP, and DICAP) and emerge along the intercostal spaces. The perforators of greatest application in mammary reconstruction are the anterior and lateral ones at the level of the fifth and sixth intercostal space. The diameter of these perforators is around 0.42mm on average, and their length is about 3.1cm on average.^{10,11} These flaps have been validated in terms of reliability and versatility by several studies that guarantee the survival of flaps wrapped around 16×5cm, with a pedicle composed of only one of these perforating.¹² Our study documents how

smartphone DIRT is a rapid, sensitive, easily accessible, and cost-effective diagnostic method for the topographical identification of intercostal artery perforators.

CONCLUSIONS

We demonstrate that smartphone-compatible thermal cameras can be used in addition to clinical examination, as well as other monitoring technologies, providing additional information not only in the selection of perforators in the operating environment, but also in the early diagnosis of the low vitality of parts of the flap, allowing the selective review of areas that would have undergone necrosis. It can be used as a rescue method at any stage of the intervention if it differs from the preoperative planning. Also in our experience, the AICAP flap is an excellent option for the reconstruction of partial defects in the breast and thoracic region. We hope this technology will be used more and more in the preparation of the flaps, and we think it can also help in the therapeutic choice through the intraoperative evaluation of the mastectomy flaps in breast reconstruction.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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