

Use of Infrared Thermography for Abdominoplasty Procedures in Patients with Extensive Subcostal Scars: A Preliminary Analysis

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Summary: Subcostal scars may increase the risk of healing complications in abdominoplasty. The authors evaluated the use of thermography as a potential tool for patient selection and surgery planning to avoid complications and improve abdominoplasty outcomes. Two candidates for abdominoplasty procedures who presented with extensive subcostal scars were submitted to an infrared thermography protocol at all phases of the procedure: preoperative, intraoperative, and postoperative at 1 and 6 months. The preoperative thermography for both patients revealed near-normal abdominal wall perfusion. The thermograms captured intraoperatively during flap elevation did not show perfusion deficits on the upper abdominal flap. At 1 month and 6 months postoperative, dynamic thermography for both patients showed normal to near-normal perfusion. The procedures had a complication-free course with a good aesthetic result. Plastic surgeons may be reluctant to perform a full abdominoplasty in patients with a previous subcostal incision. In this preliminary analysis, we raise the potential usefulness of thermography for patients with recent subcostal scars and/or important comorbidities as a strategy for adequate patient and technique selection, avoiding possible complications. Future studies, with an increased number of patients and adequate statistical analysis, may allow us to validate the utility of thermography in these cases and reassure that the presence of previous extensive subcostal scars may not be a contraindication for a full abdominoplasty, especially if they are not recent. (*Plast Reconstr Surg Glob Open* 2023; 11:e5149; doi: [10.1097/GOX.0000000000005149](https://doi.org/10.1097/GOX.0000000000005149); Published online 20 July 2023.)

INTRODUCTION

Abdominoplasty is one of the most performed cosmetic surgical procedures, limited by few contraindications. It is a considerable stressor in blood supply to the abdominal wall flap.¹ On the other hand, scars are often

present in the abdomen of patients seeking abdominoplasty, aggravating the risk to the abdomen's regional blood supply.^{2,3}

To minimize complications of previous scars in abdominoplasty, some authors suggest lipoabdominoplasty and limited undermining, placing less tension on the flap closure, delaying it, or using a different type of resection, such as reverse or Corset abdominoplasty.^{2,4-6} The possibility of inferior aesthetic results and the high risk of complications must be carefully discussed with these patients. Noninvasive methods for evaluating abdominal wall perfusion may help surgeons decide on the best option in the presence of a subcostal scar.

Medical infrared thermography (IRT) is an effective, fast, precise, portable, and safe noninvasive imaging method in plastic surgery and an option for evaluating abdominal skin perfusion.^{1,7} We applied IRT at all phases

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of abdominoplasty to two female patients undergoing a full abdominoplasty presenting with extensive subcostal scars at the right hypochondrium.

PATIENTS AND METHODS

Patient 1 was a 40-year-old woman with a history of partial hepatectomy and gastric sleeve several years before, and a body mass index of 26.3 kg per m². She presented a 25-cm-long horizontal scar, starting on the right hypochondrium crossing the midline, and extending to the left hypochondrium (Fig. 1).

Patient 2 was a 46-year-old woman with a history of open cholecystectomy 5 years before, and a body mass index of 27.8 kg per m². She presented a scar from a Kocher incision, with a maximum length of 10 cm. Neither patient presented other relevant comorbidities. (See figure 1, Supplemental Digital Content 1, which shows a photograph of patient 2, a 46-year-old woman with a previous open cholecystectomy, resulting in a right hypochondrium scar, 10 cm in length. A, Preoperative. B, 1-month postoperative result. <http://links.lww.com/PRSGO/C684>.)

The thermographic protocol was designed and applied in straight collaboration with the engineering faculty and followed international guidelines^{7,8}. [See figure 2, Supplemental Digital Content 2, Thermography protocol preoperatively (PREOP), intraoperatively (INTRA-OP), and postoperatively at 1 month and 6 months (PO 1M and PO 6M). During the preoperative period, after 10 minutes of acclimatization, the examiner captured thermograms of the abdominal wall with a thermographic camera FLIR-E60-SC (FLIR-Systems, Oregon, USA) at a 100-cm distance (Fig. 2). Static thermography was performed during the preoperative and intraoperative periods. Dynamic thermography was performed at 1 month and 6 months postoperative. In the dynamic approach, the thermograms were

Takeaways

Question: Is it safe to perform abdominoplasties in patients presenting with extensive subcostal scars?

Findings: Applying a thermography protocol at all phases of abdominoplasty, the authors found this imaging method useful for correct patient selection during the preoperative period, corroborating data during the intraoperative period, and monitoring possible complications during the postoperative period.

Meaning: In patients seeking abdominoplasty procedures and having recent extensive scars and/or serious comorbidities, thermography could be a simple, effective, and economical strategy for adequate patient selection, technique planification, and to predict possible complications.

obtained at the baseline (I.B), after the cold stimulus (ice pack) (I.0), and sequentially every minute (I.0', 1', 2', 3', 4', 5') until the 10-minute mark to record the thermal recovery. Some thermograms of patient 2 were included in the scheme to better illustrate the protocol applied. The postoperative thermograms refer to 6 months postoperative (I: image, B: baseline). <http://links.lww.com/PRSGO/C685>.]

RESULTS

In both cases, no significant disruption of the abdominal wall vascularization was documented on preoperative thermograms. The absence of significant alterations in this thermographic analysis favored our decision to perform a full classical abdominoplasty (deep fascia plane), without liposuction.

Intraoperatively, another thermogram was captured during flap elevation, showing no perfusion deficits, especially below the scars. The undermining was performed,

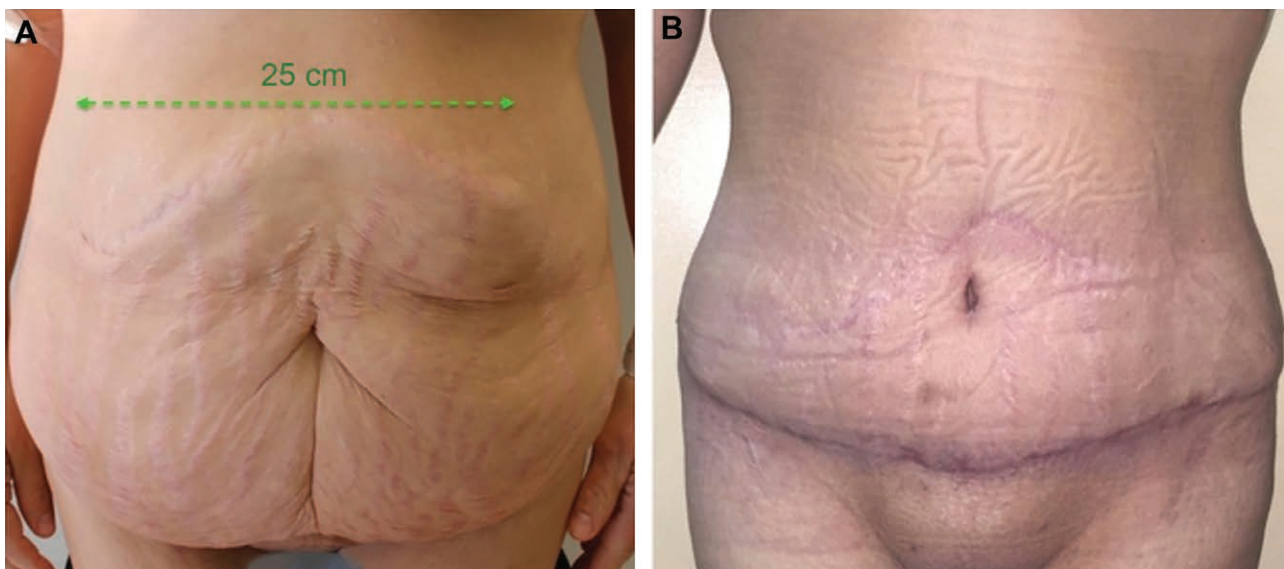


Fig. 1. Photograph of patient 1. The patient is a 40-year-old woman with previous partial hepatectomy resulting in a right hypochondrium scar crossing the midline (length: 25 cm). A, Preoperative condition. B, One-month postoperative result.

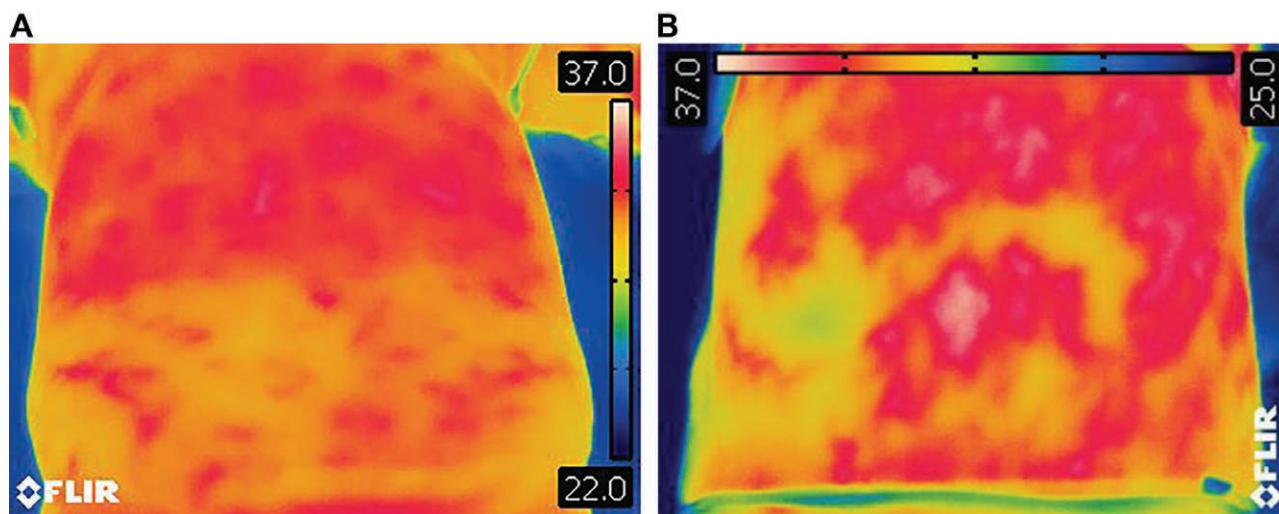


Fig. 2. Thermograms of patient 1. A, Preoperative thermogram. B, Thermogram at 1-month postoperative at the 10-minute mark of thermal recovery.

including the region of the scar, but was limited in width to allow for muscle plication and flap descent. The procedures were uneventful, with good aesthetic result (Fig. 1). There were no healing problems, and viability of the abdominal skin was never threatened.

One month after surgery, the thermographic protocol was repeated, with a dynamic approach, introducing a cold stimulus (ice pack) to the abdominal wall for 5 minutes, and thermograms were captured every minute until the 10-minute mark (Fig. 2). We observed near-normal abdominal wall thermal recovery for both patients, but the original right scar could be identified as a “cold” area in patient 1 (Fig. 2). A concordance between clinical and thermography findings was found. The dynamic thermography was repeated 6 months postoperatively, with no significant perfusion deficits.

DISCUSSION

Surgeons show reluctance to perform full abdominoplasty in patients with a previous subcostal incision because of the risk of vascular disruption.^{2,3,6} This risk may be less, especially if previous surgery was performed in the remote past and other risk factors are absent.³ Nevertheless, strategies must be implemented to avoid complications and improve outcomes.^{2,6}

IRT has already been proven useful for plastic surgery,^{7,9,10} with good acuity for evaluating tissue perfusion.^{1,7} Several studies have reported its value in monitoring flap perfusion and preoperative perforator mapping.^{1,7,11,12} Additionally, IRT is a relatively efficient noninvasive method but without using intravenous contrast.^{13,14}

In this preliminary analysis involving two patients presenting with different subcostal scars, the authors applied thermography at all phases of abdominoplasty with different purposes, which was not previously described according to the authors’ knowledge.

IRT performed preoperatively may contribute to a simple, noninvasive evaluation of abdominal wall perfusion

and may play a role in identifying suitable candidates for surgery and in defining the surgical plan in patients with subcostal scars, especially if they are recent or if the patient has other comorbidities.³ Intraoperatively, it may provide information regarding tissue viability and help the surgeon better define undermining extension. In this phase, due to time constraints and asepsis issues, we performed static thermography. Postoperatively, it may be helpful in anticipating possible perfusion complications and detecting tissue perfusion deficits in microcirculation before skin changes appear.⁷ The authors defined the period of 1-month postoperative for the thermographic evaluation because the proliferative phase of the wound healing process was almost finished, with the vascular factors being very relevant. One would expect that, in the presence of compromised perfusion around the scar, thermography would detect healing problems earlier, which did not occur for either patient. If it happened, this strategy would allow us to act correctly in time, using other medical or surgical strategies.^{15–17} The available portable thermographic cameras can start monitoring possible perfusion complications immediately after the surgical procedure, in selected patients.

We acknowledge several limitations of this report. The number of patients included is small for definitive conclusions, there was no standardized measurement for the amplitude of the detachment performed, and we could not perform dynamic thermography in the pre- and intraoperative periods due to time and asepsis concerns.

CONCLUSIONS

In an era of portable cameras and smartphone thermography software,^{18,19} this preliminary analysis encourages others toward further investigation, including increasing the number of patients, to validate this tool as a simple, effective, and economical strategy for patient selection and for predicting possible complications, especially in cases of recent scars or important comorbidities.

Large-scale prospective studies must validate the utility of this technique, helping in the decision to perform abdominoplasty, plan the surgical approach, and pre-cisely predict possible perfusion complications. These can be of use in defining the impact of abdominal subcostal scars in patients undergoing full abdominoplasty.

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DISCLOSURE

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

REFERENCES

- Nergård S, Mercer JB, de Weerd L. Impact on abdominal skin perfusion following abdominoplasty. *Plast Reconstr Surg Glob Open*. 2021;9:e3343.
- Mahabbat NA, Shah Mardan QNM, Mohamed AO, et al. Challenging the subcostal incision scar with the two-staged abdominoplasty: an innovative approach. *Plast Reconstr Surg Glob Open*. 2022;10:e4047.
- Shermak MA, Mallalieu J, Chang D. Do preexisting abdominal scars threaten wound healing in abdominoplasty? *Eplasty*. 2010;10:e14.
- Acevedo E, Nadhan KS, Everett M, et al. Corset trunkplasty: recommended with abdominal skin laxity and open cholecystectomy scar. *Plast Reconstr Surg*. 2018;141:60–69.
- Huttin C, Hendriks S, Bodin F, et al. Reverse abdominoplasty in the presence of bi-subcostal scar: technical note. *Ann Chir Plast Esthet*. 2021;66:481–485.
- Samra S, Sawh-Martinez R, Barry O, et al. Complication rates of lipoabdominoplasty versus traditional abdominoplasty in high-risk patients. *Plast Reconstr Surg*. 2010;125:683–690.
- John HE, Niumsawatt V, Rozen WM, et al. Clinical applications of dynamic infrared thermography in plastic surgery: a systematic review. *Gland Surg*. 2016;5:122–132.
- Ammer K, Ring F. *The Thermal Human Body: A Practical Guide to Thermal Imaging*. Jenny Stanford Publishing; 2019.
- Hennessy O, Potter SM. Use of infrared thermography for the assessment of free flap perforators in autologous breast reconstruction: a systematic review. *JPRAS Open*. 2020;23:60–70.
- Thiessen, FEF, Tondou T, Cloostermans B, et al. Dynamic infrared thermography (DIRT) in DIEP-flap breast reconstruction: a review of the literature. *Eur J Obstet Gynecol Reprod Biol*. 2019;242:47–55.
- de Weerd L, Weum S, Mercer JB. Dynamic infrared thermography (DIRT) in the preoperative, intraoperative and postoperative phase of DIEP flap surgery. *J Plast Reconstr Aesthet Surg*. 2012;65:694–695; author reply 695–696.
- Muntean MV, Strilciuc S, Ardelean F, et al. Using dynamic infrared thermography to optimize color Doppler ultrasound mapping of cutaneous perforators. *Med Ultrason*. 2015;17:503–508.
- Roostaeian J, Harris R, Farkas JP, et al. Comparison of limited-undermining lipoabdominoplasty and traditional abdominoplasty using laser fluorescence imaging. *Aesthet Surg J*. 2014;34:741–747.
- Resende PR, Brioschi ML, De Meneck F, et al. Predicting lipoabdominoplasty complications with infrared thermography: a delta-R analysis. *Arch Plast Surg*. 2021;48:553–558.
- Boissiere F, Gandolfi S, Riot S, et al. Flap venous congestion and salvage techniques: a systematic literature review. *Plast Reconstr Surg Glob Open*. 2021;9:e3327.
- Guarro G, Cozzani F, Rossini M, et al. The modified TIME-H scoring system, a versatile tool in wound management practice: a preliminary report. *Acta Biomed*. 2021;92:e2021226.
- Winter E, Glauser G, Caplan IF, et al. The LACE+ index as a predictor of 30-day patient outcomes in a plastic surgery population: a coarsened exact match study. *Plast Reconstr Surg*. 2020;146:296e–305e.
- Weum S, Lott A, de Weerd L. Detection of perforators using smartphone thermal imaging. *Plast Reconstr Surg*. 2016;138:938e–940e.
- Pereira N, Hallock GG. Smartphone thermography for lower extremity local flap perforator mapping. *J Reconstr Microsurg*. 2021;37:59–66.