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## Review Article

# Reconstruction of the thoracic radiation-induced ulcer with the pedicled internal mammary artery fasciocutaneous flap: Review of the literature and a case report

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## ABSTRACT

**Objective:** The pedicled Internal Mammary Artery Perforator (IMAP) flap is not yet a well-known technique. However, it seems practical for use in thoracic radiation-induced ulcer, especially in recurrence after the failure of convenient reconstructive techniques. This technique is applied to patients with breast hypertrophy. In this article, we present our experience with the indications, surgery details, and advantages of this technique.

**Materials and methods:** A 63-year-old woman had a right mastectomy 11 years ago. The patient's ulcers recurred after radiotherapy and were treated with a regional and local flap. The opposite breast was ptotic, and the patient was not eligible for microsurgery. The patient underwent reconstruction using the contralateral pedicle IMAP flap.

**Results:** The IMAP flap was designed with a size of 14 × 22 cm, including the inferior half of the breast and the areolar. The flap could completely cover the chest wall defect, and the contralateral breast was reduced to match. The final results were evaluated after two years of follow-up.

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**Conclusion:** The contralateral breast pedicle IMAP flap is a reliable, versatile, and easy-to-perform technique. This flap is a useful technique for chest wall coverage after radiation-induced ulcers, particularly in elderly patients. The major limitation of this technique is the higher risk of second primary breast cancer as the transfer flap of the contralateral breast.

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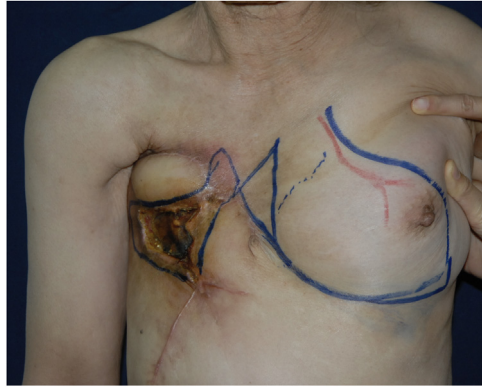
## Introduction

Radiotherapy (RT) is used as an adjuvant treatment in addition to mastectomy for breast cancer treatment, and it reduces the risk of local recurrence and increases survival rates. However, RT also damages the vascular endothelial microvessels. The radiation-induced ulcers (RIU) may involve the skin, underlying soft tissues, and even deep structures such as bone, which can appear many years after irradiation and have secondary, progressive, irreversible characteristics. Wound healing problems in these patients are often underestimated. This damage eventually causes severe adverse effects, such as radiation-induced ulcers (RIU) and osteomyelitis on the chest wall. Subsequently, the RIU often becomes infected, reducing the viability of the granulation tissue.<sup>1–3</sup> Therefore, managing RIU on the chest wall has become a clinical challenge. Although most defects can be repaired with conventional surgical techniques such as split-thickness skin grafts, and local or regional flaps, they have little effectiveness.<sup>4–9</sup> More complex cases require sophisticated surgical procedures such as perforators or free flaps.<sup>10,11</sup> In patients with failure of local or regional flaps, the free flaps are often contraindicated because of radiation-induced vascular impairment. The opposite breast can be used as a donor flap to solve these complex problems. The internal mammary artery perforator (IMAP) flap is a little-known but not forgotten choice for chest-wall reconstruction in women. This flap is an axial-pattern flap nourished by the variable IMAP. Chest-wall RIU in women with large ptotic contralateral breast can be good candidates for this technique.<sup>12,13</sup> In this paper, we present the use of an IMAP flap to treat a recurrent chest-wall RIU in a patient with a history of failure of latissimus dorsi flap and lateral intercostal perforator flap.

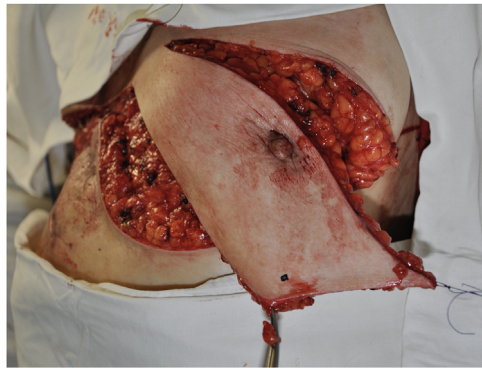
## Case presentation

A 63-year-old woman, 45 kg weight, the body mass index (BMI) of 19.1 kg/m<sup>2</sup> with a history of right breast cancer stage T2N1M0, submitted to Halsted radical mastectomy, axillary dissection, and adjuvant radiotherapy to the thoracic wall 11 years ago (cobalt therapy, 54 Gy, 22 sessions – 2 Gy/day). Five years ago, she presented a hyperpigmented area in the right chest; the ulcer appeared and progressed slowly. Last year, she was referred to the Surgery Department for thoracic wall reconstruction due to a radiation-induced anterior right ulcer with a pedicled myocutaneous latissimus dorsi flap. On postoperative day 2, the flap showed signs of congestion at the distal third, then the flap was partially necrotic with size 7 cm × 6 cm (42 cm<sup>2</sup>), causing soft tissue defects with exposed ribs. Sixteen days after the first surgery, she underwent a second debridement procedure to remove a necrotic portion of the flap and cover it with a pedicled lateral flap. However, ischaemia began to develop one day after the second surgery.

The patient was then transferred to our department with a chest wall defect of 8 cm × 13 cm (104 cm<sup>2</sup>) and partial exposure of the 5th–7th ribs (Figure 1). The scar on the back where the LD flap was harvested healed well. Histological examination showed no recurrent breast cancer or radiation-related malignancy. The patient also took mammography for recurrence screening. A racquet-shaped cutaneous glandular flap, 22 cm long and 14 cm wide, was designed based on the



**Figure 1.** A 63-year-old female patient who underwent mastectomy 11 years before and the RIU showed up. It was treated with a regional and local flap but failed. The left breast was in grade III ptosis, and the new flap design was based on IMAP in the third intercostal space.



**Figure 2.** Dissecting the skin flap, including the breast tissue and NAC.

vascular axis of IMAP. The flap covered the entire medial half of the contralateral breast. The pivot point of the flap was at the 2rd–3rd intercostal space, next to the left border of the sternum. The NAC was at the distal end of the skin flap.

**Surgical technique:** The incision follows the design down to the superficial fascia layer. The flap was raised from both sides to the centre of the flap and from the pectoralis major fascia plane to the flap pedicle. The path of the IMAP must always be controlled with the handheld Doppler from the exit site in the intercostal space to the nipple-areola complex to avoid injuring them during proximal dissection on the flap pedicle. The flap pedicle was dissected close to approximately 2 cm from where the perforator penetrated the intercostal space. The flap included the left NAC (Figure 2). The ulcer in the right chest wall was extensively resected by removing the 4th, 5th and 6th necrotic ribs. The defect was about 15 × 20 cm in size. An incision from the flap pedicle to the defect crossed the sternum, and then the flap was transferred to cover the defect without tension. The donor site was closed directly, and the scar was camouflaged within the left border of the sternum and the inframammary fold. In the left breast, a new NAC was also reconstructed by a local flap and a full-thickness skin grafting simultaneously (Figure 3). Postoperatively, the flap survived completely, the wound healing was good, the new NAC in the left breast was in good shape.

After two months of follow-up, she presented a well-healed wound and adequate thoracic wall coverage (Figure 4). Follow-up after two years, no RIU recurrence was observed, and the breast shape



**Figure 3.** The flap was transferred to cover the right breast defect, and the donor site was closed directly. The NAC of the left breast was reconstructed by a skin graft.



**Figure 4.** Results after two months. A part of the abdominal flap was ischemic, but no intervention was required.

was acceptable with no functional restriction, including respiratory ventilation function. She was satisfied with the result.

## Discussion

Although RT plays an essential role in the multidisciplinary breast cancer treatment strategy, several clinical sequelae, including skin atrophy, soft tissue fibrosis, RIU, and osteoradionecrosis, have been reported. Chronic RIU is a late-stage reaction on normal tissue after radiation to the thoracic wall, and they are difficult to heal because of reduced blood supply. Ischemia, poor healing, and infection are the causes of unfavourable ulcer progression. The management of RIU continues to be a challenge for reconstructive surgeons. The principle of RIU treatment is to remove all the nonviable tissue and reconstruct it immediately with well-vascularized tissue. The most reliable surgical resection is to remove all necrotic tissue, including a large enough skin tissue around the ulcer and obvious radiation-induced osteomyelitis of the ribs.<sup>4,5</sup> The RIU can be managed with non-surgical conventional treatments, but the little benefit has been reported.<sup>2</sup> Some regional pedicle myocutaneous flaps with an adequate blood supply can be transferred to achieve the obliteration of dead space as well as resurfacing the defect (8–10). Free flaps are also indicated when patient systemic conditions permit, the received vessels are undamaged and match the surgeon's skill.<sup>11</sup> However, whether pedicled or free flaps are used, a critical issue in treating RIU lesions is the complete resection of the skin and bone lesions. The persistence of osteonecrosis lesions causes recurrence and the risk of partial or to-

tal necrosis of the transposed muscles. Our patient developed recurrent RIU following the failure of conventional flaps. She was thin with a BMI of under 20, lacking sufficient recipient vessels and had no indication for free flap. She was diagnosed with right breast cancer and had a total mastectomy 11 years ago. The contralateral breast was large, with ptosis, and she has already been postmenopausal. So in this circumstance, we think the internal mammary fasciocutaneous flap may still be suitable.

The internal mammary vessels are considered one of the main and constantly reliable sources of blood supply to the NAC, chest wall, and breast tissue. Its largest perforating branches are mainly in the 2nd, 3rd, and 4th intercostal spaces and go towards the nipple. Accompanying each artery are two venous commitans.<sup>12,13</sup> Based on a single or double perforator of the internal mammary artery, the IMAP flap uses the same type of vascular supply as the deltopectoral flap. It offers an excellent option for local tissue with matching skin texture and colour for head and neck reconstruction. It should also be considered an alternative when the deltopectoral and pectoralis significant flaps are unavailable.<sup>14–18</sup> The idea of reconstructing the breast and chest wall from the contralateral breast, including the musculoglandular or cutaneous-glandular flap, has been described in the literature. In 1977, Hamaker et al. reported a large wound in the jugular fossa after total resection of a Merkel cell carcinoma followed by covering with a right-sided bilobed flap taken from the thoracic wall.<sup>19</sup> Hughes et al. presented the cyclops flap, an axial-pattern flap nourished by the lateral thoracic artery and the variable external mammary artery, to reconstruct the chest-wall defect for hypertrophic breasts in women. Still, this technique is little-known and has been abandoned.<sup>20</sup> In 1981, Marshall described using a contralateral side flaps to reconstruct the breast and chest wall in 60 cases. A two-stage procedure involves transferring breast tissue, typically discarded in a breast reduction, to the other side to cover the chest wall's defect. The results are encouraging, but this technique remains rarely used.<sup>21,22</sup> Schellert et al. presented a single-stage breast reconstruction using a split-breast perforator flap from the contralateral side in a 57-year-old woman with a history of mastectomy and axillary dissection. The patient had massive breast hypertrophy and underwent a reduction on the left side. The resected portion from the left breast, which pedicled on its internal mammary perforators, was used as a tissue source to reconstruct the right breast.<sup>23</sup> In 2000 and 2002, Kalender and Maillard et al. reported an IMAP island axial flap from the inframammary fold of the normal breast, which was used to cover the defect in the sternum of the inferior pole of the contralateral breast.<sup>24,25</sup> In 2009, Safarti et al. reported a cutaneous-glandular IMAP axial flap taken from the inferior part of a hypertrophic breast to reconstruct in two patients, one for contralateral breast reconstruction and the other for coverage of partial thoracic defect.<sup>26</sup> It may take one or two stages to complete the procedure. In our case, the large enough flap was designed to cover the entire defects of the right chest. The flap supplied with blood by the 2nd and 3rd IMAPs was taken from the whole lower half of the left breast with the NAC. The design was also considered so that the donor site, after harvesting, can be closed primarily without deforming the breast or during reductive procedures.

The advantages of this technique are numerous. The appearance and colour of the breast tissue flap are identical to the contralateral reconstructed breast or chest wall. The handheld Doppler can determine the path of IMAP, thereby providing a basis for flap design. The contralateral breast reduction effect can be achieved simultaneously with surgery. Short operation time due to the simple flap harvest and transfer minimizes the risk of complications. This technique is a minimally traumatic, quick, and a little haemorrhagic intervention. The scar pattern of this technique is minimal, as the patient appreciates not suffering additional scars on the abdomen or back. The flap remains flexible and easy to rotate to the distal part of the chest wall. This flap can be performed in the high-risk surgical group, requiring only a few days' hospital stays. The major limitation of this technique is the risk of second primary breast cancer. Although the probability of developing a second contralateral primary breast cancer is higher than in the general population, the statistical risk of cancer in older patient is lower than in younger patients. In postmenopausal women who have survived mastectomy for ten years, the incidence of carcinoma in the contralateral breast is the same as in the general population.<sup>21,22</sup> At the follow-up level of oncology, the clinical examination of the reconstructed breast does not differ from the classical examination of the patient after mastectomy. This technique does not increase the risk of recurrence.

## Conclusion

The technique of the IMAP flap from the contralateral voluminous residual breast may be an option for elderly patients as a salvage procedure to cover a complicated chest wall defect, especially in patients with RIU. This technique has several advantages of accessible performance and similarity in texture, and it can be a salvage option when another choice of the flap has been used up. The major drawback of this technique may be a higher risk of a second primary breast cancer.

## Declaration of Competing Interest

There are no conflicts of interest to declare, and the authors have no financial interest or funding concerning this article.

Ethical approval: Not required.

## Declaration of patient consent

All participants provided written informed consent before enrolment in the study. The privacy and confidentiality of patient records were adhered to in managing the clinical information in conducting this research.

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