**CASE REPORT**

Bilateral free flap breast reconstruction using venous cross-over bypass to contralateral internal mammary artery for salvaging thrombosed arterial anastomosis in unilateral repeated irradiation of the breast: A case report

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Abstract
Adjuvant radiotherapy in breast cancer patients might enhance complications after autologous breast reconstruction, including thrombosis of the internal mammary artery (IMA) precluding its use as recipient vessel. This case report shows a salvage procedure for thrombosis of the IMA during bilateral autologous breast reconstruction in a 51-year-old patient who had undergone repeated irradiation of the chest wall after Hodgkin’s disease and recurrent breast carcinoma of the right side. After mastectomy of the right breast and prophylactic mastectomy of the left breast, the patient desired breast reconstruction with autologous tissue. During simultaneous bilateral breast reconstruction using two deep inferior epigastric perforator (DIEP) flaps anastomosed to the left and right inframammary vessels, arterial anastomosis to the right IMA was not feasible due to arterial thrombosis. A salvage procedure using an interpositional cephalic vein graft as a crossover bypass and a subcutaneous presternal tunnel was used. The inferior epigastric artery of the right DIEP flaps was anastomosed to the venous bypass, which was anastomosed to the contralateral IMA. Both flaps healed without any complications during the postoperative course and follow-up of 6 months. The presented case shows the feasibility of a cross-over venous bypass procedure during bilateral breast reconstruction as salvage maneuver for the arterial anastomosis after repeated radiation of the unilateral breast.

1 | INTRODUCTION

Autologous breast reconstruction via free flap transfer has experienced a consequent evolution due to advances in microsurgical techniques. Nowadays, simultaneous bilateral breast reconstruction using deep inferior epigastric perforator (DIEP) flaps are a part of routine procedures in specialized centers (Heidekrueger et al., 2021; Schmauss et al., 2019; Steiner, Horch, Ludolph, & Arkudas, 2020; Steiner, Horch, Ludolph, Schmitz, et al., 2020). The use of postmastectomy radiation therapy has increased lately, reducing the local recurrence risk of breast cancer by about two-thirds (Dewar, 2006). However, radiation increases the risk of vascular complications due to inflammatory responses of the vessel wall (Cai et al., 2017). Particularly, it enhances the intraoperative microvascular complication rate in breast reconstruction patients and leads to higher rate of intraoperative revision (Fracol et al., 2016). Thrombosis is the most common reason for arterial anastomotic revisions in irradiated fields. Other more seldom mechanisms include...
narrowing of the arterial lumen and fragility due to intima damage (Fracol et al., 2016).

In this case report, an insufficient arterial anastomosis during bilateral DIEP flap reconstruction in a breast with repeated radiation therapy and salvage by an interpositional venous graft anastomosed to the contralateral side is described.

2 | CASE REPORT

A 51-year-old woman with a history of nodular sclerosing Hodgkin lymphoma with bilateral cervical, right supraclavicular and right bulky mediastinal involvement had received two cycles of chemotherapy which led to partial remission and mantle and infradiaphragmatic irradiation with a total dose of 40 and 30.6 Gy, respectively. Furthermore, the patient underwent resection of two lymph nodes in the right axilla.

Twenty-four years later, the diagnosis of an invasive carcinoma of the right breast led to breast-conserving surgery, sentinel lymph node biopsy, and adjuvant radiation therapy. Twenty months later, the patient was diagnosed with recurrent breast cancer. Consequently, the patient underwent mastectomy of the right breast and prophylactic mastectomy of the left breast 4 months later (Figure 1a).

After an inconspicuous follow-up period of 1 year, the patient desired to undergo bilateral autologous breast reconstruction. A computed tomography angiography revealed sufficient perforator vessels originating from the inferior epigastric vessels. Two DIEP flaps were planned for breast reconstruction. After partial resection of the fourth rib on the left side, the internal mammary artery (IMA) and vein (IMV) were dissected demonstrating a sufficient caliber. Blood flow in the IMA was 20 and 10 ml/min in the IMV (MiraQ™ Vascular, Medistim ASA, Oslo, Norway). Complete flap dissection was performed immediately before transplantation. First, the DIEP flap from the left side, which measured 190 g, was anastomosed to the left cranial IMA and IMV. The venous anastomosis was performed with a Synovis 2.5-mm vein coupler (Synovis Micro Companies Alliance, Birmingham, AL) and the arterial anastomosis was hand-sewn. After completion of anastomosis, the DIEP flap showed sufficient perfusion. Then the right breast was reconstructed. The fourth rib was partially resected and IMA and IMV were dissected. The tissue on the right side was fibrosed due to the repeated radiation therapy. Both IMA and IMV showed insufficient blood flow values (0–1 ml/min). Papaverine was applied and vessels were allowed to recover from spasm. Blood flow increased to 8 ml/min in the IMA and 6 ml/min in the IMV. The right DIEP flap, measuring 182 g was anastomosed to the right side. The venous anastomosis was carried out with a Synovis 2.5-mm vein coupler and appeared inconspicuous after completion. After arterial anastomosis was performed to the cranial IMA, blood flow immediately decreased due to blood clotting. The flap artery was then anastomosed to the caudal IMA. However, the intima of the vessel was extremely fragile, making anastomosis unfeasible. The caudal IMA was clipped and the third rib was partially resected to expose the IMA more cranially. Blood flow was adequate here and arterial reanastomosis to the cranial IMA was performed. Shortly afterwards,
end-to-end anastomosis was performed between the left caudal IMA and the vein graft and between the vein graft and the flap artery (Figure 2a). Thereafter, a sufficient arterial flow was evident and flap perfusion was excellent (Figure 3). Laser-assisted angiography was performed, indicating well-perfused free flaps. In addition, the microscope integrated Indocyanine Green-based video angiography tools IR800 and FLOW800 (Kinevo 900, Carl Zeiss, Oberkochen, Germany) enabled to identify adequate blood flow in the feeding artery and draining vein (Figure 2b,c). Ischemic time of the right flap lasted 231 min while total operation time was 617 min.

Postoperative anticoagulation was performed with intravenous unfractionated heparine (aPTT 45 s) and continued with Phenprocoumon (INR 2–2.5) for 3 months postoperatively. The patient was discharged from hospital after 11 days and was asked to avoid sternal compression for a total of 6 weeks. No further complications were noted during the follow-up period of 6 months after surgery (Figure 4).

3 | DISCUSSION

Breast reconstruction procedures after mastectomy have evolved over the last decade, as microsurgical techniques have advanced. Kaider-Person et al. have demonstrated the feasibility of free flap breast reconstruction via anastomosis to IMA vessels even after internal mammary lymph node irradiation. The only complication after a mean internal mammary vessel radiation dose of 37 Gy was fat necrosis (Kaidar-Person et al., 2019). The patient in this present report had a history of repeated high doses of radiation of the right chest due to Hodgkin’s lymphoma followed by breast cancer several years later (Alm El-Din & Taghian, 2008). The cumulative high doses of irradiation, exceeding the standard doses of 45–50 Gy after breast conserving surgery (Sauer et al., 2005) might explain the issues conquered during IMA anastomosis. Radiotherapy is known to improve oncologic outcomes, but it may also cause tissue injury in the short and long term (Ha et al., 2018). On top of that, irradiated tissue is more prone to perioperative complications, in particular vascular complications during autologous breast reconstruction with free flaps (Fosnot et al., 2011). In this case, IMA was not suitable for anastomosis even after removal of an additional rib to expose the IMA more cranially. Thus, there was need for an alternative recipient artery. The ipsilateral IMA perforators were not available after mastectomy and would have laid in the prior radiation field. Considering the long ischemic time of the DIEP flap after multiple unsuccessful attempts of arterial anastomosis, the thoracodorsal vessels were not used in this case as their dissection would have precluded the latissimus dorsi muscle to be utilized as a possible salvage flap for breast reconstruction in case of failure of the DIEP flap (Lhuaire et al., 2017). Regarding the use of the contralateral IMA in (bilateral) breast reconstruction, several successful outcomes have been described (Bains et al., 2007; Ha et al., 2018; Zeltzer et al., 2011). In this context, prior radiation or patients with coronaryopathy, who might eventually need IMA vessels in case of coronary bypass surgery, represent cases, where this maneuver might be favorable (Ha et al., 2018; Zeltzer et al., 2011). For instance, Ha et al.
reconstructed extensive thoracal defects after radionecrosis by using the contralateral IMA as recipient vessel for free TRAM flaps (Ha et al., 2018). Others performed simultaneous bilateral breast reconstruction by using the contralateral IM vessels for one side and ipsilateral thoracodorsal vessels for the other side. However, by using the thoracodorsal vessel one flap had a lateral position, making a medialization procedure necessary (Bains et al., 2007). Contrary to those reports, we used the cranial and caudal IMA of one side for bilateral breast reconstruction. As presented in a prior case report, the contralateral IMV can be feasible as a recipient vessel when using a cross-over bypass under a subcutaneous presternal tunnel (Steiner et al., 2020). In accordance to the described report, a venous cross-over bypass to anastomose the flap pedicle to the contralateral caudal IMA may be a valuable microsurgical option in the rare case of an unsuitable ipsilateral IMA during bilateral breast reconstruction.

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REFERENCES
Alm El-Din, M. A., El-Badawy Samy, A., & Taghian, A. G. (2008). Breast cancer after treatment of Hodkin’s lymphoma: General review. International Journal of Radiation Oncology · Biology · Physics, 72(5), 1291–1297. https://doi.org/10.1016/j.ijrobp.2008.07.060
Bains, R. D., Riaz, M., & Stanley, P. (2007). Bilateral free DIEP breast reconstruction using contralateral internal mammary and ipsilateral thoracodorsal vessels. Plastic and Reconstructive Surgery, 119(4), 1385–1386. https://doi.org/10.1097/01.pr.s.0000255180.17788.8c
Cai, A., Boos, A. M., Arkudasas, A., & Horch, R. E. (2017). Management of extremely hard-to-heal extremity wounds with severe life-threatening complications. International Wound Journal, 14(4), 708–715. https://doi.org/10.1111/iwj.12681
Dewar, J. A. (2006). Postmastectomy radiotherapy. Clinical Oncology, 18(3), 185–190. https://doi.org/10.1016/j.clon.2005.11.006
Fosnot, J., Jandali, S., Low, D. W., Kovach, S. J., 3rd, Wu, L. C., & Serletti, J. M. (2011). Closer to an understanding of fate: The role of vascular complications in free flap breast reconstruction. Plastic and Reconstructive Surgery, 128(4), 835–843. https://doi.org/10.1097/PRS.0b013e318218fc95
Fracol, M. E., Basta, M. N., Nelson, J. A., Fischer, J. P., Wu, L. C., Serletti, J. M., & Fosnot, J. (2016). Bilateral free flap breast reconstruction after unilateral radiation: Comparing intraoperative vascular complications and postoperative outcomes in irradiated versus nonirradiated breasts. Annals of Plastic Surgery, 76(3), 311–314. https://doi.org/10.1097/SAP.0000000000000545
Ha, J. H., Park, S. O., Chang, H., & Jin, U. S. (2018). Optimal reconstruction method for large Radionecrosis following breast cancer treatment: Utility of free transverse rectus abdominis myocutaneous flap using contralateral internal mammary artery as recipient. Annals of Plastic Surgery, 81(5), 584–590. https://doi.org/10.1097/SAP.0000000000001547
Heidekrueger, P. I. M., Horch, R. E., Lohmeyer, J. A., Marx, M., Heitmann, C., Fansa, H., Geenen, M., Gabka, C. J., Handstein, S., Prantl, L., & von Frisches, U. (2021). Overall complication rates of DIEP flap breast reconstructions in Germany—A multi-center analysis based on the DGPRÄC prospective National Online Registry for microsurgical breast reconstructions. Journal of Clinical Medicine, 10(5), 1016.
Kaidar-Person, O., Eblan, M. J., Caster, J. M., Shah, A. R., Fried, D., Marks, L. B., Lee, C. N., & Jones, E. L. (2019). Effect of internal mammary vessels radiation dose on outcomes of free flap breast reconstruction. The Breast Journal, 25(2), 286–289. https://doi.org/10.1111/tbj.13202
Lhuairie, M., Hivelin, M., Drame, M., Abrahams, P., Kianmanesh, R., Fontaine, C., & Lantieri, L. (2017). Determining the best recipient vessel site for autologous microsurgical breast reconstruction with DIEP flaps: An anatomical study. Journal of Plastic, Reconstructive & Aesthetic Surgery, 70(6), 781–791. https://doi.org/10.1016/j.bjps.2017.01.008
Sauer, G., Stmad, V., Kurzeder, C., Kleirenberg, R., & Sauer, R. (2005). Partial breast irradiation after breast-conserving surgery. Strahlentherapie und Onkologie, 181(1), 1–8. https://doi.org/10.1007/s00066-005-1394-7
Schmauss, D. B., Eisenhardt, S. U., Horch, R. E., Momeni, A., Rab, M., Rieck, B., Rieger, U., Schaefer, D. J., Schmidt, V. J., & Kneser, U. (2019). The “safe” flap—Preoperative perforator-mapping and intraoperative perfusion assessment to reduce flap-associated morbidity—Consensus statement of the Germany Speaking Working Group for Microsurgery of the Peripheral Nerves and Vessels. Handchirurgie, Mikrochirurgie, Plastische Chirurgie, 51(6), 410–417.
Steiner, D., Horch, R. E., Ludolph, I., & Arkudas, A. (2020). Successful free flap salvage upon venous congestion in bilateral breast reconstruction using a venous cross-over bypass: A case report. Microsurgery, 40(1), 74–78. https://doi.org/10.1002/micr.30423
Steiner, D., Horch, R. E., Ludolph, I., Schmitz, M., Beier, J. P., & Arkudas, A. (2020). Interdisciplinary treatment of breast cancer after mastectomy with autologous breast reconstruction using abdominal free flaps in a university teaching hospital—a standardized and safe procedure. Frontiers in Oncology, 10, 177. https://doi.org/10.3389/fonc.2020.00177
Zeitzer, A. A., Andrades, P., Hamdi, M., Blondeel, P. N., & Van Landuyt, K. (2011). The use of a single set of internal mammary recipient vessels in bilateral free flap breast reconstruction. Plastic and Reconstructive Surgery, 127(6), 153e–154e. https://doi.org/10.1097/PRS.0b013e31821311d9

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