



SPECIAL ARTICLE

Volume replacement techniques in oncoplastic breast conserving surgery

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Abstract We present an overview of volume replacement techniques within the context of oncoplastic breast conserving surgery. These techniques involve importing autologous tissue to the breast to reconstruct the defect caused by tumour wide local excision. They can therefore extend the indications for breast conserving surgery. Commonly used techniques are described including their anatomical basis, clinical indications, recognised complications and the potential benefits to the patient compared to mastectomy and total breast reconstruction.

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PALABRAS CLAVE

Oncoplástico;
Cirugía conservadora de mama;
Colgajos perforantes;
Reconstrucción parcial de mama

Técnicas de reemplazo de volumen en cirugía de mama oncoplástica conservadora

Resumen Presentamos un resumen de las técnicas de reemplazo de volumen en el contexto de la cirugía oncoplástica de mama conservadora. Dichas técnicas implican la importación de tejido autólogo a la mama para reconstruir el defecto causado por la amplia extirpación local del tumor. Por tanto, pueden ampliarse las indicaciones a la cirugía de mama conservadora. Se describen las técnicas comúnmente utilizadas incluyendo su base anatómica, indicaciones clínicas, complicaciones reconocidas y beneficios potenciales para el paciente, en comparación con la mastectomía y la reconstrucción de mama total.

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Introduction

Oncoplastic surgery techniques have been developed to extend the indications of breast conserving surgery based mainly on the principles of breast volume displacement or replacement.

Volume replacement involves importing autologous tissue to fill the breast defect caused by tumour excision effectively leading to a partial breast reconstruction. Described techniques include the use of chest wall perforator flaps based on a variety of vessels adjacent to the breast, flaps based on the latissimus dorsi (mini-flap and muscle sparing techniques), omentum, abdominal advancement and free flaps.¹

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As oncoplastic breast conserving procedures often entail removing large cancers from the breast, the oncological outcome of these procedures is of paramount importance. Multiple studies have shown that these procedures are oncologically safe,²⁻⁴ in addition to improving the cosmetic outcome and patient satisfaction, when compared to mastectomy with immediate reconstruction which represents the traditional approach in cases of higher tumour size to breast volume ratio.^{5,6}

This article will focus on describing some of the more commonly used partial breast reconstruction techniques, their indications, potential complications that can arise and post-operative surveillance.

Indications and planning

The indication for applying an oncoplastic technique in breast conservation is when it is predicted that simple tumour excision with glandular opposition is likely to lead to a poor cosmetic outcome. The two types of oncoplastic techniques used, entail either volume replacement, which is most useful for women with small to moderate breast size who have little breast ptosis^{1,7-9} or volume displacement, which are more often applicable in larger and/or more ptotic breasts.

The use of perforator flaps is one of the most commonly employed techniques in volume replacement. They have been defined as consisting of skin and subcutaneous fat where the blood supply is derived from perforating branches of vessels deep to the flap.¹⁰ They are named after their associated vessel including commonly used flaps such as lateral intercostal artery perforator (LICAP),¹¹ lateral thoracic artery perforator (LTAP)¹² and thoracodorsal artery perforator (TDAP).¹³ One of the main advantages of these flaps over traditional flaps used in breast reconstruction is their sparing of the underlying muscles and associated morbidity.¹²

The choice of flap depends on tumour location within the breast and ability of the perforator based flap to reach this along with clinical assessment of the perforators with a handheld Doppler probe. The perforators are identified by pulsatile signals that are maximal over a single point.¹⁴ As the flow through the perforator is directed at the probe it should give a louder signal than the underlying vessel where flow is perpendicular to the Doppler probe. The patient should be assessed in the operative position when identifying perforators by placing them in a lateral decubitus position with the ipsilateral shoulder abducted to 90 degrees.¹¹

For tumours in the lateral third of the breast LICAP, LTAP or a combined flap of these is generally the preferred option.¹² Tumours in the lower half of the breast may be suited to an intercostal artery perforator flap comprising either lateral (LICAP), anterior (AICAP) or medial (MICAP) perforators.⁷ An alternative non-perforator flap approach for inferior tumour locations would be an abdominal advancement flap.⁹ For tumours towards the middle third of the breast, a greater pedicle length is required to allow for the flap to reach the defect and consideration should be given to either LTAP or TDAP perforator flaps with the latter certainly preferred for any tumour more medial than this.¹

For medial tumours, consideration can also be given to non-perforator flaps such as those based on Latissimus dorsi,¹⁵ omental flaps¹⁶ or free flaps.^{17,18}

The majority of partial breast reconstruction flaps are based on recruiting skin and subcutaneous fat from the lateral chest wall. The lateral border of the breast is used to form the anterior border of the flap with the superior border determined by perforator location. The dimensions of the flap depend on the amount of tissue required for correcting the defect and ability to safely close the donor site.¹² The lower border is therefore determined by pinching the tissue over the chest wall with the patient in the operative position to plan a tension free closure. The flap is generally angled to allow for scar closure in the bra line,^{12,19} but has also been designed as perpendicular to lines of skin tension with the posterior tip of the flap angled superiorly in keeping with angiosome studies.²⁰

If performing a lateral chest wall perforator flap, the planned flap is raised laterally to medially with meticulous dissection when approaching the marked perforator sites. The flap needs only to be mobilised enough to sit comfortably in the tumour cavity and any perforators which do not compromise this should be preserved.¹² The flap requires de-epithelialisation before inseting, but this may be done either partially or fully following mobilisation of the flap to allow for clinical assessment of flap viability with skin colour and capillary refill during dissection.

Removal of the breast cancer and relevant axillary surgery can often be performed through the lateral breast crease incision which delineates the flap, avoiding any scarring on the breast.

Anatomy of chest wall perforator flaps

Intercostal artery perforators

An understanding of the anatomy of the underlying vessels and perforators is key to guiding their clinical assessment with the Doppler probe and surgical dissection. The relevant LICAP perforators, described by Hamdi et al.,¹¹ are to be found most commonly in the 5th–8th intercostal spaces 2.5–3.5 cm anteriorly to the anterior border of latissimus dorsi. They pass under serratus anterior to the intercostal space and can communicate with both the thoracodorsal and lateral thoracic perforator systems. These are indicated primarily for lateral breast defects as their short pedicle limits them to rotation or turnover into these areas only.¹¹

There are further useful perforators arising from the intercostal artery to be found below the breast, the anterior intercostal artery perforator (AICAP), and medially with the medial intercostal artery perforator (MICAP). These are marked in the supine position as they involve raising a flap from below the infra-mammary fold. These perforators allow flaps to correct defects in the lower half of the breast by identifying the perforator which most easily allows tissue rotation given the tumour site.⁷ In these cases, where the infra-mammary fold is disrupted, this should be recreated following inseting of the flap during wound closure.

Lateral thoracic artery perforators

LTAP flaps, described by McCulley et al.,¹² allow the raising of a similar skin paddle over the lateral chest wall to LICAP flaps and indeed the two perforator groups can be combined to ensure a robust vascular supply. The flap is based on the cutaneous branch of the lateral thoracic artery which runs down the lateral chest wall. This can be identified using Doppler in the operative lateral position as described above for the LICAP flap. The LTAP perforators tend to be found in the 3rd–4th intercostal spaces within two centimetres of the lateral breast border.¹² Flaps can be based on a combination of LTAP and LICAP perforators in which case the flap is mobilised enough to rotate into the defect with preservation of any perforators which do not restrict its movement. This allows use of the flap for similar lateral defects to the LICAP flap but with a potentially more secure blood supply. The lateral thoracic vessels can be identified at the superior border of the flap and dissected up to their origins at the axillary vessels to form a pedicled flap. This technique allows greater mobility of the flap compared to the LICAP flap giving greater reach towards the breast meridian.¹²

A further advantage to the LTAP and LICAP flaps is that they do not compromise the thoracodorsal vessels and so do not generally limit future reconstructive options. Indeed, for patients requiring a mastectomy either for more extensive disease or recurrence, latissimus dorsi flaps can still be used.^{8,12}

Thoracodorsal artery perforators

The TDAP flap reported by Hamdi et al.¹¹ is based on the vertical branch of the thoracodorsal artery which is known to give off two to three perforators in its course.²¹ The first of these generally arises 8 cm from the posterior axillary fold and 2–3 cm posterior to the anterior border of latissimus dorsi with a further perforator around 2–4 cm inferior to the first.

Hamdi's original description notes that once a TDAP perforator has been identified, this is traced through the muscle to the thoracodorsal artery which in turn is dissected up to its origin to provide pedicle length.¹¹ The serratus branch is divided if further length is required and the flap is passed through the split latissimus muscle to allow inseting in the breast.¹⁹

If there are any concerns regarding the quality or calibre of the TDAP vessels, the flap can be converted to a muscle-sparing LD flap which will be described in further detail below.^{11,19} The longer pedicle length of the TDAP flap allows for more medial tumour defects to be corrected than is possible with LTAP or LICAP flaps.¹²

There is potential to use TDAP flaps for total breast reconstruction as described by Santanelli and Hamdi.^{19,22} Santanelli reported a mean flap size of 23.7x8.8 cm using 1–3 TDA perforators in women with small-moderate breast size who did not have an abdominal flap reconstruction option. This has the advantage of preserving the latissimus dorsi muscle which would be an alternative approach in these cases. Hamdi described a muscle-sparing latissimus flap which is to be considered if the perforators are not of

suitable calibre (for TDAP should be >0.5 mm) or without visible pulsation. They describe taking a small cuff of muscle around the perforators which obviates the need to dissect their intramuscular course and reduces risk of damaging the vessels.¹⁹

There are different approaches regarding the method of dissection and perforator selection. The Nottingham group favours using LICAP or combined LICAP/LTAP flaps where possible for lateral breast tumour reconstruction with TDAP flaps reserved for those requiring more medial reach beyond the lateral third of the breast.¹² More historical descriptions have favoured examining the TDAP perforators first.²³

Complications of chest wall perforator flap reconstruction

Beyond the established complications of simple breast cancer surgery such as haematoma, wound infection and seroma, additional risks from simultaneous chest wall perforator surgery are generally uncommon. As with any flap there is a risk of flap necrosis which can be partial or full. Rates of this, generally reported as fat necrosis, vary in the literature ranging from 0 to 10.3%.^{7,12,19,24} A multicentre prospective series of 112 patients from the United Kingdom, undergoing LTAP or intercostal perforator flaps, had an overall complication rate of 7.1% of with a total of four haematomas, one wound dehiscence, one fat necrosis (0.9%), one breast seroma and one scar pain issue.²⁵ A recent systematic review including 432 cases found a fat necrosis rate of 2.4% and flap necrosis rate of 2.1%.²⁶

Partial breast reconstruction can be used to facilitate excision of moderate to large tumours in a smaller volume breast with restoration of breast shape and volume, this can reduce the need for mastectomy with immediate reconstruction and so it is relevant to compare their potential complication profile. It has been shown that oncoplastic breast surgery (including volume displacement techniques) has a lower complication rate than total breast reconstruction particularly in higher risk groups such as the obese further supporting its use.²⁷ This is reflected in presented data from our unit for complications at three months from surgery where 2.9% of perforator cases had complications requiring intervention compared to 9.7% of cases having mastectomy and immediate whole breast reconstruction.

In all cases of breast conserving surgery, it is vital to ensure clear margins to reduce the risk of local recurrence. This applies equally to partial breast reconstruction which is often reserved for proportionately larger tumours to breast size. In a recent multicentre study, the positive margin rate was 13.4% with only 0.9% requiring completion mastectomy with the remainder undergoing only further margin excision.²⁴ On reviewing our own data in this regard, the need for margin re-excision was 7.3% for perforator flap cases compared to 8.7% for simple wide local excision. The difference was more marked in cases of ductal carcinoma in situ where the re-excision rate was 12.5% for perforator flaps compared to 29.6% for simple wide local excision.

In cases with extensive DCIS and associated risk of positive margins it is worth considering a two-stage approach. This involves performing the cancer excision at a first stage through an incision that will allow the subsequent

flap to be raised at a second stage.^{12,20} The cavity of the cancer excision is filled with saline or water to maintain the space while awaiting pathology results with the second stage performed as soon as feasible.

Alternative approaches to partial breast reconstruction

Latissimus dorsi flaps

Latissimus dorsi mini-flaps were described by Rainsbury and involve a lateral breast incision extending to the axilla to allow both the cancer resection and mobilisation of the latissimus dorsi, with some of the subcutaneous fat if needed, which is used to replace volume.¹⁵ This technique avoids the traditional use of a skin paddle over the muscle to augment volume and so does not leave a scar on the patient's back. This technique can be applied in two stages, to ensure clear margins before reconstruction, and has been shown to be beneficial in terms of psychological and cosmetic outcomes.²⁸ This technique has also been described using endoscopic assistance to reduce the size of the surgical scar for harvesting the muscle.²⁹

Omental flap

Omental flap reconstruction of the breast involves mobilising the omentum and placing this into the breast cavity as a pedicled or free flap. The initial technique was described in 1963 but was limited by the morbidity of requiring a laparotomy for mobilisation.³⁰ Laparoscopic omental mobilisation with subcutaneous tunnelling to the breast was described by Costa initially for the treatment of Poland syndrome and has been applied to breast cancer surgery.¹⁶ The use of the omentum as a free flap has also been described using the gastroepiploic vessels with anastomosis commonly to the thoracodorsal vessels.³⁰

Beyond the usual risks of flap surgery such as haematoma, infection, partial or full flap necrosis, there are also potential for abdominal complications including vascular injury and abdominal wall herniation.³⁰ A further challenge is predicting the volume of the omentum which is difficult on both clinical and radiological grounds.³¹ This is more of an issue if the flap is to be used for total breast reconstruction, and it has been suggested that a maximum breast excision weight of 300 g should be considered to avoid omental volume insufficiency for reconstruction.³⁰

Abdominal advancement flaps

The use of an abdominal advancement flap has been described to aid with reconstruction of the lower breast.⁹ This involves mobilising a crescent of de-epithelialised skin and subcutaneous fat lying inferior to the inframammary fold into the lower breast followed by recreation of the fold using sutures. While there is generally little tissue overlying the chest wall below the breast, it has been described as a technique generally for women with small breasts.⁹ This technique recruits similar tissue to that seen in the AICAP as

described above relying on a skin bridge for perfusion, although there are no comparative studies between the two.

Free flap partial breast reconstruction

Lastly, there is a role for free flaps in partial breast reconstruction with various potential donor sites described.³² The transverse upper gracilis (TUG) flap partial breast reconstruction has been described for medial tumours in small-/moderate-sized breasts.¹⁷ Abdominal-based flaps have also been reported based on the deep inferior epigastric perforators (DIEP) and superficial inferior epigastric artery (SIEA).¹⁸ The potential advantage of the TUG flap in this setting would be preservation of the abdominal donor site in case of need for mastectomy with positive margins or future recurrence.¹⁷ There is also an argument for performing these procedures in two stages given the more extensive surgery and associated potential morbidity.

Breast imaging surveillance after partial reconstruction

Surveillance imaging after breast conserving surgery is recommended to identify early local recurrence. Studies have shown that the presence of a flap does not interfere with this surveillance process with no significant difference in need for further diagnostic imaging or biopsy when compared to standard breast conserving surgery.^{33,34}

From a radiotherapy perspective, the calculated volume of the tumour bed to which a boost could be applied was found to be more accurate compared to the specimen weight when the flap was incorporated into planning along with the cavity marker clips.³⁵

Patient satisfaction

The use of the chest wall perforator flaps potentially allows for the avoidance of scars on the breast while maintaining breast volume following cancer resection. As with all oncoplastic techniques the aim is to maintain a good cosmetic outcome without compromising breast oncology.¹ There is a lack of patient reported outcomes data regarding partial breast reconstruction, but multiple studies have shown very positive surgeon reported aesthetic outcomes.^{11,25,26} Partial breast reconstruction has been supported by studies showing that patient satisfaction can be higher in those undergoing oncoplastic breast conservation techniques when compared to mastectomy and immediate breast reconstruction.^{5,6}

Conclusion

Partial breast reconstruction, using the techniques described, has extended the role of oncoplastic breast conservation particularly for women who do not have a volume displacement option. They have been shown to be a safe technique with good oncological and cosmetic outcomes and should be considered where appropriate to help avoid the need for mastectomy.

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Ethical declaration

As this paper is a review article, no patient care was affected and formal ethical approval was not required. We confirm that the work was performed to the best of our knowledge in the interest of patient care.

Declaration of competing interest

The authors declare that they have no conflict of interest.

Appendix. Access to oncoplastic videos.

Authorized by authors:

<https://www.ibreastbook.com> Web page designed and edited by Yazan Massanat. Oncoplastic Breast Surgeon. Aberdeen Royal Infirmary Hospital. United Kingdom Chest wall perforated flap surgery. LiCAP AND LTAP Yazan Massanat <https://www.youtube.com/watch?v=nGh1rnDhcXA&t=52s>

Acceso a videos de Colgajo de Dorsal Ancho y otras técnicas oncoplásticas <https://www.breastsurgeonweb.com> Web page designed and edited by Benigno Acea Nebril. Oncoplastic Breast Surgeon by A Coruña University. Juan Canalejo University Hospital. A Coruña Latissimus Dorsi autologous reconstruction Benigno Acea <https://www.youtube.com/watch?v=qraCNHdGYb0>

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