Review Article

Advantages and disadvantages of using the internal thoracic artery perforators as recipient vessels in autologous breast reconstruction—a narrative review

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Abstract: The rates of breast reconstruction after mastectomy are rising each year. Autologous breast reconstruction using free tissue transfer is considered the gold standard reconstruction, especially with recent controversy surrounding breast implant-associated anaplastic large cell lymphoma (BIA-ALCL). During free tissue transfer, the flap vessels must be anastomosed to recipient vessels on the chest wall. There are multiple options of recipient vessels during microvascular breast reconstruction. Most commonly, the thoracodorsal vessels or the internal thoracic vessels [also known as the internal mammary (IM) vessels] are used as the recipient vessels for microvascular anastomosis of the free tissue transfer. Other second-line options include the thoracoacromial axis and the lateral thoracic vessels. The use of perforators of the internal thoracic vessels for free flap anastomosis during autologous breast reconstruction has been in use for almost twenty years. They are generally favoured over use of thoracodorsal vessels as they result in medialisation of the flap. In recent years, the use of perforators of the internal thoracic vessels has become popular. Great debate surrounds whether or not they should be used as recipient vessels as opposed to the conventional main vessels. In this article, we discuss the advantages and disadvantages of both techniques to guide the choice of reconstructive microsurgeons.

Keywords: Internal mammary perforators (IM perforators); internal thoracic artery (ITA); breast reconstruction; microvascular reconstruction

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Introduction

The rates of breast reconstruction are rising internationally. Breast reconstruction has been shown to have psychological benefits for patients. Autologous reconstruction is becoming very popular as it uses the patient's own tissue. It is also a better option compared to prosthetic implants if adjuvant radiotherapy is required.

During autologous breast reconstruction, a flap of tissue is transferred from elsewhere in the body, from sites such as the abdomen or the thigh. The vessels require anastomosis to native vessels in the region of the breast. The recipient vessels for anastomosis are usually the thoracodorsal or the internal thoracic vessels [also known as the internal mammary (IM) vessels]. Other secondary options, though rarely used, include the thoracoacromial and the lateral thoracic vessels (1). In recent years, the use of perforators of the internal thoracic vessels has become popular. Great debate surrounds whether or not they should be used

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as recipient vessels as opposed to the conventional main vessels. In this article, we discuss the advantages and disadvantages of the recipient vessels in microvascular breast reconstruction. A review of the literature was performed, with relevant articles obtained from SCOPUS and Medline. We present the following article in accordance with the Narrative Review reporting checklist (available at http://dx.doi.org/10.21037/abs-20-50).

Thoracodorsal vessels

The thoracodorsal were previously the vessels of choice. The thoracodorsal vessels however are potentially damaged during axillary clearances. Even if still present, during delayed breast reconstruction, there is often a significant amount of scarring in the region of the axilla due to prior surgery or radiotherapy, which may make dissection of the thoracodorsal axis technically difficult (2). When using the thoracodorsal vessels, a longer vascular pedicle is required on the free flap. There may also be a reduction of tissue available to reconstruct volume in the medial aspect of the breast due to the flap being placed laterally in the breast (2). With the advent of sentinel node biopsy, axillary node clearances are not always required. Because of this, there has been a decline in the use of the thoracodorsal axis as it is generally not exposed, as would've been the case when patients underwent node clearances (3). Also, if the thoracodorsal vessels are used at the time of sentinel node biopsy, if a subsequent axillary node clearance is required, the pedicle may be potentially compromised (4).

Internal thoracic vessels

The use of the internal thoracic axis as the recipient vessel was first described by Harashina *et al.* in 1980 (5). The internal thoracic vessels have the advantage of being a good size match to the flap pedicle, and also the site is more accessible for performing microsurgery (6). The average diameter of the internal thoracic artery (ITA) is 3.6 mm and the average size of the vein is also 3.6 mm (7). At the third intercostal (IC) space, the vessels are consistently of adequate caliber for anastomosis (8). Using the internal thoracic vessels also allows for easier positioning of the flap, and also there is a lower risk of avulsion injury and shoulder stiffness due to shoulder immobilisation when using the thoracodorsal axis for flap anastomosis. A shorter pedicle is required to optimally position the flap on the chest wall (9). Its use may also preserve the thoracodorsal vessels for use for a secondary latissimus dorsi flap in the case of flap failure (10). The internal thoracic arteries bilaterally are good size matches for the deep inferior epigastric artery, as is the right internal thoracic vein. The left internal thoracic vein however, is often much smaller than the deep inferior epigastric vein, which may lead to vessel size mismatch during microsurgical anastomosis (3). The thoracodorsal and internal thoracic vessels when used as recipients for free flap anastomosis have a similar rate of complications, however, use of the internal thoracic vessels may be associated with a higher rate of nipple necrosis in immediate nipple-sparing reconstruction (11).

The ITA is a branch of the subclavian artery. It passes inferiorly and 1–2 cm lateral to the sternal border, dividing into its terminal branches at the level of the sixth rib. Its terminal branches are the superior epigastric artery and the musculophrenic artery. In addition to these terminal branches, the ITA gives off medial and lateral branches. The medial branches give supply to the area surrounding the sternum. The lateral branches include the anterior IC arteries, which supply the ribcage, with two branches to each IC space. The branches at the lower IC spaces are larger, with the largest being in the 5th and 6th IC spaces (7). Laterally there are also branches to pectoralis major. Also, arising from the lateral border of the ITA, the anterior ICs or the muscular branches are cutaneous perforators that supply the skin. The ITA gives blood supply to approximately 60% of the breast parenchyma (12). The cutaneous vascular territory of the ITA extends from the midline medially to the mid-clavicular line, two to three centimeters lateral to the nipple laterally. Cranially, it extends to the inferior border of the clavicle. The caudal border of the skin territory supplied can vary between the ninth rib to the umbilicus (7).

There are however disadvantages to using internal thoracic vessels for free flap anastomosis. In order to anastomose the free flap pedicle to the internal thoracic vessels, a section of cartilage is often removed in order to gain access to the vessels. There are multiple methods to remove the rib, but often the methods described by Haddock et al is employed, with removal of the cartilage piecemeal with a rongeur until the posterior perichondrium is exposed (13). Rib resection can be quite painful, and resection of cartilage and surgery in this area may result in chronic IC neuralgia (14). Pain can result in post-operative atelectasis due to a reduction in deep breathing (15). Another potential disadvantage of cartilage or rib resection is that it may result in a contour deformity on the chest wall

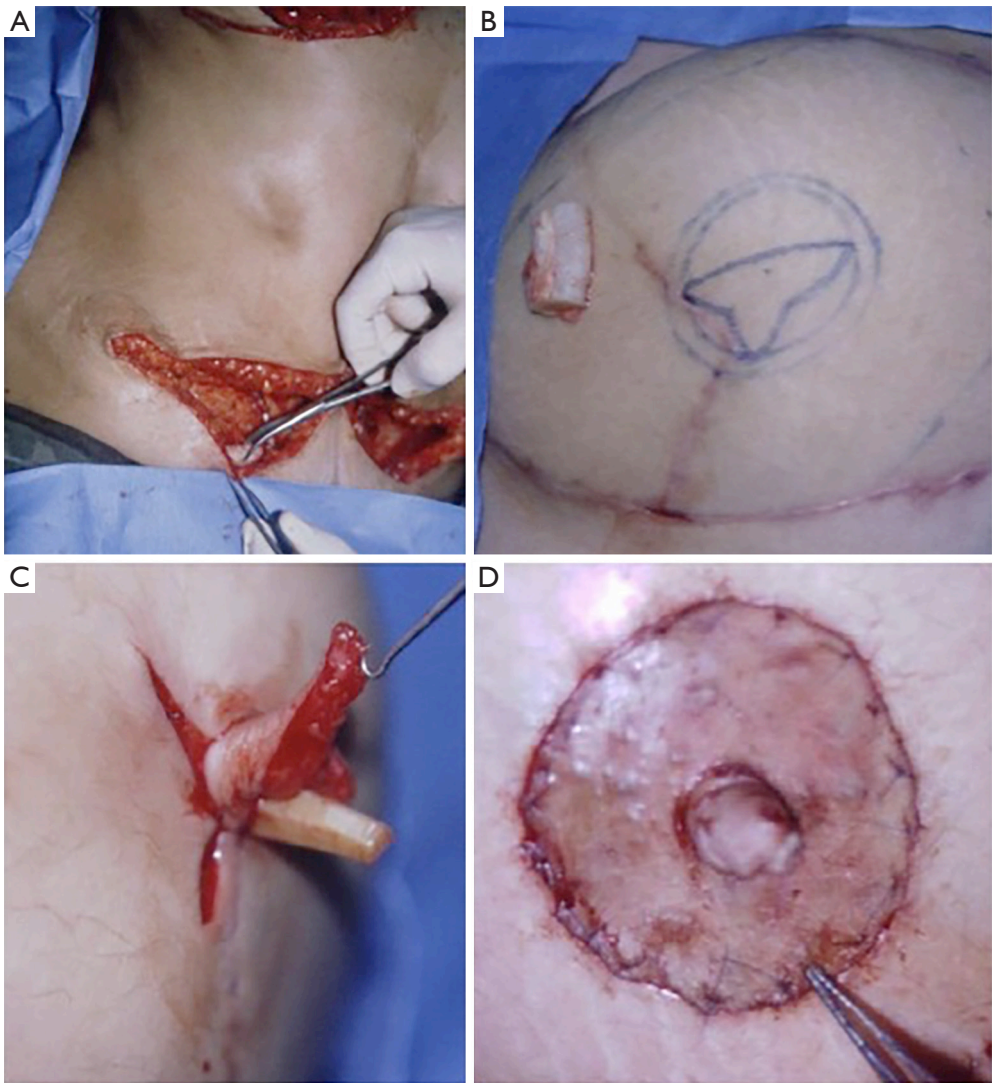

Figure 1 Costal cartilage banking and use in nipple reconstruction.

(10,16). This may require fat grafting to correct (17). One benefit to rib resection is that the cartilage can be banked and subsequently used during nipple reconstruction to give the nipple support (*Figure 1*) (18).

Of note, there is however a rib sparing technique that can be performed that prevents a contour deformity and results in less pain. This involves elevating an area of the IC muscle in the second or third IC space (9,10). The second IC space is the largest IC space (19). This may not be feasible in the presence of a bifid rib (20). In the case of the patient who has had previous radiotherapy however, the segment of ITA that is behind the rib has less damage due to the radiotherapy, which may be more reliable for anastomosis (21). In dissecting out the ITA vessels a pneumothorax may also occur (22). Another, more disadvantageous sequelae are that using the internal thoracic vessels for free flap anastomosis would mean the vessels would be removed as a potential donor for coronary artery bypass grafting. Radiotherapy is a common adjunct to treatment of breast cancer. These patients are at higher risk for coronary artery disease due the effects of radiotherapy on the cardiac vasculature. This may mean this cohort of patients may need coronary artery bypass grafting in the future (23). The ITA is the vessel of choice for surgeons performing bypass grafting (24). Sacrifice of this vessel may also lead to complications in sternal wound closure during cardiothoracic surgery (25). Performing an end to side anastomosis from the flap to the ITA, the vessel can be

potentially preserved for future bypass grafting (26). End to side vessel anastomosis is not associated with an increased risk of flap associated complications, however it may lead to increased flap ischaemia time and increased costs associated with the procedure (27). Anastomosing the free flap pedicle at the 4th or 5th IC space can also preserve the ITA for future bypass grafting (28). The ITA, with a segment of the DIEP pedicle could also be used for coronary artery bypass grafting (28).

Internal thoracic perforators

The use of a perforator of the ITA for free flap anastomosis during autologous breast reconstruction was first described by Guzzetti *et al.* in 2001 (29). Perforator flaps have become increasingly popular compared to musculocutaneous flaps as they significantly reduce donor site morbidity. By moving from main vessel to the use of perforators when choosing the recipient vessels, morbidity can also be reduced. Using perforators from the internal thoracic removes the need for resection a segment of cartilage. This reduces exposure and vessel preparation time and thus the duration of the operation. It also reduces the amount of post-operative pain (30). The vessels are then also still available for potential future coronary artery bypass grafting. The anastomosis may also be technically easier as the excursion of the vessels due to respiratory movements and the beating heart is dampened compared to the ITA, which is in closer proximity to the lung and there is more room to perform the anastomosis (2,29). The arterial or venous anastomosis can be performed conventionally by suturing. They can also be successfully performed using a coupler device (15). This can reduce flap ischaemia times. The tunica media of the ITA perforators are less affected by atherosclerotic degenerative change when compared to the main ITA vessels (31). This may make the vessels more reliable for anastomosis. The use of perforators in comparison to the main IM vessels is not associated with increased flap site complications (32).

ITA perforators are always present. They are the main perforators for the deltopectoral flap (30). Up to 91% of people have perforators greater than 1mm in the first or second IC space (33). ITA perforators can be easily identified using a Doppler (2). Duplex ultrasonography and CT angiography may also be useful in identifying adequate perforators (33-35). The most common location of perforators is in the parasternal area, where the perforators arise directly from the ITA. Usually, extensive intramuscular dissection is not required as most perforators are superficial to pectoralis major (36). If there has been previous breast surgery, they are still preserved at the level of the second IC space, as this is out of the field of mastectomy and from previous radiotherapy (6). These cutaneous perforators can vary in size, however generally a "principle perforator" exists. This can vary in location, most commonly found in the 2nd IC space, but is always present in the 1st 4 IC spaces (7,37). The majority of perforators are found between 0.5 and 3 cm from the sternum. The largest perforators are found in the second IC space (38). The diameter of perforators from the ITA is on average 1.14 mm for the artery and 1.7 mm for the vein (2,8,38).

The main issue with using ITA perforators is the caliber of the vessels. It can be technically demanding as the vessels can be small (30). This is particularly true for the thin walled perforating veins (32). The quantity of blood flow to the flap may be of concern with small diameter recipients. There may also be vessel size mismatch between the flap pedicle and the recipient vessels (2). A concomitant vein may not always be present with the perforating artery (8). An adequate recipient perforator may only be present in 27% to 63% of patients (6,32,39,40). The lower perforators may also have been sacrificed at the time of mastectomy. Preservation of perforators may be achieved in collaboration with the breast surgeon at the time of oncological resection of the breast (2,8). Also, with increased familiarity and experience with identifying and performing perforator anastomosis, the rate of successfully identifying a suitable perforator can improve (40). There is also concern that sacrifice of the perforators may compromise the mastectomy skin flaps, which may lead to skin necrosis, however it has been shown that skin necrosis rates are comparable between the use of the main vessels and perforators (32). The use of perforators may also not be suitable if a perforator flap with a short pedicle is used, such as the superior gluteal artery flap, as the pedicle may not reach the second or third IC space when the flap is placed at the desired position (40).

Conclusions

In conclusion, the main internal thoracic vessels are still the most commonly used vessels for free flap anastomosis during autologous breast reconstruction as the internal thoracic perforators vary in caliber. We would recommend assessing for the presence of adequate size perforators at the time of reconstruction, as the use of these can negate morbidity associated with the resection of ribs or cartilage.

Attempts to localize perforators are certainly justified in order to preserve the IM vessels for future potential bypass grafting. If adequate vessels are present, these should be the microsurgeon's preferred option. In the absence of adequate perforating vessels, the main internal thoracic vessels should be used.

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Footnote

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