Case Report

Incorporation of the Vascularized Serratus Fascia Flap during Latissimus Dorsi Flap Harvest to Minimize Morbidity after Axillary Clearance

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Breast cancer-related axillary node dissection is the commonest cause of upper extremity lymphedema. The ability of lymphatics to regenerate spontaneously or reconnect with native lymphatics after free or pedicled flap reconstruction has been demonstrated on lymphoscintigraphy. Lymphatic anastomosis is not always needed in these flaps. In patients who underwent axillary clearance with risk factors for the development of lymphedema, we harvested a vascularized serratus anterior fascia flap during concurrent latissimus dorsi flap harvest (for breast or chest wall reconstruction). The vascularized fascia was wrapped around the axillary vessels to provide a conduit for lymphatic regeneration, protect the axillary vessels from radiotherapy, and reduce scarring and axillary cording. This procedure was performed on three patients with none of them experiencing upper limb lymphedema or cording.

Keywords

serratus fascia, latissimus dorsi, breast reconstruction

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<https://doi.org/10.53045/jprs.2021-0006>**Introduction**

Lymphedema is a chronic debilitating condition that involves lymph flow stasis and fluid accumulation leading to chronic inflammation, fibrosis, subcutaneous fat hypertrophy, and deposition. Breast cancer and its treatment are the most common causes of upper extremity lymphedema; 49% of patients reported the sensation of lymphedema after axillary node dissection¹. The main risk factors include axillary node dissection, obesity, diabetes, radiotherapy, and infection². In our institution, 660 axillary clearances were done for positive intraoperative sentinel lymph node frozen section in patients with breast cancer from 2005 to 2012³. The occurrence of lymphedema in our clinical practice is similar to other cancer centers, with significant arm swelling occurring in up to 13% of women who underwent mastectomy and axillary clearance¹.

The ability of local lymphatics to regenerate after free or pedicled flap reconstruction is a known entity. Chang et al⁴ performed 444 delayed breast reconstructions with free flaps and pedicled latissimus dorsi (LD) flaps with a low incidence of lymphedema and speculated that bringing in healthy, well-vascularized tissue promotes lymphatic regen-

eration. Lymphatic anastomosis is not needed in these flaps, and lymphatic regeneration following free flap reconstruction has been demonstrated via radionuclide lymphoscintigraphy⁵.

Patients with locally advanced breast cancer needing axillary clearance are usually at high risk for the development of lymphedema, as they may have a node-positive disease that requires axillary radiation. An LD musculocutaneous flap can be used for breast or chest wall reconstruction, and a vascularized serratus fascia flap can be used to cover the axillary vessels. This may offer additional protection after radiotherapy and help in lymphatic drainage. It also seals up the axillary dead space, reducing seroma. Although free LD and serratus muscle flaps have been used in extremity reconstruction⁶, we believe that utilizing the vascularized serratus fascia in this way is a new concept. We aim to demonstrate that incorporation of a vascularized serratus anterior fascia flap during concurrent LD flap harvest for breast or chest wall reconstruction is a quick, easy, and convenient operation, which may lower the risk of lymphedema and axillary cording.

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Figure 1. Thoracodorsal artery and its branch to serratus anterior.

Surgical Technique

The axillary artery exits under the pectoralis minor muscle and gives off the subscapular artery, which in turn gives off the circumflex scapular artery before continuing as the thoracodorsal artery (Figure 1). The thoracodorsal artery supplies the LD while the branch to the serratus anterior muscle arises approximately 5.5 cm from the origin of the thoracodorsal artery.

The LD musculocutaneous flap is harvested routinely, except in patients with locally advanced breast cancer and a large chest wall defect where a VY skin paddle design is utilized⁷. In the lateral position, the thoracodorsal vessels are easily identified (Figure 2). Usually, two to three serratus anterior branches of the thoracodorsal vessels are visualized running subfascially on the surface of the muscle. The flap is centered on these vessels and designed with an average dimension of 6-8 cm. It should overlie the lower four slips of serratus anterior muscle, rather than the upper four slips, to reduce the risk of scapular winging and to increase the pedicle length. The long thoracic nerve lies more anteriorly and is accompanied by the lateral thoracic artery. Because of its superficial location just beneath the serratus anterior fascia, care has to be taken to identify it and avoid its inadvertent inclusion during flap elevation. The vascularized serratus fascia is elevated and pedicled on its supplying vessels, including a small amount of underlying serratus anterior muscle to avoid pedicle injury (Figure 3). It is then wrapped around the axillary vessels and anchored to the surrounding tissues with absorbable sutures. This procedure was performed on three patients with locally advanced breast cancer requiring mastectomy and axillary clearance.

Case Report

Patient A was a 55-year-old female with metastatic invasive ductal carcinoma (T4N3M1) of the left breast involving

Figure 2. The serratus anterior fascia (measuring about 6x8 cm) has been incised but not yet elevated.

Figure 3. Serratus fascia flap elevated before inset into the axilla.

contralateral axillary lymph nodes. She completed Paclitaxel, Herceptin, and Pertuzumab with partial response. She underwent left mastectomy, bilateral level II axillary clearance (left 9/15 positive, right 2/22 positive), and left pedicled VY-LD flap with vascularized serratus fascia for a chest wall defect measuring 13 cm × 15 cm. Patient B was a 48-year-old female with multifocal invasive ductal carcinoma (T2N1M0) of the right breast. She underwent a right skin-sparing mastectomy, level II axillary clearance (2/12 positive) and extended LD flap with vascularized serratus fascia for breast and axillary reconstruction, respectively. Patient C was a 44-year-old female with metastatic invasive lobular and small cell carcinoma (T4N3M1) of the left breast and low volume bone metastasis. She had disease progression despite Letrozole, Ribociclib, and Denosumab. She underwent left toilet

Figure 4. Locally invasive breast tumor requiring chest wall reconstruction post excision.

Figure 5. Post chest wall reconstruction with VY-latissimus dorsi and vascularized serratus fascia flap (Patient A). Despite radiotherapy, there is minimal scar tethering in the axilla, and she has no upper limb lymphedema.

mastectomy, level II axillary clearance (5/11 positive) and left pedicled VY-LD flap with vascularized serratus fascia for a chest wall defect measuring 15 cm × 17 cm (**Figure 4**). All surgeries were performed by the same surgeon with an average duration of 4 h, and this was not significantly longer than a routine LD flap reconstruction. All three patients did not have any immediate postoperative complications such as seroma, hematoma, or wound infection. They underwent postoperative fractionated radiotherapy of 50 Gy to the chest wall and axilla for locoregional control without delay. Immediate postoperatively, the abduction of the ipsilateral arm was limited to 45°. After 1 week postsurgery when the flap was stable, physical therapy was initiated to prevent arm contracture. At 1 month postsurgery, all three patients had full range of motion of the ipsilateral shoulder without any contracture or scapula winging. On 4 year follow-up, no delayed complications such as lymphedema or axillary cording were noted either symptomatically or on objective arm circumference measurement (**Figure 5**).

Discussion

Serratus anterior fascia has been combined with LD mus-

cle as a free flap for extremity soft tissue defects to reconstruct large wounds, provide gliding surfaces for tendons, act as a vascularized bed for skin grafting, and protect the vascular pedicle and anastomosis^{6,8,9}. Harvesting the serratus anterior fascia alone avoids the morbidity and bulk associated with harvesting the entire serratus anterior muscle. When used as a pedicled flap, the benefits include coverage of exposed axillary vessels, prevention of axillary web syndrome, reduction of seroma, and potential lymphedema prevention.

Meta-analysis of surgical techniques to reduce lymphedema include fascia-preserving dissection and microsurgery¹⁰. Lymphatics have been shown in studies to travel in the fascial planes. This corresponds to the visual confirmation of blue lymphatic vessels on the fascia after blue dye injection for sentinel lymph node localization¹¹. Fascia-preserving cancer surgery has been shown to reduce lymphedema in axillary and inguinal lymphadenectomy for melanoma and penile carcinoma without increased risk of recurrence^{10,12}. Lymphadenectomy with preservation of the muscle fascia results in less operative field fibrosis and decreased scarring of the remaining lymphatic vessels, and this results in less lymphatic vessels occlusion and encourages

Figure 6. Lymphedema prevention and treatment options.

spontaneous recanalization¹¹⁾.

Anatomical studies have demonstrated that lymph nodes are located around the distal part of the thoracodorsal vessels around the serratus vascular pedicle. The LD flap and its adjacent lateral thoracic lymph nodes¹³⁾ have been reported as a vascularized lymph node transfer (VLNT) modality for patients with established lymphedema. After the removal of scar tissue, bringing a healthy vascularized flap into the dead space bridges the area of lymphatic obstruction through the scar tissue. These lymph nodes and lymphatics serve as a source of vascular endothelial growth factor¹⁴⁾ that enhances lymphangiogenesis and stimulates lymphatic reconnections between the proximal and distal lymphatic system. Although we do not specifically isolate any lymph nodes in our technique, the presence of healthy vascularized tissue and lymphatics should produce the same effect as free lymphatic vessel transplantation with minimal risk of inducing iatrogenic lymphedema¹⁵⁾.

Lymphaticovenular anastomosis (LVA) and VLNT are established treatments for fluid-predominant lymphedema as evidenced by pitting on physical examination. However, LVA is only effective for early disease, and VLNT can cause donor site lymphedema and contour deformity. VLNT is only indicated in delayed breast reconstruction patients with established lymphedema because of the risk of inducing iatrogenic lymphedema by dissecting in a previously operated axilla¹⁴⁾. Koshima et al¹⁶⁾ proposed the vascularized lymph vessel transfer (VLVT) on the basis of the first dorsal metatarsal vessels and reported favorable outcomes. VLVT mediates its therapeutic efficacy through lymphangiogenesis, spontaneous formation of lymphatico-lymphatic anastomosis¹⁷⁾, and the functioning smooth muscles lining the healthy vascularized lymphatic vessels contracting and transporting lymph fluid into the venous system. The severity of the lymphatic injury can be seen on indocyanine green (ICG) lymphography with a “linear” pattern suggestive of preserved functioning lymph vessels and a “diffuse” pattern suggestive of severe lymphatic injury. LVA can be offered if there are

preserved functioning lymph vessels, whereas VLNT/VLVT can be offered for the absence of functioning lymph vessels (Figure 6). Chen et al¹⁵⁾ harvested thin superficial circumflex iliac perforator flaps, which only included the superficial lymph vessels while preserving the lymph nodes in six patients with extremity lymphedema. Preoperative and postoperative ICG lymphography showed improvement and correlated with subjective relief in patient symptoms and objective reduction in limb circumference. “Linear” patterns were seen in the postoperative ICG lymphography, indicating the postoperative formation of spontaneous lymphatico-lymphatic connections. Other studies¹⁷⁾ have demonstrated lymph flow restoration using ICG studies after flap transfers (even without fascia where the bulk of lymphatic vessels reside¹¹⁾) without the need for supermicrosurgical lymphatic anastomosis.

In immediate breast reconstruction, another proven method is the LYMPHA¹⁸⁾ (Lymphatic Microsurgical Preventive Healing Approach), which involves the prophylactic bypass of lymphatic vessels transected at the time of lymph node dissection, with anastomosis to nearby venous outflow tracts. Nevertheless, it is technically challenging and requires supermicrosurgery. Additionally, there is often a paucity of nearby recipient veins after axillary clearance. Our report highlights our observation that concurrent serratus fascia with LD flap can help reduce the risk of lymphedema in immediate reconstruction. Harvesting the serratus fascia is a safe and convenient procedure that does not lengthen the operation significantly. It is a prophylactic maneuver that can lower the risk of lymphedema and should be considered as part of immediate breast reconstruction. Although a larger case series is required, we have discussed a simple and effective alternative method of lymphedema prophylaxis in patients at high risk for its development. We are in the process of recruiting more patients with established lymphedema for breast reconstruction with LD and serratus fascia flap and doing ICG studies preoperatively and postoperatively to demonstrate lymphatic recanalization.

Conclusion

We described a pedicled chimeric LD muscle and vascularized serratus fascia flap for simultaneous breast/chest wall and axillary reconstruction. We believe that the fascia has a potential role in lymphatic drainage considering our three patients who had an uneventful postoperative recovery without lymphedema.

Author Contributions: All authors contributed to the study conception and design. Procedures performed, patient follow up, material preparation, data collection, analysis and manuscript writing were performed by Dr Ang Chuan Han and Dr Wong Manzhi. All authors read and approved the final manuscript.

Conflicts of Interest: There are no conflicts of interest.

Ethics Approval and Consent to Participate: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of retrospective study, decision for publication did not affect management of the patient.

Consent for Publication: Informed consent was obtained from the patients for publication of this article and accompanying images.

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