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The Chimeric Versatility of the Subscapular System Revisited: Backup Options, Coverage for Bone Transplants and Vascularized Lymph Nodes

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Summary: Traumatic soft tissue and bone defects are demanding challenges for the reconstructive microsurgeons. Common and safe workhorses for these reconstructions are free microvascular flaps based on the subscapular system. In this article, we want to demonstrate the versatility of the serratus anterior muscle combined with other components of the subscapular system for reconstruction of complex lower extremity defects. Three patients with traumatic soft tissue and bone defects of the lower extremity were planned for reconstruction. The defects varied in size and could be covered by 1 or 2 slips of the serratus muscle or split muscle combined with latissimus dorsi muscle flap. In 1 case, the thoracodorsal lymph node package was included for addressing severe posttraumatic lymphedema after burn injury. In another case, the serratus slips served as coverage for a free scapula bone transplant. The chimeric flaps healed without complications; no further operations were needed for reconstruction. By the use of only 1 or 2 slips of the serratus muscle, we could prevent functional impairments for the patients and reduced further scarring compared with classic latissimus dorsi—(para-) scapular combinations. *(Plast Reconstr Surg Glob Open 2018;6:e1765; doi: 10.1097/GOX.0000000000001765; Published online 15 May 2018.)*

Microvascular free flaps based on the subscapular artery system are safe workhorses for reconstruction of the lower extremity.[1–3] Cadaveric dissections revealed a variety of branching patterns originating from the subscapular artery and demonstrated the anatomical reliability of this system.[4,5] There are multiple tissue components that can be harvested as composite, chimeric flaps or added via in-flap anastomoses in case of anatomical variations with separated origin. The largest flap for coverage of extended and complex 3-dimensional defects to the lower extremity is the combined (scapular-) parascapular and latissimus dorsi (LD) flap.[6,7] Traditionally included components are skin, fascia, muscle, and bone grafts from the scapula, for which the recent literature provides sufficient evidence on the components per se and some variations in combining flaps.[8,9]

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We will readdress the chimeric versatility of the subscapular system including thoracodorsal lymph nodes and want to guide the readership to advanced backup options of including serratus muscle components (slips) to an LD flap, bone transplant or lymph node flap with reduced morbidity compared with the (para-)scapular flap in case of small additional defects distant to the major defect.

PATIENTS AND METHODS

Three patients suffering from complex defects of the lower extremity were selected from our database, which has been scheduled for microsurgical reconstruction. Two cases consisted of a major, "main" defect to the lateral or medial distal lower extremity, accompanied by a second, significantly smaller defect at the corresponding medial or lateral distal portion of the lower extremity. The major defects required coverage with an LD flap, whereas the smaller corresponding defects could not be addressed by the same flap due to pedicle position, recipient vessel selection, and proximal narrowing shape of the LD muscle. While a

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split-thickness skin graft as an adjunctive transplant would not have enabled stable coverage, an additional (para-) scapular component would have meant additional donor-site morbidity, scarring and somehow overtreatment. In this technical modification, we addressed the chimeric versatility of additional slips of the serratus muscle supplied by the serratus branch of the thoracodorsal artery and vein to limit the donor-site morbidity.

In 1 case where posttraumatic lymphedema was already manifested 3 weeks posttrauma, we included a vascularized thoracodorsal lymph node package to therapeutically approach lymphedema next to the above-mentioned concept that provides a new, prophylactic-therapeutic approach in the early onset of posttraumatic lymphedema. One additional case summarizes the backup option of the serratus muscle to cover small defects above a free scapular bone transplant.

RESULTS

Case 1

An 84-year-old female suffered from an open fracture of her right ankle with severe soft-tissue trauma. After initial external fixation, she developed skin and soft-tissue necrosis over the medial and lateral malleolus, resulting in a major defect with exposed bone over the lateral ankle (size 15×12 cm) and a minor defect over the medial ankle (5×3.5 cm). Due to the increased thickness of her fasciocutaneous donor sites and an insufficient anterior tibial artery, the LD was chosen as a muscle flap to provide an optimal, nonbulky reconstructive result and provide sufficient pedicle and transplant length for covering the lateral defect with medial recipient vessels. One slip of the serratus muscle covered the minor defect and provided an optimal rotation arc, limited additional donor-site morbidity and a high degree of versatility (Fig. 1; **See figure, Supplemental Digital Content 1**, which displays result 4 weeks postoperative lateral view, showing the LD flap, ***http://links.lww.com/PRSGO/A767***; **See figure, Supplemental Digital Content 2**, which displays medial minor defect reconstructed by the serratus flap (a) after 4 weeks, ***http://links.lww.com/PRSGO/A768***).

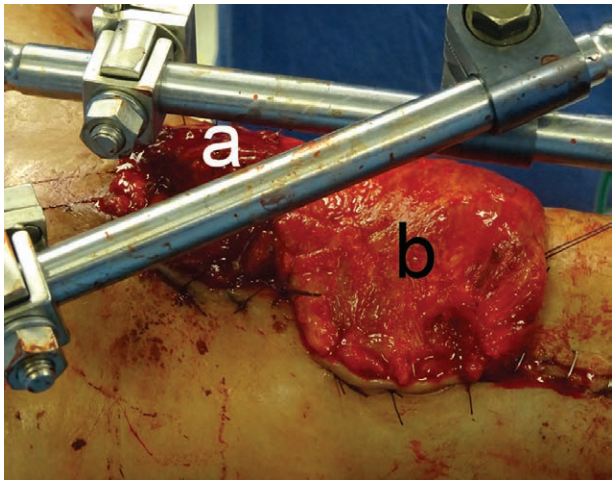

Fig. 1. Case 1. Reconstruction of a bifocal soft-tissue defect over the ankle with a combined LD- (b)/ serratus-(a) flap.

Case 2

A 36-year-old firefighter suffered from a severe burn injury from an electric arc with burns of 30% total body surface area. The exit point at the dorsum of the right foot showed a full thickness burn and ended up in a large defect at the right distal lower leg and foot (size 17×15 cm) with exposed tendons and bone at the lateral part and dorsum of the foot. There was a second smaller defect over the medial malleolus (size, 6×5 cm) with exposed bone. Coverage of the bifocal defect was scheduled using a combined LD and split serratus anterior flap to approach both separated defects while maintaining the original skin at the medial foot arch. We included a thoracodorsal lymph node flap to the same pedicle, as the patient showed severe posttraumatic edema of the injured leg. In this particular case, we designed a perforator-based monitoring island to the LD, which enables resection after finishing the critical monitoring time with bedside ligation.[10] The chimeric flap (Fig. 2) was anastomosed to the posterior tibial artery. Healing was successful without complications, and posttraumatic edema was clearly reduced 8 weeks postoperative (Fig. 3; **See figure, Supplemental Digital Content 3**, which displays reconstructive result 8 weeks postoperative—medial view showing the serratus flap (*) ***http://links.lww.com/PRSGO/A769***; **See figure, Supplemental Digital Content 4**, which displays reconstructive result 8 weeks postoperative—lateral view showing the LD flap (#) ***http://links.lww.com/PRSGO/A770***).

Case 3

A 55-year-old male suffered from an open fracture of the left first metatarsal bone. Initial reconstruction was performed with internal fixation and soft-tissue resection. The patient was referred to our microsurgical unit for covering the soft-tissue defect at the dorsum of the foot

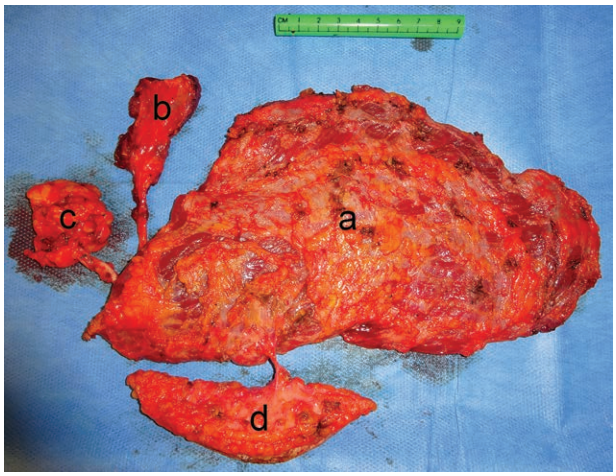

Fig. 2. Case 2. Chimeric LD—serratus anterior—thoracodorsal lymph node flap. (a) LD muscle flap. (b) Serratus anterior muscle flap. (c) Thoracodorsal lymph node flap. (d) Perforator-based monitoring island.

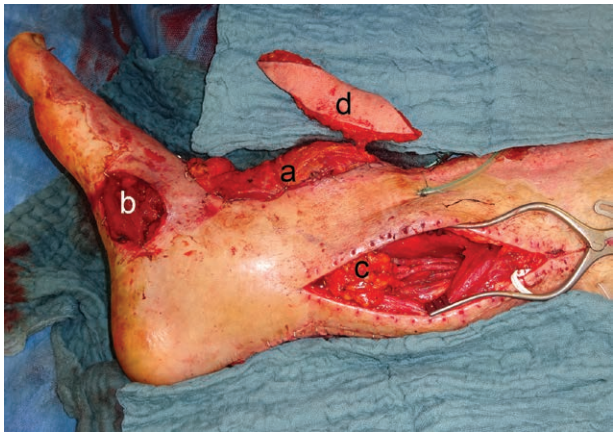

Fig. 3. Case 2. Reconstruction with chimeric flap (Fig. 2). (a) LD muscle. (b) Serratus anterior muscle. (c) Thoracodorsal lymph node flap. (d) Perforator-based monitoring island.

(size, 15×8 cm). Debridement revealed multiple necrotic fragments of the first metatarsal bone. The resection resulted in an osseous defect of 4 cm with intact base and head segments. Histologic analysis excluded osteomyelitis of the remaining bone. Reconstruction was performed using a chimeric scapula bone flap and 2 serratus anterior slips based on the thoracodorsal pedicle and anastomosed to the dorsal pedal artery (Fig. 4). Soft tissue and osseous healing were successful without complications (**See figure, Supplemental Digital Content 5**, which displays chimeric flap containing 2 serratus muscle slips (a) and the scapula bone transplant (b) ***http://links.lww.com/PRSGO/A771***; **See figure, Supplemental Digital Content 6**, which displays x-ray of the scapula bone transplant for reconstruction of the first metatarsal bone 4 months postoperative, ***http://links.lww.com/PRSGO/A772***).

DISCUSSION

Extended and multifocal soft-tissue defects with exposed tendons, bones, or implants require a decisive reconstructive plan. Single flaps are often not suitable for multifocal defects, while split (double) perforator flaps may provide an option but with limited size. In contrast, large combined flaps may increase donor-site morbidity and scarring. Next to the classical chimeric flaps raised from the subscapular artery system,[7,11,12] we revisited the versatility by adding serratus muscle components (slips or split muscle), which has successfully been shown to be a backup workhorse for smaller additional defects providing a good arch of rotation from its branch. Its vascular anatomy is very constant, thus in-flap anastomoses are rarely necessary. In the presented cases, additional separately vascularized serratus anterior split muscle or slips served as a versatile flap for minor additional defects, such as coverage of a bone transplant and for the first time described as chimeric lymphonodal-latissimus-serratus muscle flap. This provides an additional versatility if the optimal recipient vessels due to optimal location and flap positioning are not addressable. A major advantage compared with other donor sites is the greater versatility in flap composition and positioning due to pedicle length and course.[11]

A perforator-based monitoring island of the LD flap is another opportunity to limit the donor site and enable a certain versatility as a backup option for additional minor coverage. To limit donor-site morbidity, it is important to only raise 1 to a maximum of 3 slips of the serratus muscle.

Integrating vascularized lymph node tissue is a meaningful therapeutic approach in complex lower extremity injury with early onset of lymphedema. The addition of the thoracodorsal lymph node flap to a combined flap for soft-tissue coverage and lymphedema treatment has been successfully performed by us for the first time and allows a promising approach in microsurgical extremity reconstruction

Fig. 4. Case 3. Reconstruction of the dorsum of the foot an the first metatarsal bone with a combined scapula bone and serratus muscle flap.

CONCLUSIONS

The split serratus muscle flap (or slip) based on the serratus branch is a versatile tool in raising combined chimeric flaps from the subscapular artery system. Compared with the perforator-based monitoring island of the LD, it provides a greater arc of rotation and positioning and serves as a backup option and alternative to the classical combinations. As shown for the first time, it allows a chimeric design including thoracodorsal lymph node tissue for soft-tissue coverage and posttraumatic lymphedema treatment in case of early onset or with prophylactic means.

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