

Pedicle muscle sparing myocutaneous flaps: versatility and various applications

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Abstract: Muscle flaps have been classified by Mathes and Nahai into five types according to the principal means and pattern of their blood supply. Harvesting a myocutaneous flap almost leads to Loss of its motor function in all the cases, because all or Part of the muscle is included. Perforator flaps demonstrate the latest descendent in the line of progression that started with the random pattern flaps. Kroll and Rosenfield stated that perforator flaps integrate the reliable blood supply of musculocutaneous flaps with lessened donor site morbidity of a skin flap. The reduced donor site morbidity often leads to faster recovery and reduced hospital stay. Safe perforator flap dissection requires Nominated expertise and a steeper learning curve, as this flap is dependent on specifically harvested perforators from either the main branch or pedicle. If adequately-sized perforators are not available, the perforator flap can be converted into a muscle-sparing flap as in case of thoracodorsal artery perforator flap or lateral circumflex femoral artery perforator flap as salvage procedure. If some portion of that muscle chosen as the flap and the rest is left intact at its insertion and origin with retention of its innervation, some function will be preserved after the rest of the muscle has been transferred. Twelve patients with various soft tissue defects of the trunk and extremities were reconstructed with those muscle sparing latissimus and vastus lateralis flaps in this study and their outcome was evaluated.

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1. Introduction:

The identification of muscle flaps as a source of vascularized tissue offered greater flexibility and more options anatomically for wound coverage and defect reconstruction⁽¹⁾The growing interest in muscle circulation resulted in recognition of the contribution of muscle flap circulation to the overlying skin territory, which raised our ability to close complex composite defects with improved function and cosmesis. Each superficial muscle supply vascular connections through musculocutaneous perforators to the overlying skin. Identification of vascular connections to the skin made it possible to include a segment of skin with the muscle flap⁽²⁾ the chimeric flap primarily conceived as a combination of local flaps from the same anterolateral thigh angiosome⁽³⁾.

Huang et al.⁽⁴⁾ had further subdivided chimeric flaps into three subtypes based on their specific blood supply of which two are the most common the branch-based like the subscapular vascular system and perforator-based as in lateral circumflex femoral system; where Tobin et al. made the observation that the latissimus dorsi muscle could be divided into two flaps based on either vertical or horizontal branches of the thoracodorsal artery⁽⁵⁾.

This lead to development of concept of function preservation when using a muscle flap; This can be achieved by splitting the muscle into distinct segments; each can be served by a different dominant pedicle as in case of latissimus dorsi muscle. Likewise

individual secondary segmental pedicles can serve as an alternative to preserve part of the muscle as in case of vastus lateralis muscle. Muscle sparing free TRAM flap was utilized for breast reconstruction with high patient satisfaction and success rate and reduced abdominal wall morbidity⁽⁶⁾.

The aim of this study is to evaluate the versatility of two pedicle muscle sparing musculocutaneous flaps that is different in the anatomy of the nourishing vessels and to estimate their outcome in the reconstruction of different trunk and extremity defects.

2. Patients and methods

The current study included twelve patients with various soft tissue defects of the trunk and extremities resulting from different etiologies reconstructed with pedicle muscle sparing latissimus dorsi and vastus lateralis myocutaneous flaps; they were nine males and three female patients of various age groups from 22 to 60 with a mean age of 29 years. Patients were randomly chosen from those presenting to the plastic surgery Department of Kasr El Aini Hospitals in the period from July 2011 to December 2013. A summary of clinical cases is shown in **table (1)**.all the operations were performed by the authors. Motor power Evaluation of latissimus dorsi and quadriceps femoris muscles was done using the British medical research council grading system of the motor power⁽⁷⁾which was done before surgery and twelve months postoperatively **table (2)**.

Vertical branch muscle sparing latissimus dorsi flap: (six cases)

- Preoperative marking of the anterior border of the latissimus dorsi muscle.

- The skin island was designed vertically where the lateral edge of the skin paddle is marked 1-2 cm lateral to the anterior border of the latissimus dorsi muscle to ensure maximal perfusion from the perforators of the descending branch of the thoracodorsal artery.

- With the patient positioned in the lateral decubitus position, skin incision is done along the anterolateral aspect of the designed island in order to identify the fascial plane between the anterior border of the latissimus and serratus anterior muscles.

- Development of a cleavage plane between latissimus and serratus anterior muscles till visualizing the serratus anterior artery siphon that points to the thoracodorsal artery. **Fig. (1).**

- Serratus anterior artery is either ligated or left intact according to the required arc of rotation.

- Visualization of the intramuscular bifurcation of the thoracodorsal artery using transillumination in order to include the descending branch with the lateral portion of the muscle.

- Skin incision along the posterior aspect of the probable island. The dissection proceeds in subfascial plane of the latissimus dorsi muscle using blunt ended scissors and bipolar electrocautry till reaching 1-2 cm medial to vertical branch of latissimus dorsi.

- The latissimus dorsi muscle is then split vertically along its natural muscle fibers. **Fig. (2).**

- Dissection is stopped before it reaches the bifurcation point of the thoracodorsal artery, to preserve the transverse branch and corresponding thoracodorsal nerve which is left intact to guard against denervation atrophy of the remaining portion of the muscle.

- Wide Subcutaneous tunneling for the flap with Tension-free flap inseting.

- Suction drains are applied both in the recipient and donor sites.

The donor site is closed primarily.

Muscle sparing vastus lateralis myocutaneous flap: (six cases)

- Pre-operative detection of the perforators around a line drawn between the Anterior superior iliac spine and lateral aspect of the patella by the hand held Doppler, the pedicle was then marked and the proposed flap was designed in relation to the detected perforators. **Fig. (3).**

- The muscle sparing vastus lateralis flap is harvested in a subfascial plane, this approach allowed for easier identification of perforators and for better exposure of the intermuscular septum and descending

branch of the LCFA (lateral circumflex femoral artery).

- The medial incision was made down to and through the deep fascia, exposing the rectus femoris muscle.



Fig. (1) Intraoperative view showing the cleavage plane between latissimus dorsi and serratus anterior muscles with visible serratus anterior artery siphon.

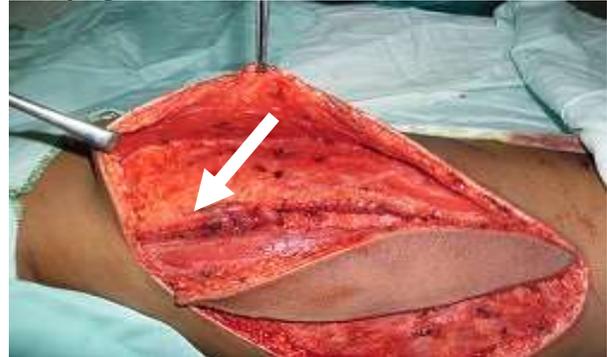


Fig. (2) Intraoperative view showing the vertical splitting of latissimus dorsi muscle along its natural fibers with an arrow pointing towards the new lateral border of the latissimus muscle.

- The dissection proceeds in a lateral direction until the septum separating the rectus femoris from the vastus lateralis was visualized.

- The septum was exposed by retracting the rectus femoris medially. At the medial aspect, the descending branch of the LCFA can be seen running over the vastus lateralis muscle. The perforators arising from the descending branch were observed piercing the vastus lateralis muscle to reach the skin of the anterolateral aspect of the thigh.

- Cuff of muscle fibers from superficial portion of the vastus lateralis muscle around the musculocutaneous perforators was included.

- Muscle dissection proceeds until the perforator take-off from the descending branch of the LCFA or further till an adequate pedicle length is achieved. The main nerve and nerve branches supplying the vastus lateralis and the rectus femoris

are carefully dissected away from the vessels and preserved.

- The descending branch was transected distant to the point of perforator emergence.

- Dissection of the descending branch was completed in a proximal direction in the intramuscular septum between rectus femoris muscle and vastus lateralis muscle up to the lateral circumflex femoris artery.



Fig. (3) Pre-operative detection of perforators together with marking of the flap borders.

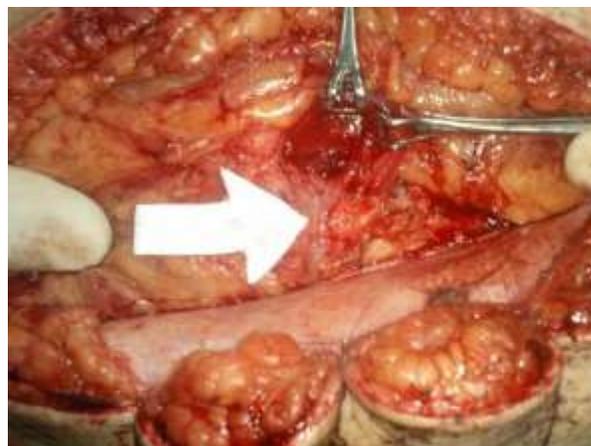


Fig. (4) Intra-operative view showing a cuff of fibers from vastus lateralis muscle around the musculocutaneous perforator

- If more length was required, transection of transverse branch of LCFA can be done.

- The donor site was closed primarily after insertion of suction drains both in donor and recipient sites.

Table (1) clinical characteristics of the patient

Case number	Age/sex	Etiology of the defect	Defect size/cm	Flap type	Donor site closure	complications
1	26,M	Release of postburn axillary contracture	21x11cm	Latissmus dorsi muscle sparing myocuttaneous flap	primary	Wound dehiscence (RECIPIENT)
2	24,F	Reconstruction of post burn contracted breast	23x11cm	Latissmus dorsi muscle sparing myocuttaneous flap	primary	Hypertrophic scar
3	25,F	Reconstruction of post burn contracted breast	24x9cm	Latissmus dorsi muscle sparing myocuttaneous flap	primary	Nil
4	23,F	Reconstruction of post burn contracted breast	24x10cm	Latissmus dorsi muscle sparing myocuttaneous flap	primary	Nil
5	27,M	Post electrical burn raw area of the axilla and arm	24x10 cm	Latissmus dorsi muscle sparing myocuttaneous flap	primary	Nil
6	26,M	Release of postburn axillary contracture	23x10cm	Latissmus dorsi muscle sparing myocuttaneous flap	primary	Nil
7	33,M	Traumatic trochanteric defect	15x7cm	Vastus lateralis muscle sparing myocutaneous flap	primary	Nil
8	46,M	Trochanteric bed sore	14x6cm	Vastus lateralis muscle sparing myocutaneous flap	primary	Nil
9	39,M	Hidradenitis suppurativa groin	16x7cm	Vastus lateralis muscle sparing myocutaneous flap	primary	Wound Dehiscence (RECIPIENT)
10	60,M	Trochanteric bed sore	14x7cm	Vastus lateralis muscle sparing myocutaneous flap	primary	NO
11	31,M	Traumatic groin defect with exposed vessels and nerves	13x7cm	Vastus lateralis muscle sparing myocutaneous flap	primary	NO
12	22,M	Hidradenitis suppurativa groin	16x8cm	Vastus lateralis muscle sparing myocutaneous flap	primary	Wound infection

Report of the cases:

Case (9): 39 years old male patient was presented with severe hidradenitis suppurativa affecting his left groin. (**Fig.5**). He was a regular smoker. He took daily oral antibiotics in order to reduce flare ups, which nevertheless occurred regularly. The pain associated with these made it difficult for him to walk, and he was often embarrassed by the foul-

smelling discharge. A decision was made to perform a radical excision and reconstruction using pedicled muscle sparing vastus lateralis myocutaneous flap (**Fig.6**). The surgery was uncomplicated and the wounds have healed well. The patient has no ongoing symptoms and has returned to his full previous activity.



(Fig.5). Preoperative photo showing left groin severe hidradenitis suppurativa.



(Fig.6). 4 months postoperatively showing good cosmetic results and well healed donor site.

Case (5):

27 years old male patient who sustained high voltage electrical injury to both upper extremities,

early generous fasciotomies were performed, repeated sessions of debridement were followed ending after two weeks with below elbow amputation

of the left upper extremity and raw area of the right upper extremity affecting the axilla and proximal arm with exposed neurovascular bundle (**Fig.7**). Necessitating an urgent reconstruction to save his precious limb .vertical branch muscle sparing latissimus dorsi flap was harvested for urgent coverage of the right axilla and arm. (**Fig.8**). the surgery was uncomplicated and the wounds have healed well.



(Fig.7). Preoperative photo showing post electrical burn raw area of the right axilla and proximal arm with exposed neurovascular structures.



(Fig.8). Twelve months Postoperative photo showing well healed recipient and donor sites.

Case (2): 24 years old female patient who sustained a flame burn to chest and abdomen 20 year ago, her burns were allowed to heal spontaneously with resulting hypertrophic scarring of the abdomen and obliteration of the right inframammary fold (**Fig.9**).vertical branch muscle sparing latissimus dorsi flap was utilized for release of the contracted breast together with reconstruction of the inferior pole of her right breast (**Fig.10**). The patient had smooth postoperative recovery with no recorded complications in both donor and recipient sites.



(Fig.9). Preoperative photo showing contracted right breast with obliteration of the right inframammary fold and inferior pole of the breast.



(Fig.10). Twelve months Postoperative photo showing full release of the contracted right breast with reconstruction of the inferior pole of the breast by Muscle sparing latissimus dorsi flap.

3. Results: (see Table 1)

50% of the cases were reconstructed using muscle sparing latissimus dorsi flap, remaining 50% were reconstructed using muscle sparing vastus lateralis flap. Flap size ranged from (13-15cm x7cm) for muscle sparing vastus lateralis and from (21-24cm x11cm) for muscle sparing latissimus dorsi; maximum cutaneous portion of the flap width was 11 cm. The muscle portion harvested with the flap measured on average 3-4 cm in width. All donor sites

of were closed primarily. Flap harvesting and transfers were uneventful. Complications included two cases of minor recipient site Wound dehiscence, which healed on its own by secondary intention. There was one case of wound infection where the reconstruction was for chronic, severe groin hidradenitis suppurativa. Debridement was performed and the wound Healed by secondary intention. There were no incidences of seroma. At 12 months follow-up of all patients reported full range of motion (Grade 5 motor power) with no functional deficits in their activities of daily living.

Table (2).British medical research council grading system of motor power.

GRADE	MOTOR POWER
Grade(0)	No movement.
Grade(1)	Trace or flicker movement.
Grade(2)	Eliminated movement with gravity.
Grade(3)	Eliminated movement against resistance but not against gravity.
Grade(4)	Active movement against gravity with resistance.
Grade(5)	Normal power.

4. Discussion:

The situated interest of the flap surgery revolution is along two lines. The first is to reduce donor site morbidity, to develop thin flaps easy to tailor. The second aim is to use increased anatomical knowledge to allow the design of flaps that contain only the tissues necessary for a particular reconstruction. The development of perforator flaps has to some extent addressed both lines of development by providing a wide spectrum of donor sites, and permitting the harvest of skin, adipose tissue, fascia, and muscle as separate components of the flap. (8)

Different methods have been applied for the reconstruction of the upper extremity and trunk, including free flaps, e.g. antero-lateral thigh flap (9), (10); as well as pedicled flaps, such as the circumflex scapular artery perforator flap (11). The latissimus dorsi flap is favoured for its reliability, which was augmented with its various modifications. Passing from harvesting full latissimus dorsi flap to the development of thoracodorsal artery perforator (TAP) flap. In contrast to the TAP flap, this muscle-sparing latissimus dorsi flap design incorporates a small segment of muscle which attaches to the lateral portion of the flap in order to ensure adequate blood supply. The added bulk from the muscle is therefore minimal and however, the advantages of having this

part of the muscle around the pedicle outweigh this small disadvantage. The vascular pedicle is given a degree of protection by the muscle (decreases tension on the perforators), and the surgeon does not need to expand more operating time performing a perforator dissection. This flap is extremely versatile, as there is freedom of rotation by the skin paddle to chest (even reaching to the midline), upper extremity. it was found that there is no detectable difference in the range of motion between operated and non-operated sides, and lack of post-operative seroma where there is Limited undermining over the latissimus dorsi muscle and in the axilla, which is an important privilege when compared with full width latissimus dorsi flap harvest. Muscle sparing latissimus dorsi flap also can be used as a salvage procedure for TAP flap; when the perforators are less than 0.5mm there is a high risk for shearing of the skin from the muscle and to decrease tension on the perforators and this had been applied in one of the cases of this study.

Likewise the vastus lateralis muscle is a versatile donor for pedicled and free flaps. Its harvest is fast and unsophisticated and permits a two-team approach in most of the cases; its pedicle can be very long and has a large caliber, which makes it a fascinating option for reconstruction of variable defects (12). However, in spite of the reports of low donor site morbidity (13), (14) quadriceps function is impaired after vastus lateralis harvest, even when the vastus lateralis is damaged with inaccurate intramuscular dissection during anterolateral thigh flap harvest (15); Kimata. And Hanasono. Suggested a positive correlation between weakness of the limb and surgical injury to the vastus lateralis (16), (17)

So as regard muscle sparing vastus lateralis inclusion of a small cuff of muscle around the musculocutaneous perforators offered easier dissection and greater reliability of the flap. Where the vastus lateralis consists anatomically of three muscular partitions and two aponeuroses (18) its superficial distal portion can be harvested easily and safely with resultant longer vascular pedicle and wider arc of rotation and minimized functional sequelae which was evident in this clinical study.

Conclusion:

When comparing the pedicled muscle sparing musculocutaneous flaps to the traditional previous total muscle harvest it had been concluded that muscle sparing myocutaneous flaps are reliable with reduced bulk ,offered reduced donor site morbidity with better function preservation which is mandatory in bilateral reconstruction and it is also suitable when resurfacing is needed rather than filling contour defect; when compared to their analogous perforator pedicled flaps it had been found that

muscle sparing design showed safer approach with less operative time and faster patient recovery.

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