



Versatile Application of Pedicled Anterolateral Thigh Flaps in Reconstruction

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Background: Reconstruction of extensive defects of the lower abdomen, trochanter, groin and knee without using complex microsurgery is a reconstructive challenge. Pedicled anterolateral thigh (ALT) flaps offer many advantages over other regional flaps for this purpose, such as the large skin area and soft-tissue availability, a remarkable pedicle length, and possessing multiple components and reliability. We present our experience of using pedicled ALT flaps for repairing various defects. **Methods:** From September 2006 to October 2012, 32 pedicled ALT flaps were used in 31 patients for defects of the lower abdomen (3 patients), trochanter (26 patients), groin (1 patient) and knee (1 patient). Eighteen of the patients were male (58%) and the age ranged from 22 to 103 years. The flap size ranged from 8×5 cm (40 cm²) to 9×20 cm (180 cm²). **Results:** Satisfactory coverage was achieved in all patients. **Conclusions:** Our experience has shown the wide arc of rotation, large skin replacement potential, multiple components and reliability of pedicled ALT flaps.

Key words: pedicled flap, anterolateral thigh flap, groin defect, lower abdominal defect, knee defect

INTRODUCTION

Introduction of the anterolateral thigh (ALT) flap by Song *et al.* in 1984¹ led to a revolution in reconstructive microsurgery, with the subsequent introduction of so-called “perforator flaps”.² In recent years, the free ALT flap has become a workhorse for reconstructing skin and soft-tissue defects. Following extensive experience with free ALT flaps, Wei *et al.*³ characterized it as an ideal soft-tissue flap, because of its remarkably long pedicle, its reliable vascularity, its tremendous versatility and the minor level of donor site morbidity. Koshima *et al.*⁴ first reported its use as a pedicled flap for the reconstruction of an extensive perineal defect.

We used this flap in the reconstruction of trochanteric defects caused either by pressure sores or by osteomyelitis of the trochanter with implant extrusion.⁵ We refined the procedure as a modified pedicled ALT myocutaneous flap based on the descending branch of the lateral

circumflex femoral artery to cover trochanteric pressure sores.⁶ Three cases of abdominal wall and 1 groin defect were also covered using pedicled ALT flaps⁷ and 1 case of a prosthesis-exposed knee with infection was successfully reconstructed using a reversed ALT flap.⁸

PATIENTS AND METHODS

This is a review of 31 patients treated with pedicled ALT flaps from September 2006 to October 2012 for patients with lower abdomen, groin, trochanter and knee defects at the Tri-Service General Hospital, Taipei, Taiwan.

Surgical approach

During surgery, all flaps were raised by a standard dissection technique.³ In brief, a straight line was marked between the anterior superior iliac spine and lateral edge of the patella. The midpoint of this line was identified and a 3-cm radius circle was outlined. The vascular perforators that are usually located within this area were detected by Doppler ultrasonography preoperatively. The desired size of the flap was marked and centered over the perforators. Then, a medial incision above the rectus femoris muscle was made and extended down to the sub-fascial plane. The dissection was continued underneath the deep fascia and extended laterally until the perforator was encountered. The route of the perforator (intramuscular or septocutaneous) and the dissection proceeded

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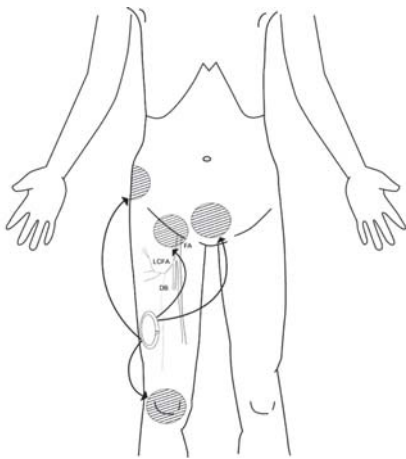


Fig. 1 The potential arcs of applying a pedicled ALT flap shown with curved arrows. Key: FA, Femoral artery; LCFA, lateral circumflex femoral artery; DB, descending branch.

laterally toward the intramuscular space between the rectus femoris and vastus lateralis muscles to identify the main descending branch of the lateral circumflex femoris artery. The lateral incision of the flap was then made superficial to the fascia lata. A strip of fascia lata was elevated as an integral part of the flap in 3 cases. During the entire harvest, the fascia lata strip showed good bleeding from its subfascial and prefascial vascular plexi. Dissection of the septocutaneous or musculocutaneous perforator toward the origin of the main pedicle completed the elevation of the flap.

For proximally based flaps, the flap was rotated medially and passed over the rectus femoris muscle to reach the lower abdominal wall and groin. The flap was rotated laterally to reach the trochanteric area. For distally based flaps, after dissection of the perforator vessel, the descending branch of the lateral circumflex femoris artery was dissected proximally for 10 cm and distally for 7 cm proximal to the patella. At this point, a vascular clamp was used to occlude the proximal blood supply temporarily, and the perfusion of the distally based flap was estimated as excellent. Then, the proximal descending branch was ligated. The flap was attached to the defect and the pivot point was located 7 cm proximal to the lateral superior angle of the patella (Fig. 1).

RESULTS

From September 2006 to October 2012, 32 pedicled

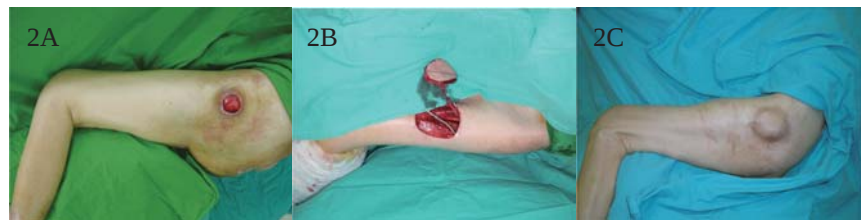


Fig. 2 A. Preoperative appearance of a defect in the left trochanteric region. B. The 10 × 14 cm fasciocutaneous flap was raised based on the septocutaneous perforator coming from the descending branch of the lateral circumflex femoris artery. C. The appearance of the flap 10 months after surgery. Note that the tenor fasciae latae flap was preserved for repairing possible recurrent trochanteric sores.

ALT flaps were applied for 31 patients (Table 1). Satisfactory coverage was achieved in all cases. Three flaps were applied for lower abdominal defects, 26 for trochanteric flaps (bilateral ALT flaps were used to cover the bilateral osteomyelitis of hips in patient 6), 1 for a groin defect and 1 reversed flap for a knee defect. Eighteen of the patients were male (58%) and the age ranged from 22 to 103 years. The flap size ranged from 8 × 5 cm (40 cm²) to 9 × 20 cm (180 cm²). The length of the pedicle ranged from 9 to 16 cm, which was enough to reach the defect without tension. In 28 flaps, donor sites were closed primarily and 4 underwent split-skin grafting.

Case reports

Patient 1

A 90-year-old woman with paraplegia presented with a left trochanteric pressure sore (Fig. 2A). After debridement, an 8 × 8 cm left ALT fasciocutaneous island flap was raised based on a septocutaneous perforator (Fig. 2B). The flap was passed above the vastus lateralis muscle, then through a subcutaneous tunnel in the lateral thigh to reach the trochanteric defect. The donor site was closed primarily. Both the donor site and the flap remained healed at the 10-month follow-up (Fig. 2C).

Patient 2

A 20-year-old man sustained traumatic orthopedic injuries to his pelvis and bladder rupture in a scooter accident. An orthopedic team stabilized the pelvic fracture initially and the patient underwent a suprapubic cystostomy, together with multiple subsequent debridements of the open lower abdominal wound (Fig. 3A). Following its complete debridement, the defect was approximately 13 × 13 cm at its greatest dimensions. To fill the dead space above the ruptured bladder, a portion of the vastus

Table 1

Patient	Age (y) /Sex	Cause	Flap size (cm)	Component	Follow up (months)	Donor site
1	75/M	Trochanteric sore	10 × 14	Fasciocutaneous	12	Skin graft
2	90/F	Trochanteric sore	8 × 8	Fasciocutaneous	10	Primary closure
3	89/M	s/p bipolar hemiarthroplasty with osteomyelitis	9 × 20	Musculocutaneous	11	Skin graft
4	80/M	Trochanteric sore	10 × 15	Fasciocutaneous	4	Primary closure
5	88/F	Trochanteric sore	8 × 10	Fasciocutaneous	3	Primary closure
6	40/M	s/p THR with osteomyelitis, right	8 × 12	Musculocutaneous	9	Primary closure
		s/p THR with osteomyelitis, left	5 × 11	Musculocutaneous	2	Primary closure
7	87/M	Trochanteric sore	10 × 8	Musculocutaneous	32	Primary closure
8	78/F	Trochanteric sore	8 × 6.5	Musculocutaneous	29	Primary closure
9	78/F	Trochanteric sore	10 × 7	Musculocutaneous	28	Primary closure
10	88/M	Trochanteric sore	11 × 7	Musculocutaneous	27	Primary closure
11	82/F	Trochanteric sore	12 × 9	Musculocutaneous	1	Primary closure
12	67/M	Trochanteric sore	12 × 10	Musculocutaneous	1	Primary closure
13	82/M	Trochanteric sore	10 × 7	Musculocutaneous	17	Primary closure
14	46/M	Trochanteric sore	10 × 8	Musculocutaneous	14	Primary closure
15	52/F	Trochanteric sore	9 × 5	Musculocutaneous	14	Primary closure
16	83/F	Trochanteric sore	10 × 6	Musculocutaneous	12	Primary closure
17	89/F	Trochanteric sore	12 × 9	Musculocutaneous	11	Primary closure
18	97/M	Trochanteric sore	9 × 7	Musculocutaneous	11	Primary closure
19	81/M	Trochanteric sore	13 × 9	Musculocutaneous	10	Primary closure
20	87/F	Trochanteric sore	10 × 6	Musculocutaneous	10	Primary closure
21	73/M	Trochanteric sore	11 × 7	Musculocutaneous	9	Primary closure
22	64/F	Trochanteric sore	9 × 6	Musculocutaneous	9	Primary closure
23	76/F	Trochanteric sore	11 × 8	Musculocutaneous	8	Primary closure
24	88/M	Trochanteric sore	10 × 8	Musculocutaneous	7	Primary closure
25	103/F	Trochanteric sore	19 × 7	Musculocutaneous	4	Primary closure
26	87/M	Trochanteric sore	21 × 8	Musculocutaneous	3	Primary closure
27	34/M	s/p sarcoma wide excision with abdominal wall defect	15 × 11	Vastus lateralis muscle	13	Primary closure
28	22/M	Bladder rupture with abdominal wall defect	13 × 13	Musculocutaneous	23	Skin graft
29	63/F	Ventral hernia s/p mesh repair with infection and abdominal defect	8 × 5	Composite fasciocutaneous ALT and tensor fascia lata flap	10	Primary closure
30	57/M	s/p Total knee replacement with infection and exposed prosthesis	10 × 5	Fasciocutaneous flap	6	Primary closure
31	72/M	s/p squamous cell carcinoma with inguinal skin defect	14 × 12	Fasciocutaneous flap	11	Skin graft

Key: s/p, status post; THR, Total Hip Replacement.

lateralis muscle was included. The dead space above the bladder and around the suprapubic cystostomy tube was filled with a portion of the muscle and the flap was then set into the lower abdominal defect without tension (Fig.

3B). One year later, we split the ALT to reposition the suprapubic tube. Twenty-three months later, the wound had healed without infection or dehiscence (Fig. 3C)



Fig. 3 A. Abdominal wall showing a skin defect with a ruptured bladder (arrow). B. Good flap viability was observed at the 1-week follow-up. C. One year later, we split the ALT to reposition the suprapubic tube. Twenty-three months later, the wound had healed without infection or recurrence.

DISCUSSION

Since Song *et al.*¹ first reported the use of the ALT flap in 1984, it gained popularity and has been used widely in reconstructive surgical procedures, especially as a free flap for head and neck reconstruction.^{2,3} Although not

used extensively, it has also been used successfully as a proximally or distally pedicled flap for reconstruction of defects to the groin, lateral and medial thigh, perineum, gluteal region, abdominal wall and knee.⁵⁻²²

Reconstruction options for defects of the lower abdomen, groin, trochanter and knee includes myocutaneous pedicled flaps, such as those from the sartorius, gracilis, rectus abdominis and rectus femoris muscles, the tensor fascia latae (TFL), ALT flaps and local skin flaps or free flaps.^{9,10} Because of its long vascular pedicle, wide arc of reach, reliable skin territory, variety of tissue components and proximity to these sorts of defects, we prefer a pedicled ALT for reconstruction of these soft-tissue defects.

Trochanteric pressure sores are a common complication in long-term bedridden patients and osteomyelitis of the trochanter with implant extrusion is a severe complication following total hip replacement. Since first introduced by Nahai *et al.*,²³ the TFL flap has become a standard approach to the management of such defects. There are several potential pitfalls to this design. For example, the most distal and poorly vascularized portion is usually placed into the bed of the sore and a 'dog-ear' deformity is often created in the lateral thigh. We used proximally based pedicled ALT fasciocutaneous flaps to cover four cases of trochanteric pressure sores and 3 of trochanteric osteomyelitis.⁵ These provided good esthetic coverage and durability while preserving the ascending branch of the lateral circumflex femoral artery, and made a conventional TFL flap possible if a recurrent pressure sore developed. Although the anatomy of the ALT flap and the dissection technique required for preparing it are now well established, perforators exhibit considerable anatomic variation and tedious dissection is necessary. To address this problem, we modified and simplified the pedicled ALT perforator flap into a myocutaneous flap for covering 21 trochanteric pressure sores.⁶ Myocutaneous flaps provide good blood supply and bulky padding and are effective in treating infected wounds. They contain the cutaneous portion of the ALT and part of the vastus lateralis muscle and do not require skeletonization of the perforators. The advantage of this method is that it allows quick and easy harvesting of the ALT flap and maintains the TFL as a reserve in case the pressure sores recur.

Kimata *et al.*¹² reported their experience of 7 ALT flaps for abdominal wall reconstruction, of which 3 were pedicled. Friji *et al.*²⁴ also used 3 pedicled ALT flaps for abdominal reconstruction. In our series, we also had 3 abdominal defects covered with pedicled ALT flaps. The first patient had a defect in the abdominal wall and peritoneum, so a pedicled ALT flap combined with the tensor

fascia lata was used for repair. The second patient had a large lower abdominal defect (13×13 cm) and a ruptured bladder with a cystostomy caused by trauma. We selected a pedicled ALT myocutaneous flap using the muscular portion to fill the dead space above the ruptured bladder, fixed it around the cystostomy tube, and used the cutaneous portion to cover the lower abdominal wound. For the third patient, only the muscular portion of the pedicled ALT flap was used to reconstruct a large abdominal wall defect caused by sarcoma excision surgery.⁷

Gravvanis *et al.*¹⁶ reported the use of two reversed pedicled ALT flaps to cover exposed knee joints caused by burn injuries. We used the same type of flap to cover a chronic wound on one knee after total knee replacement surgery with exposure of the prosthesis, to preserve the prosthesis and to achieve satisfactory knee motion and an acceptable cosmetic result.⁸

Fifty-six flaps were applied for covering groin defects in Friji's series reporting the treatment of patients for fungating nodal disease with extensive skin involvement and exposed blood vessels.²⁴ One of our patients had a groin defect because of a metastatic squamous cell carcinoma and we covered the wound with a proximally pedicled ALT flap.

In our series, all defects were reconstructed by pedicled ALT flaps offering the benefits of free tissue transfer without the complexity of microsurgery. The flap provides versatility in its components as it can be raised as a fasciocutaneous flap, a myocutaneous flap, a fasciocutaneous flap combined with the TFL, or just as a plain muscle flap depending on the tissue component need in the defect. The other advantage of the ALT flap is the hidden donor site; a defect measuring up to 21×9 cm can be closed primarily.

CONCLUSIONS

Pedicled ALT flaps are versatile for skin and soft-tissue replacement with a reliable blood supply. They have long pedicles and a wide arc of reach ranging from the lower abdomen, groin and trochanter to the knee. They are technically simple to apply as myocutaneous/septocutaneous flaps with minimal donor site morbidity.

DISCLOSURE

All authors declare no competing financial interests.

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