Original Article

Has the anterolateral thigh flap replaced the latissimus dorsi flap as the workhorse for lower limb reconstructions?

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Abstract

Objective: To compare the applicability and reliability of free Anterolateral thigh flap (ALTF) with Latissimus Dorsi free flap (LD) in different reconstructive scenarios of lower limb. To compare flap elevation time, vessel diameters, pedicle lengths, total operative time, peri-operative blood requirement, number of secondary procedures and complications between the two types of flaps.

Methods: Patients of all age groups with lower limb soft tissue defects requiring free tissue transfer, reporting to Department of Plastic Surgery, Combined Military Hospital, Rawalpindi, from November 2005 to November 2008, were included in the study. The patients were distributed into two groups irrespective of the primary disease; Group 'A' patients underwent LD reconstruction and Group 'B' patients had an ALTF transfer.

Results: A total of 60 cases were included in the study (Male: Female = 6.5:1). Mean patient age was 30.33 ± 10.082 years. The mean follow up period was 19.73 ± 9.303 months. Larger defects were covered with ALTF as compared to LD (p=0.003). The total surgery time was longer in Group 'A' (p=0.017). Peri-operative blood requirements and debulking procedures were also more frequently required in Group 'A' (p=0.002, 0.007). There was no significant difference in rest of the flap and operative parameters between the two groups.

Conclusion: ALTF is as reliable a flap as LD for various lower limb defects. Its additional advantages include short operation time, decreased requirement of peri-operative blood transfusion and subsequent debulking procedures. Considering these benefits, the ALTF may be labeled as the 'New Workhorse' for lower limb reconstructions requiring free tissue transfer (JPMA 60:76; 2010).

Introduction

Lower limbs defects resulting from trauma, tumour extirpation or debridement of chronic osteomyelitis commonly lead to exposure of underlying tendons and bones. These defects have conventionally been covered by muscle flaps, owing to their increased vascularity as compared to fasciocutaneous flaps.[1] Over the years, the Latissimus Dorsi free flap (LD) has become 'The workhorse' for lower limb defects requiring free tissue transfer.[2] Its advantages are well documented and include a reliable anatomy, potential for coverage of large defects, adequate pedicle length, good sized vessels and minimal donor site morbidity.[3] Various modifications of the LD have been described including flap expansion[4] and composite flaps containing bone.[5]

The anterolateral thigh flap (ALTF), first described by Song et al,[6] makes use of tissue from a hidden donor site which is concealable in everyday clothing. It has a long pedicle with good vessel size. The flap is pliable, can be thinned down[7] and is potentially sensate.[8] In the past few years it has become a very popular flap among reconstructive surgeons due to the large amount of skin available and widespread applicability. It has been used for a myriad of defects from the head to the toe. It has also been suggested as an "ideal flap" universally suited for all reconstructions.[9]

In this study, we have compared the applicability and reliability of the free ALTF with the time tested free LD in different reconstructive scenarios in the lower limbs. Flap elevation time, vessel diameters, pedicle lengths, total operative time, peri-operative blood requirement, number of secondary procedures and complications are compared between these two flaps.

Patients and Methods

This Quasi-experimental study was conducted at the Plastic and Reconstructive Surgery Department of Combined Military Hospital, Rawalpindi, Pakistan from November 2005 to November 2008. Sampling was convenience based. The sample size was dictated by the duration of the study i.e., all patients of all age groups with lower limb soft tissue defects requiring free tissue transfer, reporting primarily/referred to our department, were included in the study. Patients with a previously failed free flap, severe co-morbidities, multi-organ injuries, known peripheral vascular disease and metastatic malignancy were excluded from the study. All cases were worked-up in detail to assess the general physical fitness for a prolonged surgery. All tumour cases were also evaluated in the Soft tissue Sarcoma Clinic at our hospital. The Extent of resection and type of reconstruction was also planned at these clinics. The study was conducted in accordance with the Helsinki Declaration of 1975, as revised in 1983 and was approved by the hospital ethical committee.

The patients were distributed into one of two groups, irrespective of the primary cause of the soft-tissue defect; Group 'A' patients underwent an LD reconstruction and Group 'B' patients had an ALTF transfer. Lower leg arteriography was done routinely in all the post traumatic cases. Doppler perforator marking using 10 Mhz hand-held Doppler (Dopplex® II. Huntleigh Healthcare Limited, Cardiff, UK) was routinely done in all patients in group 'B' (ALTF). All the procedures were performed under general anaesthesia along with epidural blockage to prevent lower limb vasospasm. Simultaneous flap elevation was commenced wherever a two-team approach was possible. All the tumour resections and debridements were done by our Orthopaedic colleagues. The Flaps were designed using custom-tailored templates for each defect. All the flaps were raised and anastomosed. The Time of flap elevation was recorded as the time taken from skin incision to complete dissection of the flap and its pedicle. The Total operation time was calculated from induction of anaesthesia to recovery.

The Standard technique of LD elevation was used.[10] ALTF was designed over the middle 1/3rd of the thigh along a line joining the anterior superior iliac spine (ASIS) and the lateral border of the patella. The flap elevation was started from medial to lateral, identifying the perforators and the descending branch of lateral circumflex femoral artery (LCFA) and finally dissecting the pedicle up to its origin from the LCFA. The Deep fascia was routinely included during flap elevation. If a deep musculocutaneous perforator was encountered, a 1.5 to 2 cms cuff of vastus lateralis muscle was taken along with the perforator. Thinning, if required, was done with the pedicle still attached to the donor vessel. Heparin 5000 units was given intravenously just before the division of pedicle in both the groups. Post-operatively all patients were nursed in an intensive care unit for 48 hours and operated leg was kept elevated. Flap monitoring was done at 02 hourly intervals using skin/muscle colour, temperature and bleeding response to needle scratch, as parameters. Tab Acetylsalicylic acid 150 mg OD (PO) was started within 24 hours of anastomosis and continued for 02 to 04 weeks post-operatively. The first dressing change was done on the 5th to 7th post-operative day unless a vascular or infective complication warranted an earlier change of dressing. The patients were discharged from the hospital in the second post-operative week, if there were no complications.

The patients were followed up weekly for four weeks, and then monthly. Weight bearing on the operated leg was allowed after four weeks, if not, otherwise, contraindicated from the point of view of bone union. All the data in the two groups was compared for 2-tailed significance using 't-test' on SPSS 11.0 for windows®. Correlations between different variables within the same group were calculated using the Pearson Test. A 'p value' of < 0.05 was considered significant.

Results

Sixty cases were included in the study with a Male to Female ratio of 6.5:1 (52 males, 8 females). The age of these patients ranged from 6 to 55 years with a mean of 30.33 ± 10.08 years. The mean follow up period was 19.73 ± 9.30 months (Range 2 to 36 months).

The nature of soft tissue defects was quite variable including 32 (53.3%) post-traumatic cases, 14 (23.3%) oncologic surgical defects, six (10%) cases each of chronic osteomyelitis and unstable scarring and two (3.3%) cases of exposed orthopaedic hardware. The Foot (38%) and calf (37%) were the most commonly involved regions followed by defects involving more than two regions of the leg (8%), knee (7%), ankle (7%) and calf with ankle (3%). Twenty-nine reconstructions were done using ALTF and 31 using the LD.

Group A (LD arm, n = 31). In Group A there were 23 trauma cases (Figure-1), and two cases each of oncologic surgical defect, chronic osteomyelitis, unstable scarring and exposed orthopaedic hardware. The size of the defects ranged from 50 to 140 cm^2. Sixteen of these (51.6%) were covered with myocutaneous flaps, while in the rest, muscle-only flaps, covered with split-thickness skin graft, were used. Eleven (35.5%) of these flaps were done as a part of limb salvage procedure. LD pedicle length ranged from eight to 14 cm with arterial and venous diameters ranging from 2.0 to 3.0 mm. Flap elevation time ranged from 43 to 70 minutes with the total operation time ranging from 5 to 10 hours. The thoracodorsal artery was anastomosed to posterior tibial

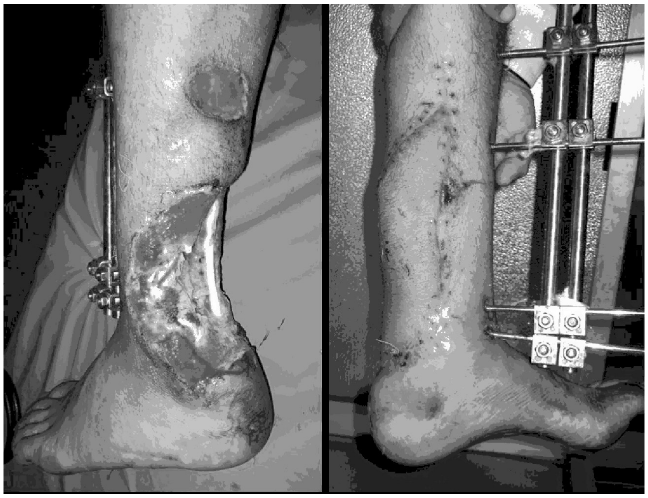

Figure-1: A patient with a firearm injury on the posterior aspect of the left lower calf covered with myocutaneous latissimus dorsi free flap.

artery, anterior tibial artery and femoral artery in 22 (71%), seven (22.6%) and two (6.5%) cases respectively. Three to four peri-operative blood transfusions were required per case. Four cases (12.9%) required additional skin grafting to cover the exposed pedicle site. Two cases (6.5%) developed vascular compromise more than 48 hours after the anastomosis. Both were heparinized systemically, but only one of these survived completely, after an episode of superficial epidermolysis. Early recipient-site wound dehiscence occurred in four cases (12.9%). Upto two secondary procedures per case were done, including minimal debridement, secondary suturing, re-grafting or flap debulking. Five cases (16.1%) developed donor site complications including seroma, wound dehiscence, stretched scar and hypertophic scarring. Five cases (16.1%), in which muscle-only flap was used, developed long term instability of the grafted area. None of the variables within this arm were strongly correlated.

Group B (ALTF arm, n = 29). The most common defect type in this group was post-tumour-resection defect (12, 41.4%) (Figure-2) followed by post-traumatic defect (9, 31%). Other defect types included 4 cases (13.8%) each of chronic osteomyelitis and unstable scarring. Seventeen cases (58.6 %) were done for limb salvage. These limbs were at risk because of either the extent of resection required for oncological clearance (12 cases of post-tumour-resection defects) or the extensive trauma (five post-traumatic cases). Ten (34.48%) of these flaps had septocutaneous perforators. Up to five mm thinning was done in six cases (20.68%) to adjust the flap to the reconstructive requirements. The size of the defect ranged from 45 to 200 $cm.^2$ Pedicle Length ranged from 8 to 18 cm with arterial diameter ranging from 2.0 to 3.5 mm and venous diameter ranging from 2.0 to 3.0 mm. Flap elevation time ranged from 50 to 90 minutes and total operating time ranged from 6 to 10 hours. Two to four units of blood were transfused

Figure-2: A patient with Recurrent Fibromatosis Left Foot. Defect covered with anterolateral thigh flap.

in the perioperative period. LCFA was anastomosed to posterior tibial artery in 12 (41.4%), anterior tibial artery in 11 (37.9%), popliteal artery in four (13.8%) and femoral artery in two (6.9%) cases. Two cases (6.9%) required additional skin grafting to cover exposed pedicle site. One case (3.44%) had to be re-explored for vascular compromise and the arterial and venous anatomoses were re-freshened but the flap could not be salvaged. Another case which developed vascular compromise was salvaged by re-adjusting the flap and relieving pressure over the pedicle. Recipient-site wound dehiscence occurred in two cases (6.9%), which were managed conservatively. Five (17.2%) donor sites were closed primarily and the rest were grafted. Graft take was satisfactory in all the grafted cases. Two cases (6.9%) complained of weakness and stiffness of the donor leg. These complaints settled within six to 10 weeks after the surgery and there were no long term complaints. Debulking as a secondary procedure was done in six cases (20.7 %). There were no issues of long term graft instability seen at the recipient site. None of the variables within this arm were strongly correlated.

Comparison between Group A and B (Table). Both groups had comparable age and gender distribution with equal variety in site and spectrum of the defects. Significantly larger defects were covered with ALTF as compared to LD. Mean flap elevation time was 4.57 minutes (SD ± 3.748 minutes) longer in group B (60.83 minutes ± 11.464) as compared to group A (56.26 minutes ± 7.716) , but this difference was not statistically significant (p = 0.074). Contrary to this, the total surgery time was significantly longer in reconstructions done with LD flap. Similarly the peri-operative blood requirements

Table: Group Statistics.

	Group (Mean ±Standard Deviation) A	B	p value
Age (yrs)	29.68 ±10.672	31.03±9.549	0.607
Defect Dimensions (cm2)	87.23±27.517	115.48±41.211	0.003
Pedicle Length (cm)	10.68 ±1.956	11.59 ±2.653	0.135
Pedicle Arterial Diameter (mm)	2.484 ±0.3976	2.483 ±0.5085	0.992
Pedicle Venous Diameter (mm)	2.597 ±0.3271	2.534 ±0.3518	0.480
Flap Elevation Time (min)	56.26 ±7.716	60.83 ±11.464	0.074
Total operation time (hours)	8.52 ±1.061	7.76 ±1.327	0.017
Peri-operative blood transfusion (Number of units)	3.52 ±0.508	2.97 ±0.778	0.002
Vascular Compromise	1.94 ±0.250	1.93 ±0.258	0.946
Additional graft requirement	1.87 ±0.341	1.93 ±0.258	0.447
Flap failure	1.97 ±0.180	1.93 ±0.258	0.523
Salvage after vascular compromise	2.87 ±0.499	2.86 ±0.441	0.942
Recipient site wound dehiscence / infection	1.87 ±0.341	1.93 ±0.258	0.447
Donor site morbidity	1.84 ±0.374	1.93 ±0.258	0.273
Debulking	2.00 ±0.000	1.79 ±0.412	0.007
Number of secondary procedures performed	0.26 ±0.575	0.41 ±0.628	0.320

were significantly more in group A. Debulking was more frequently required in LD flaps (All myocutaneous cases) and this difference was significant. There was no significant difference in rest of the flap and operative parameters between the two groups.

Discussion

For years muscle flaps had been the most logical answer to all lower limb defects[11] with LD[Error! Bookmark not defined.] and Rectus Abdominis (RA)[Error! Bookmark not defined.] free flaps being the fore-runners. LD was popularized as the "workhorse"[Error! Bookmark not defined.] for lower limb reconstruction and it has been shown to be superior to RA in many studies.[2,3,12] This is primarily due to much lower donor site morbidity and very large dimensions of flap available conform to almost all lower limb defects. In the past decade or so this role of LD has been challenged by the proponents of fasciocutaneous flaps.[13] In addition, improving the blood supply in the area, comparable to muscle flaps, the fasciocutaneous flaps are reported to be better conformed for secondary bone fixation procedures and for improving venous drainage and lymphatics in the leg distal to the flap.[14] The Radial forearm free flap was suggested by many as the fasciocutaneous flap of choice for this purpose, especially for the coverage of foot defects.[15] Despite favourable results, this flap has never been able to replace the role of LD due to many reasons. Firstly, the forearm skin is considered to be a more precious site for lower limb reconstruction, especially with the relatively high rate of donor site complications.[16] Secondly, it sacrifices a major artery in the limb.

The ALTF has already been studied extensively for the versatility of its usage.[9] Its role as a substitute to radial forearm free flap and in many cases as a first choice for head and neck reconstructions is well reported.[16] It is also considered by many as an ideal choice for lower extremity soft tissue reconstruction.[14,17] To validate this potential there was a need for ALTF to be compared to the "gold standard" LD for various lower limb reconstructive scenarios.

Overall our findings were similar to that of Yazar et al[14] and we found no major advantage in choosing a muscle flap over a fasciocutaneous flap for lower limb reconstruction. Numerically, the ALTF pedicle parameters (Pedicle length, vessel diameters) in this series were better as compared to that of LD. This is a very important factor especially when we consider that the appropriate recipient vessels in the lower limb are mostly found lying deep in the muscles and/or away from the zone of injury. The skin island in ALTF is usually planned with the perforators in the centre; this gives the surgeon more freedom to orientate the flap according to the shape of the defect and the available recipient vessel. In this series, although ALTF elevation time was longer than that of LD, the total operation time was significantly longer in cases reconstructed with LD. This resulted from time spent on the change of position that was required in most of the LD cases, whereas, two-team approach (simultaneous flap elevation) was almost always possible in ALTF group. This, compounded by the fact that significantly more blood transfusions were required in LD group, translates into ALTF being a much safer procedure in terms of fewer chances of anaesthetic and transfusion-related complications.

The reliability of ALTF is also evident by the equally low rates of complications in group B. Similar number of flaps in both the groups, developed vascular compromise in the early post-operative period and there was no difference in the flap salvage rate. This finding is suggestive of the fact that the presence of very small diameter perforators in ALTF leading to early and irreversible thrombosis,[18] may not be a very important consideration when comparing them with muscle flaps. The rates of venous congestion cases requiring re-exploration in our ALTF arm were similar to those seen by Yildirim et al[17] (3.44% vs 4.7%). Flap failure rates of both the arms were also comparable to those observed by Yazar et al[14] for muscle and fasiocutaneous flaps in general; 1.97% (LD) vs 2% (All muscle flaps), 1.93% (ALTF) vs 1.3% (All fasciocutaneous flaps). Chronic traumatic wounds remain a significant risk factor for flap failure.[19] Both the cases that failed in our series were flaps done to cover post-traumatic wounds with bone exposed for more than 4 weeks.

As opposed to a common misconception, free flaps for lower limbs are not associated with high complication or failure rates; the only flap related factors significantly associated with high flap failure rate being the use of vein grafts and muscle flap covered with skin graft, due to increased chances of thrombosis and difficult identification of post-operative thrombosis, respectively.[19] The only flap failure which occurred in group A in this series was also a muscle-only LD covered with a skin graft. Similarly the flap failure that occurred in ALTF arm was a case in which vein grafts were used during anastomosis. The muscle-only flaps are also reported to be associated with long-term graft instability;[20] 26.1% in our grafted LD cases. All these cases of graft instability were limited to the foot and ankle areas. Not only that muscle covered with graft may be a problem, especially in the weight-bearing area of the foot, but a myocutaneous flap is also considered to be unsuitable for this purpose because of the shearing effect between the muscle and the overlying skin.[21] In contrast a thin ALTF provides one-stage contouring and minimizes shearing, and a skin paddle that resists pressure and improves durability.[22]

Donor site morbidity is also very important in considering fasciocutaneous flaps, as whole of the defect, including its depth, is to be covered and filled-in by the skin island. ALTF harvest leads to a hidden donor site with minimum donor-site morbidity.[16] Donor-sites up to 9 cm wide can be closed primarily[16] (17.2% in this series). Also, as the upper limbs and torso are totally spared, this facilitates early patient mobilization. Donor-site morbidity, reported with LD, is mostly described in terms of scar complications or weakness of shoulder movements.[23] The painful, post-operative, LD donor-site and associated weakness, results in difficulty in early ambulation of the patient on crutches[21] and even simply trying to get up on the bed causes tension on the back in a bed-ridden patient.[24] This should be an important consideration when considering LD for lower limb reconstruction.

With ALTF, large amount of adipose tissue in excess of the skin island[18] can be used to fill-in a three-dimensional defect. Although not used in this series, another positive attribute of ALTF is its ability to be used as a flow-through flap[17] for limb salvage. Thickness or bulkiness is less often seen with ALTF, especially when adequate thinning has been done depending upon the reconstructive requirements.[7,14] On the other hand thinning is not a possibility with LD and bulk remains one of its major disadvantages.[25] We had a similar observation that Debulking or any other secondary surgery was less commonly required in ALTF arm than in LD arm (p =0.007, 0.320).

This article provides strong evidence in favour of ALTF to replace the all-time favourite LD for lower limb reconstructions. However, there is a need for a multi-institutional randomized control trial to be conducted for universal acceptability of this flap.

Conclusion

ALTF is as reliable a flap as LD for various lower limb defects. Its additional advantages include shorter total operation time (possibility of two-team approach) and lesser requirement of peri-operative blood transfusion or subsequent debulking procedures (possibility of flap thinning). Considering these benefits, ALTF may rightly be labeled as the 'New Workhorse' for lower limb reconstructions requiring free tissue transfer.

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