

Outcome of Venous Supercharged Pedicled Anterolateral Thigh Flap for Reconstruction of Soft Tissue Defect around the Knee Joint

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Abstract

Introduction: Soft tissue defects around the knee are common following motor vehicle accidents, burns especially electric burn, excision of malignancy etc. Reconstruction of soft tissue defect around the knee needs thin, pliable and tough skin. Recently distally based pedicled anterolateral thigh flap has been used for soft tissue reconstruction for its several advantages like long pedicle, sufficient amount of soft tissue and less donor site morbidity. But it has tendency towards venous congestion and this can be overcome with venous supercharging. This study was designed to evaluate the effectiveness of venous supercharging in reducing venous congestion in pedicled anterolateral thigh flap for reconstruction of soft tissue defect around the knee joint.

Methods: This prospective observational study was carried out at Department of Plastic Surgery and Burn Unit, Dhaka Medical College Hospital and Sheikh Hasina National Institute of Burn and Plastic Surgery (SHNIBPS), Dhaka from August 2017 to June 2019. Twenty (20) patients who presented with defect around the knee were included in this study according to inclusion and exclusion criteria.

Results: Maximum patients 5(25%) were day labour and wounds were created by MVA in most of the cases 10(50%). Most common site was anterior aspect of knee joint 8(40%). The dimension of the wound size ranged from 5×3cm upto 7×14cm. Majority of the wounds ranged from 15×13cm to 17×14cm. The flap size ranged from 6×3.5cm upto 20×18cm. 18 (90%) flaps had no venous congestion, but 2(10%) cases had it. All flaps (20) survived well, 18 cases had acceptable scar and in 2 cases infection occurred. Regarding functional outcome of knee joints, 15 (75%) patients had full range of motion and 5(25%) patients had 5p -10p restriction in flexion of knee joints. Final outcome was found excellent in 16(80%) and satisfactory in 4(20%) cases.

Conclusion: Venous supercharging in pedicled anterolateral thigh flap for soft tissue defect around the knee joint have shown to be effective in reducing venous congestion.

Keywords: Venous-supercharged, Pedicled anterolateral thigh flap, Reconstruction, Soft tissue defect around the knee joint.

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Introduction

Soft tissue reconstruction around the knee joint needs thin, pliable and tough skin. The availability of local tissue would meet the requirements best is limited¹. The skin and soft tissue defect around the knee is a challenge to the plastic surgeons. Skin around the knee is thin and is immediately above the joint, so injury causing easily exposure of tendons and joint. A thin, pliable coverage of the knee joint is a justified option. As a rule knee and upper third of tibia can be covered effectively with rotational muscle flap, but muscle flap is thick and requires skin graft. Recently distally based pedicled anterolateral thigh flap has been used for soft tissue reconstruction around the knee and it has several advantages such as long pedicle, a sufficient amount of tissue, possible composite transfer with fascia lata if required and minimal donor site morbidity².

Since its introduction by Song et al³, The ALT flap has become widely popular and versatile workhorse. It can

provide ample soft tissue for coverage including a large skin paddle and good color match. It can be used as distally based, proximally based and as free flap⁴. The blood supply of ALT is based on the perforators from descending branch of lateral circumflex femoral artery (LCFA) anastomosing with the perforators from superior lateral genicular artery. SLGA takes part in the anastomosis around the knee region and the flap is perfused by the retrograde flow through these vessels after ligation of the descending branch of LCFA. At the superior level of the flap while elevating it can be septocutaneous or musculocutaneous perforator, when musculocutaneous, cuff of vastus lateralis muscle is included with intramuscular pedicle⁵.

The flap has not gained wide spread acceptance like reverse sural, reverse soleus and reverse upper extremity flap because of their tendency towards venous congestion.

Anatomically arteries have no valves, so bidirectional arterial flow can occur, but in lower extremity due to presence of valves in the vein, reverse flow in the veins may be compromised. An ideal reverse flow flap therefore, should rely on antegrade outflow. This can be accomplished with venous supercharging². A simple modification of dbALT harvest technique that provides antegrade venous out flow to the great saphenous vein (GSV) is expected to improve flap reliability. Song et al in 1984 retrospectively reviewed that non-supercharged procedure was related with venous congestion but supercharged procedure was not. However, dbALT must be based on antegrade venous supercharge to reduce the risk of venous congestion⁶.

There are several options for soft tissue coverage around the knee joint, like Gastrocnemius muscle flap, the proximally based sural artery flap, Superior lateral genicular artery flap and free flap. But these options have some disadvantages. The volume of the distal part of Gastrocnemius muscle is small and sometimes does not provide enough coverage for larger defect around the knee joint, particularly suprapatellar region. The Sural artery perforator flap provides thin and pliable tissue for the reconstruction of a knee defect, but the size is limited. Free flap is an option but it is time consuming and expertise is required. Pedicled ALT flap is a good option because it is local, has reliable vascularity, tremendous versatility and good color match.

So, considering all these problems this study was performed by using pedicled ALT flap for covering the

soft tissue defect around the knee joint and venous supercharging was done to reduce congestion and improve flap survivality.

This study was done to evaluate the effectiveness of venous supercharging in reducing venous congestion in pedicled anterolateral thigh flap for reconstruction of soft tissue defect around the knee joint.

Methods

This prospective observational type of study was conducted in the department of Plastic Surgery and Burn Unit, Dhaka Medical College Hospital and Sheikh Hasina National Institute of Burn and Plastic Surgery (SHNIBPS), Dhaka from August 2017 to June 2019. A total number of 20 patients who presented with soft tissue defect around the knee were included in this study as per inclusion and exclusion criteria. Data were collected from patients and attendants by using a pre tested and pre designed structured data collection form. All the data were checked and edited after collection. Then the data were entered into Excel data sheet and statistical analysis of the results was obtained by using windows based computer software Statistical Packages for Social Sciences (SPSS-22) (SPSS Inc., Chicago, IL, USA)..

Operative technique

With the patient in supine position a line was drawn connecting the anterior superior iliac spine and the superolateral border of the patella (AP line), which roughly corresponds to the intermuscular septum between the rectus femoris and the vastus lateralis muscle. The midpoint of this line was also marked. A handheld ultrasound Doppler was used to thoroughly explore the perforators supplying the ALT flap along the AP line, particularly around midpoint of the line. The initial design of the flap was then marked including these perforators.

The medial incision was first made down to the deep fascia above the rectus femoris muscle. Subfascial dissection then proceeded laterally until the intermuscular septum was reached. We preferred to open the septum in a distal to proximal direction. Care should be taken not to compromise the potential septocutaneous perforators that traverse the septum. Once the septum was adequately opened, the overall characteristics of the LCFA descending branch could be visualized.

If there was an oblique branch originating from the LCFA descending branch, it could be seen as a vessel lying laterally to the descending branch. If a vessel supplying the flap from the oblique branch was a septocutaneous perforator, it could be easily dissected out up to the point of origin from the descending branch. For musculocutaneous perforators, intramuscular dissection was needed. The descending branch proximal to the origin of the oblique branch was then ligated and cut, and the pedicle was distally dissected to the point where the descending branch entered the vastus lateralis muscle. This point might serve as the pivot point. The descending branch was normally not dissected within the vastus lateralis muscle. The main motor nerve supplying the vastus lateralis muscle was carefully preserved. The flap was then raised completely and transferred to the recipient site through a subcutaneous tunnel or an open wound. The great saphenous vein (GSV) was identified, isolated and transposed to the recipient site. To match the diameter between recipient vein and GSV, the great saphenous

vein was cut obliquely and end to end anastomosis was done. The donor site was primarily closed in layers over closed suction drains and in some cases by STSG. Postoperatively, the skin paddle was monitored clinically for changes in color, turgor and temperature without any specialized instruments. The donor thigh was monitored for signs of neurovascular injury and compartment syndrome. The sutures were removed 14 days postoperatively and the patients were encouraged to walk with regular physiotherapy after that.

Results:

For all the patients included in the study, proper history taking, clinical examination, standard Anterior- Posterior and Lateral X-ray of knee joint, and routine investigations for assessment of anaesthesia fitness were performed pre operatively. All patients were treated by venous supercharged pedicled anterolateral thigh flap for reconstruction of soft tissue defect around the knee joint. Patients were followed up for at least 1 to 3 months. Results were expressed in frequency, percentage and mean± SD.

Table-II

<i>Details of the patients who underwent pedicled ALT flap (distally based)</i>								
Age/Sex	Mechanism of injury	Site of injury	Wound Size (cm)	Flap Size (cm)	Venous Congestion		Functional Outcome of Knee Joint	
					Pre-operative	At 3 months F/U	At 3 months	Outcome
35/F	Electric Burn	Front of knee	16×14	20x18	Absent	FRM	FRM	Excellent
40/F	After release of burn contracture	Popliteal fossa	11×7	14x8	Present	5p restriction	10p restriction	Satisfactory
60/M	Excision of SCC	Popliteal fossa	17×13	20x16	Absent	FRM	5p restriction	Excellent
25/M	MVA	Lateral side of knee	15×10	19x12	Absent	FRM	FRM	Excellent
35/M	Excision of ulcer with post burn scar	Popliteal fossa	16×13	19x16	Present	5p restriction	10p restriction	Satisfactory
42/M	Electric Burn	Lateral side of knee	10×8	14x12	Absent	FRM	FRM	Excellent
21/M	MVA	Lateral side of knee	7×4	9x5	Absent	FRM	FRM	Excellent
35/M	Excision of ulcer	Prepatellar region	10×8	12x10	Absent	FRM	FRM	Excellent
22/M	MVA	Front of knee	16×13	20×16	Absent	FRM	FRM	Excellent
17/F	MVA	Front of knee	12×9	14x11	Absent	FRM	FRM	Excellent
13/M	Flame burn	Popliteal fossa	5x3	6x3.5	Absent	FRM	FRM	Excellent
18/M	MVA	Medial side of knee	8x5	10x6	Absent	FRM	FRM	Excellent
38/M	MVA	Front of knee	15×14	17×16	Absent	FRM	FRM	Excellent
40/F	Excision of ulcer	Prepatellar region	9×7	11×9	Absent	FRM	FRM	Excellent
52/M	MVA	Front of knee	16×14	19×17	Absent	FRM	FRM	Excellent
20/F	Excision of ulcer	Popliteal fossa	7×5	9×6	Absent	FRM	FRM	Excellent
36/M	MVA	Front of knee	13×11	14×13	Absent	FRM	FRM	Excellent
35/M	Electric Burn	Medial side of knee	10×7	12×10	Absent	FRM	FRM	Excellent
32/M	MVA	Front of knee	16×13	19×16	Absent	FRM	10p restriction	Satisfactory
44/M	MVA	Front of knee	16×14	19×17	Absent	FRM	10p restriction	Satisfactory



Figure-1: A. Pre-operative, B, C. Marking of flap, D, E, F, G: Peroperative: H, I, J: Postoperative follow up.

Discussion

Various flaps have been used to cover soft tissue defect around the knee. Factor which affect the choice of flap, include the location and size of the defect, potential donor site morbidity and status of the vessels. A local

random pattern skin flap has indistinct perfusion and is limited in size. Although the free flap covers the defect effectively in a single procedure, but it requires special set up, expertise hand, long operating time and also technically difficult because of deep recipient vessels.

The conventional gastrocnemius muscle flap is also a choice for providing soft tissue coverage over the knee; the main disadvantage is that the volume of the distal part of the muscle is small and sometimes it does not provide enough coverage for large defect around the knee joint, particularly in the supra patellar region^{8,9}. The bulk of local muscle flaps should also be considered. The sural artery perforator flap can provide thin and pliable tissue for the reconstruction of a knee defect, but the size of the flap is limited^{10,11}. Pedicled ALT flap is a versatile option for reconstruction of soft tissue defects within its reach. Many authors focused the utility of pedicled ALT for various soft tissue defects pertaining to specific anatomical regions Zelken et al¹².

The main aim of the present study is to see the efficacy of venous supercharging of distally based pedicled ALT flap in reducing the venous congestion for reconstruction of soft tissue defect around the knee joint. In present study among 20 cases, age of the patients ranged from 13 to 60 years. Majority of respondents 9(45%) were between 31-40 years of age. Mean age was 33±12.08 years. Maximum patients were male 15 (75%) and 5 (25%) were female. Male female ratio was 3:1. Male patients were predominant in this study. Al-Moktader et al¹³ conducted a study included 10 patients were men and 5 patients were women with age range 13 to 55 years and mean age 39.3±14.42 which correlate well with present study. MVA (50%) was the main etiology of soft tissue defect in this study. Lin et al² also observed MVA (Motor Vehicle Accidents) as the most common cause of leg defects reconstructed with this flap. Khan et al¹⁴ reported road traffic accidents were the most common etiology of the soft tissue defects (68.8%).

The most common site was the anterior aspect of knee joint 8 (40%). Kim et al¹⁵ reported most common involved site (69%) was the front of the knee. Naalla et al¹⁶ also found that 44% patients had injuries in front of the knee joint. The findings of this study are consistent with these studies.

Out of 20 cases the dimension of the wound size ranged from 5×3cm upto 17×14cm. The most common size 8(40%) of the wound ranged from 15×13cm to 17×14cm. The flap size ranged from 6×3.5cm upto 20×18cm. The most common size (7 patients, 35%) of the wound ranged from 19×16cm to 20×18cm. Lin et al³ reported a range

the size of the wounds from 6×7cm to 22×20cm. The mean of common size of defect was 17.6×9.4cm. On the other hand, flap size ranges from 12×6cm to 27×12cm. The mean of the common size of flap was 21.4×8.8cm. This data was almost similar to present study. The flap was always designed slightly larger than the defect. In each case flap dimension was (>1cm) more both in length and width than that of the wound in this study.

In this study, all the perforators were found within 3cm of midpoint. 9 perforators were found at midpoint, 5 lateral to midpoint and 6 cases were medial to midpoint. Bekarev et al¹⁷ reported that distally based island ALT flap, with the proximal and distal perforators localized within 4-6 cm of the initial incision midpoint. Venous supercharging was done in all the cases, 18 (90%) flaps had no venous congestion completely, but 2(10%) cases had congestion in spite of supercharging. That was managed by removal of some stiches and adding of heparin in the drip and the condition of flaps improved within three to four days. Later there was partial epidermal necrosis and split thickness skin graft was done. All the flaps were survived completely. Naalla et al¹⁶ reported no complication was seen in six cases among nine, 1 patient had partial flap necrosis and one patient had hematoma at the flap site, which required drainage. The postoperative outcome of flap of our study had no gross dissimilarity compared to other studies.

In most cases, the skin defect of less than 14cm over the donor site was closed directly in 11 cases and split thickness skin graft needed in 9 cases. Bekarev et al¹⁷ observed two out of five donor sites were closed primarily and rest of the three cases were closed by split thickness of skin graft. In our series 18 cases had acceptable scar and in 2 cases infection occurred which was confirmed by clinical examination and culture and sensitivity of discharged. Specific treatment was given according to culture and sensitivity and wound was healed without surgical intervention. Among 20 patients in this series all flaps survived completely. Liu et al¹⁸ reported all flaps (total 7 cases) survived without any major complications, which correlates with our study.

Functional outcome of knee joint was measured by goniometer. Traumatic patients were assessed peroperatively after giving spinal anaesthesia. Postoperatively 18 (90%) patients had full range of

motion of the knee joint and 2 (10%) patients with 5p - 10p restriction of knee flexion whereas at final follow up we found 15 (75%) patients with full range of motion and 5 (25%) patients developed 5p - 10p restriction of knee flexion (P value is <0.05). Two patients supposed to have previous capsular contracture due to post burn scar. Five patients developed restriction of movement due to lack of physiotherapy and regular follow up. Bekarev et al¹⁷ mentioned 60% of patients with full range of motion as the functional outcome of knee movement.

In this study most of the cases after pedicled ALT flap, outcome was found excellent in 80% and satisfactory in 20% cases. It was concluded that venous supercharged pedicled anterolateral thigh flap based on descending branch of lateral circumflex femoral artery is a good option in the reconstruction of the defects around the knee joint. Bekarev et al¹⁷ performed distally based anterolateral thigh flap for peri-patellar wound coverage on five patients. They had excellent outcome in four cases and satisfactory results in one case.

The venous supercharging in pedicled anterolateral thigh flap has shown to be effective in reducing venous congestion and it is also shown that the flap is good option for coverage of defect of anterior, medial and lateral aspect of knee. The arc of rotation however is limited for popliteal fossa. A disadvantage of the venous supercharged pedicled anterolateral thigh flap is the dissection of the flap and venous anastomosis. There is need of accurate surgical technique, especially if intramuscular dissection is needed. Under these circumstances, the use of optical magnification is recommended to ensure greater safety.

Conclusion

Venous supercharging is an effective option of reducing venous congestion in distally based pedicled anterolateral thigh flap for reconstruction of soft tissue defect around the knee joint with less donor site morbidity.

Conflict of interest statement: None declared.

Ethical approval: Internal Review Board (IRB) approval was obtained from the institution.

Consent: Informed written consent was obtained from the patients.

Clinical photography permission: Obtained from patients.

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