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

KS ARJU, PC DASH, T AHMED, HK REZA, G BISWAS, MN KHAN

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 (25%) were day labour and wounds were created by MVA in most of the cases (50%). Majority of the wounds ranged from 15×13cm to 17×14cm. The flap size ranged from 6×3.5cm to 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 5°-10° 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.

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 limited. 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 morbidity.

Since its introduction by Song et al, 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 flap. 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 pedicle.

The flap has not gained widespread 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 supercharging. A simple modification of dbALT harvest technique that provides antegrade venous outflow 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 congestion.

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 survivability.

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 pretested 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 preoperatively. 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

**Details of the patients who underwent pedicled ALT flap (distally based)**

<table>
<thead>
<tr>
<th>Age/ Sex</th>
<th>Mechanism of injury</th>
<th>Site of injury</th>
<th>Wound Size (cm)</th>
<th>Flap Size (cm)</th>
<th>Venous Functional Outcome of Outcome</th>
<th>Pre-operative Congestion</th>
<th>At 3 months</th>
<th>F/U</th>
</tr>
</thead>
<tbody>
<tr>
<td>35/F</td>
<td>Electric Burn</td>
<td>Front of knee</td>
<td>16×14</td>
<td>20×18</td>
<td>Absent FRM</td>
<td>FRM</td>
<td>FRM</td>
<td>Excellent</td>
</tr>
<tr>
<td>40/F</td>
<td>After release of burn contracture</td>
<td>Popliteal fossa</td>
<td>11×7</td>
<td>14×8</td>
<td>Present 5p restriction 10p restriction</td>
<td>Satisfactory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60/M</td>
<td>Excision of SCC</td>
<td>Popliteal fossa</td>
<td>17×13</td>
<td>20×16</td>
<td>Absent FRM</td>
<td>FRM</td>
<td>5p restriction</td>
<td>Excellent</td>
</tr>
<tr>
<td>25/M</td>
<td>MVA</td>
<td>Lateral side of knee</td>
<td>15×10</td>
<td>19×12</td>
<td>Absent FRM</td>
<td>FRM</td>
<td>FRM</td>
<td>Excellent</td>
</tr>
<tr>
<td>35/M</td>
<td>Excision of ulcer with post burn scar</td>
<td>Popliteal fossa</td>
<td>16×13</td>
<td>19×16</td>
<td>Present 5p restriction 10p restriction</td>
<td>Satisfactory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42/M</td>
<td>Electric Burn</td>
<td>Lateral side of knee</td>
<td>10×8</td>
<td>14×12</td>
<td>Absent FRM</td>
<td>FRM</td>
<td>FRM</td>
<td>Excellent</td>
</tr>
<tr>
<td>21/M</td>
<td>MVA</td>
<td>Lateral side of knee</td>
<td>7×4</td>
<td>9×5</td>
<td>Absent FRM</td>
<td>FRM</td>
<td>FRM</td>
<td>Excellent</td>
</tr>
<tr>
<td>35/M</td>
<td>Excision of ulcer</td>
<td>Prepatellar region</td>
<td>10×8</td>
<td>12×10</td>
<td>Absent FRM</td>
<td>FRM</td>
<td>FRM</td>
<td>Excellent</td>
</tr>
<tr>
<td>22/M</td>
<td>MVA</td>
<td>Front of knee</td>
<td>16×13</td>
<td>20×16</td>
<td>Absent FRM</td>
<td>FRM</td>
<td>FRM</td>
<td>Excellent</td>
</tr>
<tr>
<td>17/F</td>
<td>MVA</td>
<td>Front of knee</td>
<td>12×9</td>
<td>14×11</td>
<td>Absent FRM</td>
<td>FRM</td>
<td>FRM</td>
<td>Excellent</td>
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<tr>
<td>13/M</td>
<td>Flame burn</td>
<td>Popliteal fossa</td>
<td>5×3</td>
<td>6×3.5</td>
<td>Absent FRM</td>
<td>FRM</td>
<td>FRM</td>
<td>Excellent</td>
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<td>18/M</td>
<td>MVA</td>
<td>Medial side of knee</td>
<td>8×5</td>
<td>10×6</td>
<td>Absent FRM</td>
<td>FRM</td>
<td>FRM</td>
<td>Excellent</td>
</tr>
<tr>
<td>38/M</td>
<td>MVA</td>
<td>Front of knee</td>
<td>15×14</td>
<td>17×16</td>
<td>Absent FRM</td>
<td>FRM</td>
<td>FRM</td>
<td>Excellent</td>
</tr>
<tr>
<td>40/F</td>
<td>Excision of ulcer</td>
<td>Prepatellar region</td>
<td>9×7</td>
<td>11×9</td>
<td>Absent FRM</td>
<td>FRM</td>
<td>FRM</td>
<td>Excellent</td>
</tr>
<tr>
<td>52/M</td>
<td>MVA</td>
<td>Front of knee</td>
<td>16×14</td>
<td>19×17</td>
<td>Absent FRM</td>
<td>FRM</td>
<td>FRM</td>
<td>Excellent</td>
</tr>
<tr>
<td>20/F</td>
<td>Excision of ulcer</td>
<td>Popliteal fossa</td>
<td>7×5</td>
<td>9×6</td>
<td>Absent FRM</td>
<td>FRM</td>
<td>FRM</td>
<td>Excellent</td>
</tr>
<tr>
<td>36/M</td>
<td>MVA</td>
<td>Front of knee</td>
<td>13×11</td>
<td>14×13</td>
<td>Absent FRM</td>
<td>FRM</td>
<td>FRM</td>
<td>Excellent</td>
</tr>
<tr>
<td>35/M</td>
<td>Electric Burn</td>
<td>Medial side of knee</td>
<td>10×7</td>
<td>12×10</td>
<td>Absent FRM</td>
<td>FRM</td>
<td>FRM</td>
<td>Excellent</td>
</tr>
<tr>
<td>32/M</td>
<td>MVA</td>
<td>Front of knee</td>
<td>16×13</td>
<td>19×16</td>
<td>Absent FRM</td>
<td>FRM</td>
<td>10p restriction</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>44/M</td>
<td>MVA</td>
<td>Front of knee</td>
<td>16×14</td>
<td>19×17</td>
<td>Absent FRM</td>
<td>FRM</td>
<td>10p restriction</td>
<td>Satisfactory</td>
</tr>
</tbody>
</table>
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. 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 soft tissue defects within its reach. 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.

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 were between 31-40 years of age. Mean age was 33±12.08 years. Maximum patients were male and 5 (25%) were female. Male female ratio was 3:1. Male patients were predominant in this study. Al-Moktader et al compared the results with present study. MV A (50%) was the main etiology of soft tissue defect in this study. Lin et al observed MV A (Motor Vehicle Accidents) as the most common cause of leg defects reconstructed with this flap. Khan et al 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 (40%). Kim et al reported most common involved site (69%) was the front of the knee. Naalla et al 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 to 17×14cm. The most common 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, the size of the flap ranges from 12×6cm to 27×12cm. The mean of the common size of flap was 21.4×8.6cm. 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 al 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 stitches 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 al 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 al 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 al 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.

**References**


