

Original Research Article

Analysis of challenging reconstruction of soft tissue defects around the knee joint and evolving a treatment algorithm

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ABSTRACT

Background: The soft tissue defects around knee joint give a challenging experience to reconstruct. There are various ways to reconstruct soft tissue defects around knee joint. In this study, a reconstructive algorithm is formed for soft tissue defect around knee joint using pedicled flaps.

Methods: Reconstructive procedures were done for 15 cases of soft tissue defects around knee joints following different etiologies during the tenure of January 2017 to December 2018 in the Department of Burns, Plastic and Reconstructive Surgery, Kilpauk Medical College, Chennai.

Results: Soft tissue defects around knee joint need flap to have a durable cover, to protect the underlying structures – bones, vessels, tendon, and to enable ease of free movement of knee joint without producing contracture. There are various etiologies for soft tissue defects around knee joint-post traumatic injuries, post total knee replacement, post electric burn injuries, post burn scar contracture release of knee joint. 15 cases of soft tissue defects around knee joint were reconstructed using various pedicled flaps-medial thigh rotation flap, gastrocnemius muscle and myocutaneous flap, reverse anterolateral thigh flap, propeller flap. In this retrospective study, reconstructive algorithm for soft tissue defects around knee joint is provided.

Conclusions: The reconstruction of soft tissue defects around knee joint is difficult one. In this study, a simple reconstructive algorithm is provided based on the experience in Department of Burns, Plastic, and Reconstructive Surgery, Kilpauk Medical College, Chennai.

Keywords: Reconstructive algorithm, Pedicled flaps, Reverse antero lateral thigh flap, Knee soft tissue defects

INTRODUCTION

The knee joint and its surrounding structures are essential for locomotion and stability of the body while standing, walking, jogging and running. The soft tissue defects around the knee joint give a challenging experience to reconstruct.

Yur-Ren Kuo et al described composite anterolateral thigh flap with vascularised fascia lata for the reconstruction of knee joint soft tissue and patellar tendon defects.¹ Auregan et al proposed distally based vastus lateralis muscle flap without skin component for the reconstructive alternative for complex soft tissue defects around the split knee.² Sahasrabudhe et al described distally based split vastus lateralis musculocutaneous flap for the

reconstruction of complex soft tissue defects around the knee joint.³

The Kilpauk medical college hospital, Chennai is one of the largest tertiary burn care centre and plastic and reconstructive care centre in South India. There are various ways to reconstruct the soft tissue defects around the knee joint. In this study, a reconstructive algorithm is formed for the soft tissue defect around knee joint using pedicled flaps.

METHODS

Study design

Reconstructive procedures were done for 15 patients with soft tissue defects around knee joints following different etiologies during the tenure of 2 years, January 2017 to December 2018 in the Department of Burns, Plastic and Reconstructive Surgery, Kilpauk Medical College Hospital, Chennai. All patients with only soft tissue defects around the knee joint from different aetiologies in all age groups were included in this retrospective study. Patients who were treated with free flaps and only skin grafts were excluded from the study.

Surgical technique

Soft tissue defects over knee region from different etiologies were assessed preoperatively about the position of the defect, size of the defect, structures exposed – muscles, tendon, vessels and bone. The surrounding regions of the knee defect – thigh and leg were clinically assessed about the presence of any scar, any other injuries. Pre-operatively the limb was evaluated about the vascularity of the flaps planned for each cases using hand held 8 MHz Doppler.

Soft tissue defects were thoroughly debrided surgically. In case of medial gastrocnemius myocutaneous flap, incision was extended downward vertically from the wound in the anterior knee, 2 cm from the medial border of tibia bone and a posterior incision in posterior midline was made to include the cutaneous flap. These two incisions were connected to raise the flap about 10 cm above the medial malleolus. The medial gastrocnemius muscle was dissected. The musculotendinous junction at the tendo Achilles was identified and divided with one cm of tendo Achilles extension with the muscle. The muscle flap was tagged to the cutaneous paddle with 3-0 vicryl suture. The myocutaneous flap was elevated and rotated to the anterior knee defect. The flap inset was given to the knee defect with 3-0 ethilon. The muscle and doner site were covered with skin graft taken from the thigh. In case of gastrocnemius muscle flap, the incision was extended from the defect downwards the leg vertically either in the posterior midline or medially 2 cm from the medial border of tibia depending on the defect. The skin flap was undermined and the gastrocnemius muscle was dissected and elevated along with 1 cm of

Achilles tendon extension. The muscle is rotated to the defect anteriorly to reach the defect in the knee and secured with bolster suture with 2-0 vicryl. The muscle was covered with skin graft taken from the thigh. Donor site was closed primarily.

In case of lateral gastrocnemius muscle flap, after wound debridement, the incision was extended from the wound in the knee region down to the leg through posterior midline and the lateral gastrocnemius muscle was dissected and elevated to accommodate the knee defect in the lateral aspect. The muscle is then covered with skin graft from thigh. Donor site was closed primarily.

For the medial thigh based rotation advancement flap, wound debridement was done for the soft tissue defect in the anterior knee region. Incision was extended to the thigh laterally with base of the flap on the medial side. The vascular basis of this flap was based on the perforators from the medial genicular arteries and the musculocutaneous perforators. Depending on the wound size, rotation flap was constructed and flap inset was given with no skin graft in one case and with skin graft in the donor site in the thigh in four cases.

Reverse anterolateral thigh flap is based on the perforators from reverse flow from the lateral genicular artery which will be about 8 to 10 cm from the superolateral border of patella, which forms the pivot point of the flap and the skin paddle is on anterolateral region of the thigh. Flap design was done according to the defect size. The skin flap was raised along with the perforators arising from the descending branch of the lateral circumflex femoral artery, which have communication to lateral genicular artery and also included a part of vastus lateralis muscle for the venous drainage. The flap was dissected upto the pivot point. Skin incision was made connecting the flap and defect and the flap was transposed to the defect along with the vascular pedicle dissected. Flap inset was given with 3-0 prolene. Donor site was covered with skin graft taken from the thigh.

In one case, propeller flap from the lateral aspect of the lower thigh was planned for the defect over the lateral aspect of the knee. Preoperative Doppler was done to identify and locate the perforator from the superior lateral genicular artery and this formed the pivot point. The flap was designed according to the size of defect and flap was raised based on the perforator. Flap was then rotated to the defect in the lateral knee defect and inset was given with 3-0 prolene and the donor site was covered with the skin graft taken from thigh.

In all the cases, tube drain was kept under the flap, which was removed after two to three days. Flap was monitored periodically to ensure the adequate vascularity. In two cases there was skin discolouration due to the flap congestion, some of the sutures were removed to release the tension and to increase the blood flow to the area.

RESULTS

In this study, it was found that the pedicled flaps were done for the knee region defects in all age groups and in both sexes. Out of 15 patients included in this study, males predominate – 11 patients including one child about 73% were male who were treated with pedicled flaps for the knee region defects. The etiologies for the soft tissue defects over the knee in this study included were post electric burn raw areas, post traumatic raw areas and post-surgical – post total knee arthroplasty raw areas (Figure 1). Of the 15 patients who had pedicled flaps done for soft tissue defects around the knee, 67% cases were done on the right knee, and 33% cases were done on the left knee (Table 1).

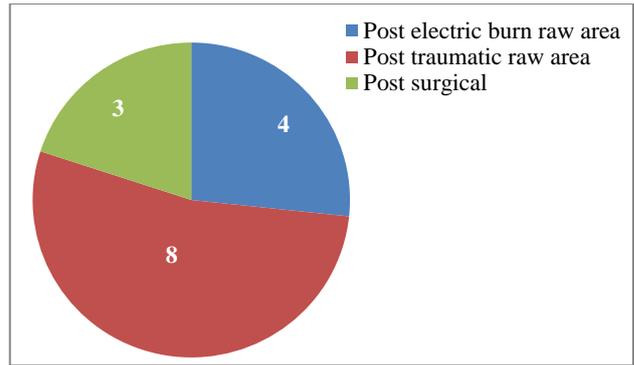


Figure 1: Different etiologies of the soft tissue defects over the knee region.

Table 1: Distribution of patients according to their demographic and clinical characteristics.

Variable	Number (%)
Age distribution (years)	
<12	1 (7)
12–40	12 (80)
40–60	2 (13)
Gender distribution	
Female	4 (27)
Male	11 (73)
Side wise distribution	
Right knee	10 (67)
Left knee	5 (33)
Etiology wise distribution	
Post electric burn raw area	4 (27)
Post traumatic raw area	8 (53)
Post-surgical (post total knee replacement)	3 (20)
Complication wise distribution	
Wound dehiscence	1 (7)
Partial necrosis of flap	1 (7)
Wound infection	2 (13)

Table 2: Various pedicled flaps carried out for the reconstruction of knee defects.

Pedicled flaps	Number of patients (%)
Medial thigh based rotation advancement flaps	5 (33)
Reverse antero lateral thigh flaps	4 (27)
Gastrocnemius muscle flap with split skin graft	5 (33)
Propeller flap	1 (7)

In this present study, medial thigh based rotation advancement flaps were done in 5 patients – 33% of cases. In another 33% of cases, gastrocnemius muscle/myocutaneous flaps were done. In 7% of cases, propeller flap was done. In 27 % of cases, Reverse anterolateral thigh (RALT) flap cases were done (Table 2).

The complications of these flaps include infection in 2 cases, wound dehiscence in 1 case, and partial necrosis of the flap in 1 case. Most of the complications were managed conservatively (Table 1). The partial necrosis of

the flap occurred in RALT flap which was debrided and skin grafted subsequently.

DISCUSSION

The skin over the anterior knee region is thin and pliable to give adequate movement of the knee joint in full flexion without giving discomfort to skin. While in flexion of knee joint, the skin exhibits extreme stretch without making break and gives adequate protection. In the posterior aspect of the knee region, the popliteal fossa is the main transition zone between thigh and leg. The

popliteal vessels and tibial nerve are protected by surrounding muscles in the popliteal fossa, which is a diamond shaped structure bounded superomedially by semimembranosus and semitendinosus muscles, superolaterally by biceps femoris muscle, inferomedially by medial head of gastrocnemius muscle and inferolaterally by lateral head of gastrocnemius muscle.

There is abundant vascular anastomosis around the knee joint region. Descending genicular artery arises from the femoral artery and gives branches – superior medial genicular artery and saphenous artery. Superior lateral genicular artery arises from popliteal artery and has anastomosis with descending branch of lateral circumflex femoral artery. This anastomosis forms the vascular basis for the RALT flap. Inferior medial and lateral genicular arteries arise from popliteal artery and have anastomosis

with superior genicular arteries and inferiorly with circumflex fibular artery and recurrent branch from anterior tibial artery. Popliteal artery supplies the gastrocnemius muscles through medial and lateral sural arteries. These arteries form the vascular basis for the gastrocnemius muscle flaps. There are multiple skin perforators from these named vessels which form the vascular basis for the perforator or propeller flaps used for the reconstruction of knee defects.

In this study, medial thigh based rotation advancement flaps were done for 5 patients with knee defects. In all these cases, the defect was in the anterior knee region (Figure 2).

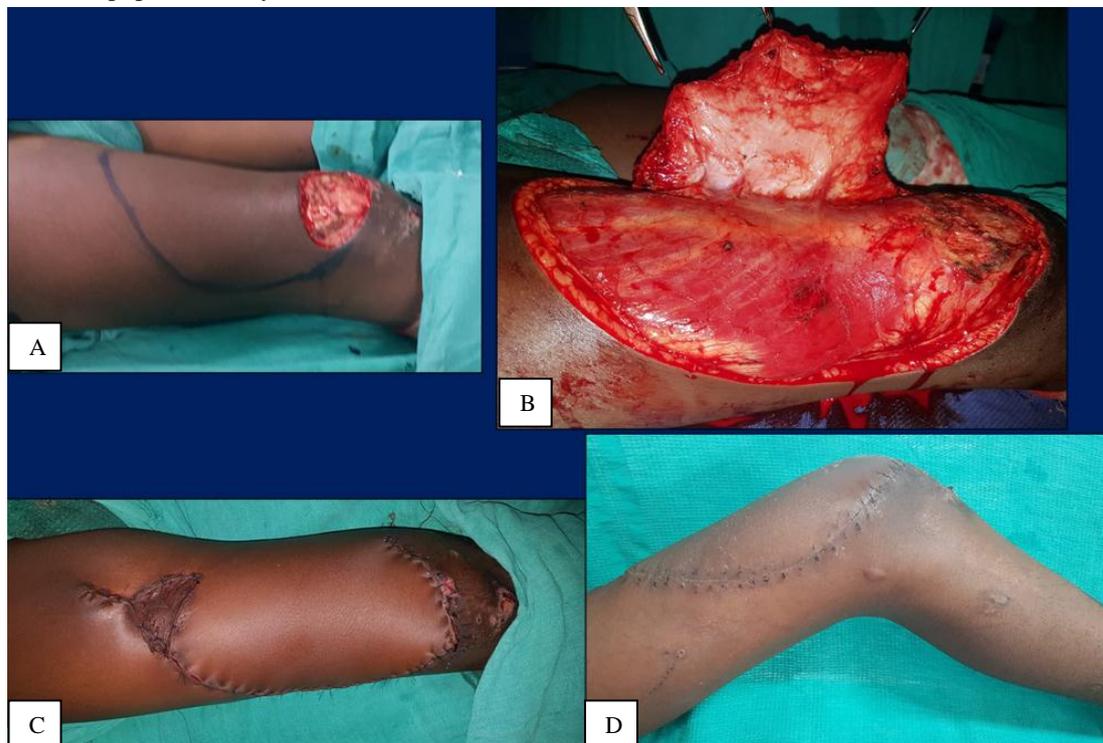


Figure 2 (A-D): Medial thigh based rotation advancement flap along with perforators at the pedicle, was done for the reconstruction of anterior knee soft tissue defect.

RALT flaps were done in 4 patients with knee soft tissue defects. Here one flap was used to cover anteromedial knee soft tissue defect (Figure 3), two flaps were used to cover lateral knee soft tissue defect and one flap was used to cover posterior knee soft tissue defect (Figure 4). The donor site defect was covered with split skin graft (SSG). In a study by Demirseren et al, there was discussion about the clinical experience with reverse flow anterolateral thigh perforator flap in 17 cases for the reconstruction of soft tissue defects of the knee and proximal lower leg.⁴ In our present study, not only the reverse anterolateral thigh perforator flaps were done for the knee defects, but also included other possible flaps like medial thigh based rotation advancement flaps,

gastrocnemius muscle/myocutaneous flaps and propeller flaps which were carried out to cover the knee defects.

Gastrocnemius muscle flaps were carried out in 5 patients with knee soft tissue defects. Here medial gastrocnemius muscle flaps with SSG were done in two cases (Figure 5), medial gastrocnemius myocutaneous flap was done in one case (Figure 6) and lateral gastrocnemius muscle flap with SSG was done in two cases (Figure 7).

Propeller flap was carried out in one case. In this case, the flap was used to cover the lateral knee soft tissue defect. The flap was based on the perforator from the superior lateral genicular artery.

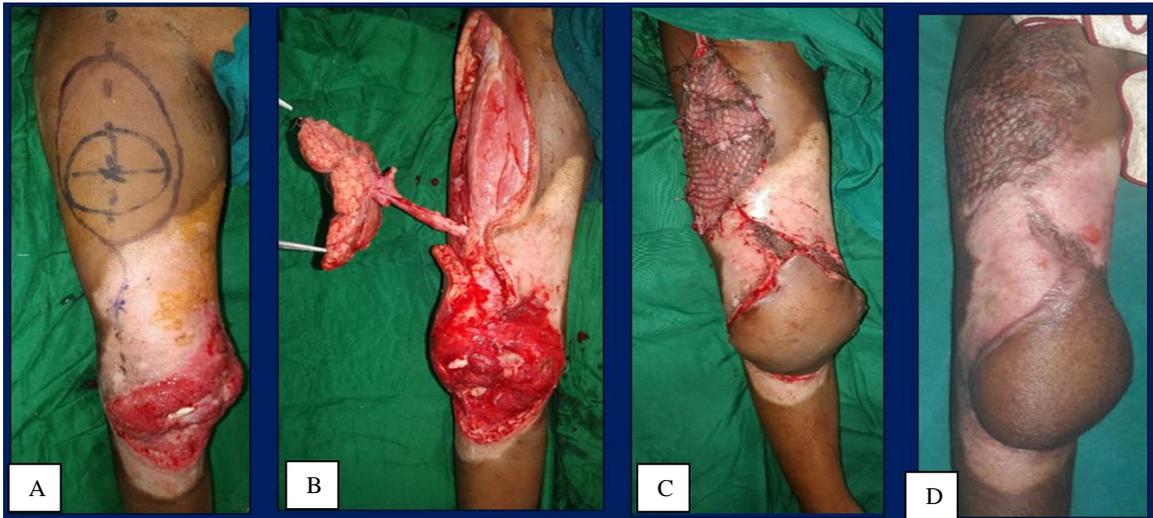


Figure 3 (A-D): Reverse anterolateral thigh flap was done for anteromedial knee defect following electric burn injury.



Figure 4 (A-C): 28 year old male with post electric burn raw area over posterior aspect of right knee was covered with RALT flap.



Figure 5 (A-D): 42 year old male with post traumatic medial knee region defect was reconstructed with medial gastrocnemius muscle flap with SSG.

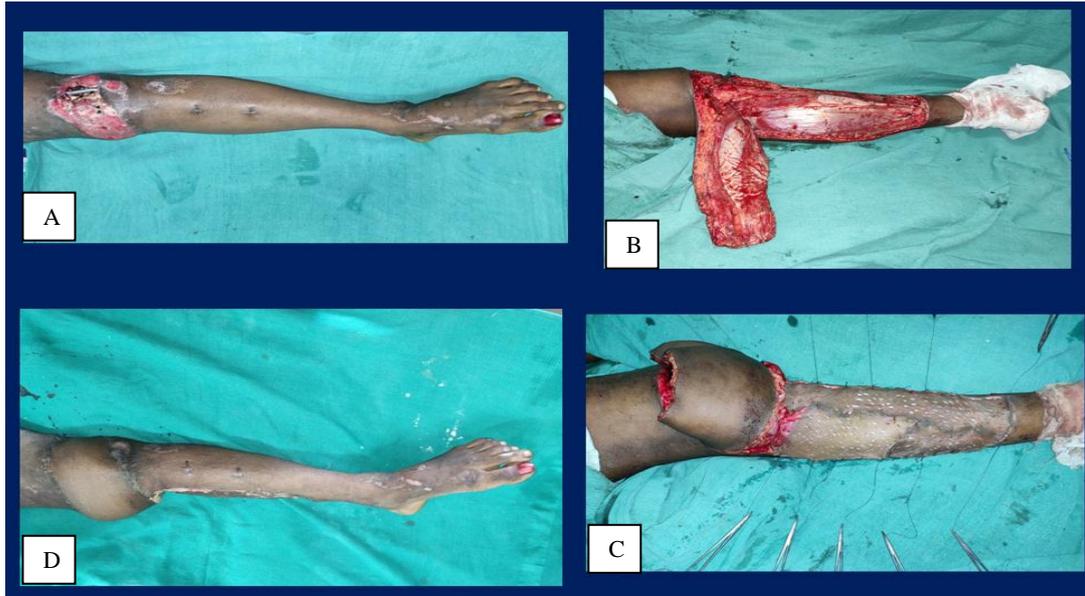


Figure 6 (A-D): 28 year old male with post traumatic post-surgical ORIF for femur fracture with soft tissue defect in anterior and lateral aspect of knee was covered with medial gastrocnemius myocutaneous flap.



Figure 7 (A-C): 36 year old male with post traumatic lateral knee defect was covered with lateral gastrocnemius muscle flap with SSG.

Rao et al, Wagner et al and Amin et al articles described various reconstructive options for soft tissue defect following total knee arthroplasty.⁵⁻⁷ In all these articles, they included the knee defect following total knee arthroplasty. But etiologies included in our present study were not only the knee defect following total knee arthroplasty, but also included other etiologies like knee defects following post electric burn injuries and post traumatic injuries.

Soft tissue defects around the knee joint need flap to have a durable cover, to protect the underlying structures – tibial and femoral condyles, popliteal vessels, patella and patellar tendon. Cover over the knee joint should be able

to have free movement of the knee joint. Reconstructive options with local flaps are limited. The presence of other multiple defects precludes free flap options, particularly in post electric burns. There is a review article for the reconstruction of the knee defects and proposed algorithm and it included the reconstruction of knee defects with skin graft, pedicled and free flaps.⁸ But our present study is an original article and it did not include defects covered with skin grafts and free flaps, which are always options for all kind of defects whenever needed and applicable.

In our present study, RALT flap provided adequate cover of knee region soft tissue defect and also provided the

vastus lateralis muscle over the bone and it covered all regions – anterior, posterior, medial and lateral soft tissue defects of knee. Gastrocnemius muscle flap provided good blood supply to the exposed bone and it covered both medial and lateral knee soft tissue defects. Medial thigh based rotation advancement flaps were used to cover anterior knee region soft tissue defects. Propeller

flaps based on medial or lateral genicular arteries can be used to reconstruct knee soft tissue defects over anteromedial or anterolateral aspect.

Based on this study, it is possible to make a simple algorithm for the reconstruction of knee defects using pedicled flaps (Table 3).

Table 3: Algorithm for the reconstruction of the soft tissue knee defects using pedicled flaps.

Knee region soft tissue defect	Reconstructive options
Anterior	Medial thigh based rotation advancement flap Reverse antero lateral thigh flap Medial gastrocnemius myocutaneous flap
Posterior	Reverse antero lateral thigh flap
Medial	Medial gastrocnemius muscle flap with SSG Reverse antero lateral thigh flap Propeller flap
Lateral	Lateral gastrocnemius muscle flap with SSG Reverse antero lateral thigh flap Propeller flap

CONCLUSION

The knee region should have adequate cover to safeguard the underlying vital structures like popliteal vessels, tibial nerve, condyles of femur and tibia and patella and patellar tendon. The reconstruction of soft tissue defects around the knee joint region by pedicled flaps is demanding and sometimes exasperating to the plastic surgeons, particularly in the situation of multiple defects due to burns. In this study, a simple reconstructive algorithm was provided based on the experience in the Department of Burns, Plastic, and Reconstructive Surgery, Kilpauk Medical College, Chennai.

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Conflict of interest: None declared

Ethical approval: Not required

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