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Original Research Article

Inferiorly Based Anteromedial and Anterolateral Thigh Flap for Reconstruction of Defects Around The Knee Joint

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Abstract:

Background: Soft tissue defects around the knee joint are caused by varied etiology. They present a challenge to the treating surgeon as the flap used for these has to not only cover the defect but also has to be pliable enough to restore full mobility of the joint after healing. Moreover, due to pliable and relatively lax skin, we have used inferiorly based anterolateral and Anteromedial thigh flap to reconstruct defects around knee joint.

Aims and Objectives: The aim of this study is to evaluate the use of inferiorly based anterolateral and Anteromedial thigh flap to cover soft-tissue defects over the proximal one-third of the leg, patellar region, knee, and lower thigh.

Materials and Methods: This study was conducted during the period between July 2024 and March 2026. Inferiorly based anteromedial thigh fasciocutaneous flap was performed on 12 patients and inferiorly based anterolateral thigh fasciocutaneous flap on 16 patients. The sites of the soft-tissue defects included patellar regions, infrapatellar region, suprapatellar region, and over the knee joint.

Results: Patients were evaluated post-operatively in terms of viability of flap, the matching of the flap with the recipient site, and donor site morbidity. All the flaps survived well except two which developed distal one centimeter marginal flap loss, two in which wound dehiscence was noticed. Two patient with wound dehiscence achieved complete healing by secondary intention. Patient who developed distal flap loss required debridement and skin grafting. No appreciable4 donor site morbidity was encountered. Skin colour and texture of the flap matched well with the recipient site. knee joint movement was adequate and according to the primary joint pathology.

Conclusions: The inferiorly based anterolateral and Anteromedial thigh flap is a reliable flap to cover the defect over patellar regions, infrapatellar region, suprapatellar region, and over the knee joint.

Keywords: Defect around the knee joint, inferiorly based thigh flap, anterolateral thigh flap, Anteromedial thigh flap, perforator based flap.

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Introduction

Soft tissue defects around the knee joint are caused by varied etiology. They present a challenge to the treating surgeon as the flap used for these has to not only cover the defect but also has to be pliable enough to restore full mobility of the joint after healing. Soft-tissue defects around the knees are common problems in the victims of trauma, post-operative wound or after arthroplasty and excision of various lesions, which is usually associated with bone and implant exposure.[1] Apart from post-traumatic defects[2,3] and oncological resections[4-7] knee soft tissue defects may arise from chronic infection, post-surgical radiation[8], or surgical release of postburn flexion contractures[9]. Moreover, can be caused by multiple previous operations[10,11,12]. Wound complications following total knee arthroplasty can occur up to 20% of patients, and are related to skin/soft tissue necrosis and possible exposure of the implant. Gross infection may lead to loss of the prosthesis or even of the limb[10,11,13]. Risk factors for knee wound complications could be related to the patient's general status and to local wound factors [14]. Diabetes is associated with dehiscence and infection[13], smoking is related to bleeding complications and infection[15], obesity may induce dehiscence and deep-venous thrombosis[15]. Local factors predisposing to complications are previous scars, major vessel trauma, hematoma, local infection, tension at the skin closure, and previous

irradiated skin[14]. Multiple options such as local fasciocutaneous flaps, gastrocnemius muscle flaps, perforator flaps and free microvascular flaps are available for periarticular knee defects. Most local flaps such as fasciocutaneous flaps and muscle flaps may share a common zone of injury. This limits the available options for reconstruction to distally based anterolateral thigh (ALT) flaps and free microvascular flaps. The distally based ALT flap was described first by Zhang in 1990. (16) This flap is not a popular choice because of its unreliable venous drainage and need for venous supercharging.2, 4, 5, 6 The distally based vastus lateralis muscle was first described by Wang et al. (17) in 1999. A study by Wang et al. demonstrated three arteries from the superior lateral genicular artery penetrating the distal part of the muscle. Coverage of these defects requires appropriate planning to keep the knee joint functioning. Currently, various reconstructive options available are gastrocnemius flap,[15] sural fasciocutaneous flap,[18] and saphenous flap.[19] These flaps are harvested from the leg, which is usually involved in traumatized lower limb. In this series, therefore, inferiorly based thigh flap has been used, including anteromedial thigh fasciocutaneous flap and anterolateral thigh (ALT) fasciocutaneous flap in 16 patients having soft-tissue defects around the knee joint for the coverage. Lu et al.[20] first confirmed the presence of at least one supragenicular fasciocutaneous perforator within 3 cm above the adductor tubercle. This perforator arises from the saphenous branch of the descending genicular artery, which accompanies two venae comitantes.[20] Inferiorly based anteromedial thigh fasciocutaneus flap can be taken from anteromedial aspect of thigh, which survives on supragenicular fasciocutaneous perforator. In 1990, Hayashi and Maruyama[21] have reported the inferiorly based ALT fasciocutaneous flap based on the perforators of the lateral superior genicular artery (LSGA) for reconstruction of defects around the knee, popliteal region, lower third of the thigh, and upper one-third of the leg. Due to variable pathway of its pedicle, this flap was not used widely at that time. Since its description, there are few publications focusing clinical application of this flap.[22,23] It was found in these publications that this flap can be very useful for soft-tissue coverage around knee joints.

Material and Methods

This prospective study was conducted in the period between July 2024 and March 2026. The sites of the soft-tissue defects included patellar regions, infrapatellar region, suprapatellar region, and over the knee joint. [Table 1]. The aetiology of the defects were trauma (n = 10), burn (n = 2), infections (n = 2), tumour excision (n = 1), and post-arthroplasty wound dehiscence (n = 1) [Table 2]. Pre-operatively control of infection was confirmed by culture test.

Table 1: Distribution of wound

Site of soft tissue defect	No. of patients	Percentage
Patellar region	8	28.5
Suprapatellar region	4	14.2
Infrapatellar region	12	42.8
Over the knee joint	4	14.2
Total	28	

Table 2: Aetiology of soft-tissue defect

Aetiology of knee defect	No. of patients	Percentage
Trauma	18	64.2
Infection	4	14.2
Tumour excision	3	10.7
Burn	2	7.1
Post-arthroplasty	1	3.5
Total	28	

The largest size of the defect was 28 cm × 10 cm, whereas the smallest size was 17 cm × 8 cm. The inferiorly based anteromedial thigh fasciocutaneous flap [Figures 1 and 2] was performed on 18 patients and inferiorly based anteromedial fasciocutaneous flap on four patients [Table 3 and Figure 3]. The size of the flaps ranged from 32 cm × 11 cm to 20 cm × 9 cm depending on the size of the defect.

Surgical Anatomy

Anteromedial thigh flap: The saphenous artery originates from the descending genicular artery at 9.16 ± 1.36 cm proximal to the adductor tubercle, and it travels distally towards the knee joint within the adductor canal.[20] Saphenous artery and its venae comitantes give off supragenicular fasciocutaneous perforator and its venae comitantes, which supply the inferiorly based anteromedial thigh flap. The saphenous artery with its venae comitantes penetrates the adductor aponeurotic plate into a space formed by the Sartorius anteriorly and

adductor magnus posteriorly at the distal part of the adductor canal.The saphenous artery travels distally into the subcutaneous tissue between the sartorius and gracilis. In this course, saphenous artery is accompanied by the saphenous nerve and gives off 2-5 direct fasciocutaneous perforators and 2-6 musculocutaneous perforators. These perforators supply the overlying skin and underlying sartorius muscle. At least one supragenicular fasciocutaneous perforator always arises from the saphenous artery within 3 cm proximal to the adductor tubercle and it accompanies two venae comitantes.[20] Supragenicular fasciocutaneous perforator passes through the anterior margin of sartorius in 90% of cases and in remaining cases, it passes through the posterior margin of the sartorius. Supragenicular perforator divides into ascending and descending branches. The ascending branch anastomoses with subcutaneous branches arising from other perforators of the saphenous artery, thus, forms a subcutaneous vascular plexus to supply the skin overlying inferiorly based anteromedial thigh flap.

Anterolateral thigh flap: Anterolateral thigh (ALT) flap can be used as a distally based pedicled musculocutaneous flap to cover the defects over the knee. The descending branch of lateral circumflex femoral artery has rich communications distally with perforators of lateral genicular artery and anastomosis around knee joint. 24 25 This flap has a large size and can reach up to 14 cm below the knee joint. The fascia lata can be utilized for reconstructing the quadriceps tendon if required. 26 As in case of the distally based flaps, a delay procedure will ensure better survival of the flap. A venous augmentation may be done by repairing the cut end of vein to a local vein to prevent possible venous congestion. 27 To reduce the bulk, an adipofascial flap can be raised which reduces the bulk of the flap and can be covered with a skin graft 28 (Fig. 5A-B). The lateral superior genicular artery originates from popliteal artery. It travels superolaterally and gives branches to the knee joint, vastus lateralis, and biceps femoris. It runs in the intermuscular space between vastus lateralis and biceps femoris. Then, it penetrates through the deep fascia proximal to the knee joint just above the lateral condyle of the femur and terminates as a skin perforator in this region.[29] The cutaneous perforators of LSGA penetrate through the deep fascia 5 cm proximal to the femoral condyle. The terminal branches of these perforators anastomose with musculocutaneous/septocutaneous perforators of the lateral circumflex femoral artery and perforator of profunda femoris and popliteal artery.[21]

Surgical Technique: All the patients were operated under spinal anaesthesia in the supine position.

Considerations for Coverage of Defects around Knee Joint

Knee joint is a hinge type joint with main movements of flexion and extension apart from minimal rotation. The thin pliable skin around the joint permits these movements without problem and any flap must be able to match this. When a flap is bulky, the extent of the defect can be planned with knee in full flexion so that it will not restrict the flexion of the joint. The stability of the joint depends on the integrity of the ligaments and other structures around the joint. In case of loss of these structures like patellar tendon, they should also be reconstructed along with the flap coverage either separately with a fascia or using the aponeurotic portion of the covering flap. Achieving a primary healing in a shortest possible time reduces the duration of immobilization and helps preventing stiffness of the joint.

Anteromedial thigh flap: The axis of the flap is delineated by drawing a line between the medial femoral epicondyle and midpoint of the inguinal ligament on the anteromedial aspect of the thigh. Supragenicular fasciocutaneous perforator arises from the saphenous artery within 3 cm above the adductor tubercle, which is the pivot point of the flap. Pre-operatively, location of these perforators is confirmed using hand-held Doppler, recipient site is prepared, and the size of the defect is measured. The size and location of the flaps were designed by following basic principle of the plastic surgery of planning in reverse.

First of all, the lateral border of the flap was incised and dissection was performed in the subfascial plane towards the medial side. During this process, intermuscular septum between vastus medialis and sartorius was identified and incised. Then, supragenicular perforator was identified along the anterior border of sartorius. This perforator was found within 5 cm of adductor tubercle. After visualisation of perforator, superior and medial borders of flap were incised and dissection continued proximally. Flap was, then, transferred to the defect. Donor site was closed primarily in most of the cases. In addition, skin grafting was required in some cases.

Anterolateral thigh flap: First of all, a line was drawn on the anterolateral aspect of thigh between the anterior superior iliac spine and the lateral border of the patella. Using hand-held Doppler, cutaneous perforator was marked around the lower part of this line. Again, similar to anteromedial thigh flap, by following the principle of planning in reverse, flap was designed. Dissection was performed proximally in the subfascial plane and intermuscular septum between rectus femoris and the vastus lateralis muscle was incised. During the process of dissection, perforators were identified at the pre-operatively marked sites in the space between vastus lateralis and biceps femoris just proximal to the lateral condyle of femur. After identification of the

perforators, flap was rotated about 5 cm above the patella and transferred at the recipient site. Donor site was skin grafted.

Results

All the patients were evaluated post-operatively in terms of viability of flap, the matching of flap with the recipient site and donor site morbidity. All flaps survived completely except one in which distal flap loss was noted and three in which minor complications occurred, including mild venous congestion in two patients and wound dehiscence in one patient [table 3]. Patient with distal flap loss required debridement and split thickness skin graft. Venous congestion in two patients subsided on its own within 3 days. One patient with ALT flap with suture line dehiscence achieved healing by regular dressings and antibiotics. The donor site healed well without major complications in all patients except acceptable minimal scar line and donor site skin graft. Two patients were dissatisfied with the appearance of the thigh due to skin graft. Skin colour and texture of the flap matching well with the recipient site was also observed.

All the flaps survived well except two which developed distal one centimeter marginal flap loss, two in which wound dehiscence was noticed. Two patient with wound dehiscence achieved complete healing by secondary intention. Patient who developed distal flap loss required debridement and skin grafting. No appreciable donor site morbidity was encountered. Skin colour and texture of the flap matched well with the recipient site.knee joint movement was adequate and according to the primary joint pathology.

Picture Gallery

Picture 1: Anteromedial thigh flap

Picture 2: Anteromedial thigh flap

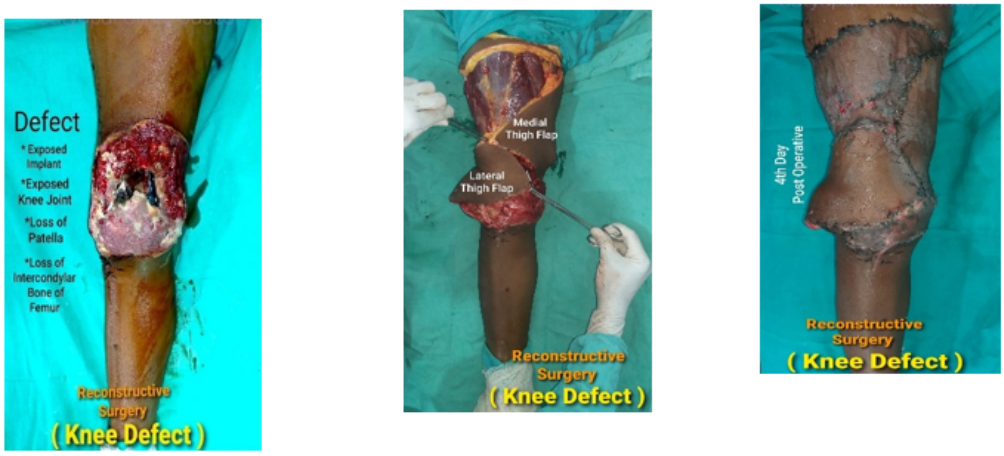

Figure 3: Anteromedial and anterolateral thigh flap

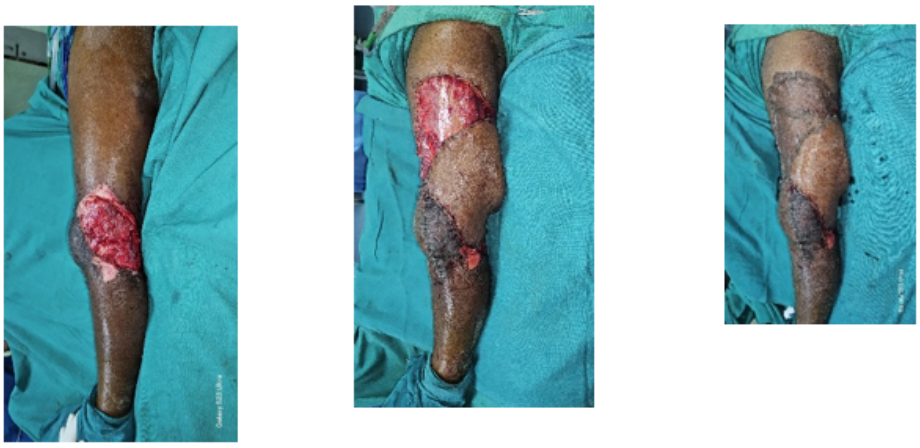

Figure 4: Anteromedial thigh flap

Picture 5: Anterolateral thigh flap

Table 3: Complications

Complication	No. of patients	Percentage	Treatment
Wound dehiscence	2	7.1	No treatment required
Distal flap loss	2	7.1	Debridement and skin grafting

Discussion

The aim of coverage of soft-tissue defect around the knee joint is to provide aesthetically acceptable appearance and maintain the function of joint.[30] There are many possible reconstructive options for the coverage of these defects. The flap can be harvested from the leg or thigh. Flap harvested from the leg can be muscle flap or fasciocutaneous flap. Muscle flaps are too bulky to provide better contouring to the knee. Fasciocutaneous flaps can be harvested, but it is difficult in a traumatised limb. Local random flap can cover only small defect and has unreliable vascularity. Cross leg flap has difficulty in immobilising the limb for 3 weeks. The vastus lateralis is too bulky giving unacceptable appearance and donor site problem.[31] The gastrocnemius flap is one of the good alternatives, but the low volume of the distal part of the muscle is a disadvantage, which is incapable of providing good coverage in large defect in suprapatellar region.[32,33] The sural artery flap can also be used due to its thin and pliable nature, but its size is limited.[34,35] Free flap is one of the good options that provide good coverage in one stage, but its use is difficult as it requires expertise, long operating time, and deep location of recipient vessels in this region.[36] Local advancement or rotation flaps is useful only for very small defects around the knee joint.[37] Moscatiello et al.[38] used skin islands from the distal anteromedial aspect of the thighs of six patients as local perforator flaps in order to reconstruct the peripatellar region and upper leg soft-tissue defects. They concluded that the propeller distal anteromedial thigh perforator flap can reliably be transferred based on the only one adequate perforator vessel, but the disadvantage is that it becomes a microsurgical technique where the dissection of the pedicle is performed by using binocular magnifying glasses. Since thigh is usually spared in the traumatised limb, and due to pliable and relatively lax skin, it is convenient to harvest flap from this region. Depending upon the location of the defect around the knee joint, flap can be harvested from the anteromedial or antero-lateral thigh. Lu et al.[39] performed their study on cadavers and confirmed the presence of supragenicular fasciocutaneous perforator within 3 cm above the adductor tubercle. These perforators originate from saphenous branch of the descending genicular artery. They performed their study on 11 patients with skin defects over the popliteal fossa, proximal 1/3 leg, and amputation stump below knee. Using distally based anteromedial thigh flaps, they successfully covered these defects and showed acceptable functional and cosmetic results in terms of movement at the knee joint and matching of skin paddle with the recipient site respectively. Chou et al.[40] described the distally based anteromedial thigh fasciocutaneous island flap for patellar soft-tissue reconstruction in seven patients. These island flaps were based on cutaneous feeders' vessels and perforator vessels in the muscle septum and deep fascia of the saphenous artery. In their series, all flaps survived uneventfully with only one having venous congestion. In our series, we performed inferiorly based anteromedial thigh flap on 12 patients with a size ranging from 32 cm × 11 cm to 24 cm × 8 cm (length to width ratio 2.9:1-3:1). All the flaps survived well except two, out of which, one developed mild venous congestion, which subsided after removing compressive dressings, whereas other developed distal flap marginal necrosis which, required debridement and skin grafting. Venous congestion is one of the common complications in distally based flaps. In the Chou et al. study, only one patients developed venous congestion which, subsided after removal of single stitch and compressive dressing. Lin et al. found that venous drainage is not liable to danger in distally based flap despite the presence of valves.[41] The reasons for distal flap necrosis could not be clearly identified in our series. Compression of pedicle, infection, and poor general condition of the patient could be one of the reasons. Zumiotti et al.[42] performed an anatomical and histomorphometrical study of the lateral genicular artery flap in 18 fresh cadavers and clinical results of knee reconstruction were demonstrated in four patients. They identified cutaneous perforator of the LSGA in all specimens at a mean distance up to the lateral condyle of the femur of 7.40 ± 2.77 cm and thus, they confirmed the constant location of the vascular pedicle. It was concluded that inferiorly based thigh fasciocutaneous flap on the perforators of LSGA is a useful option in the reconstruction of the defects around the knee joint. Al Moktader et al.[43] performed inferiorly based thigh flap on 15 patients on the perforators of LSGA for the reconstruction of defects around the knee joint. They had excellent outcome in all cases except one in which distal marginal flap necrosis was noticed that healed by debridement and dressings. The inferiorly based thigh perforator flap (LSGAP flap) is closer than the distally based reverse flow ALT flap to the knee or popliteal region, making it more versatile for coverage of defects of these regions.[44]

Conclusion

In our series, all the ALT flap survived well except one in which suture line dehiscence was observed that achieved healing by regular dressings and antibiotics. Old age and infection could be the reasons of wound dehiscence in this case.

Thin tissue, adequate length of vascular pedicle with flexible arc of rotation, early ambulation, cosmetically acceptable appearance and minimal donor site morbidity makes the inferiorly based ALT

flap, one of the good alternatives for soft-tissue reconstruction around the knee joint.[45]

Inclusion of the perforators in our series had several advantages. This helped in narrowing the base and increasing the length to breadth ratio of the flap. Narrowing the base also helped in increased rotation of the flap, and to some extent reducing the dog ear.

Regarding the donor site closure, various authors suggest closure in case the size is <8 cm. Donor defect more than 8 cm has to be skin grafted.[46,47] In our series, a donor defect of up to 9 cm was primarily closed, which depends upon laxity of the skin. Since anteromedial thigh skin is more lax as compared with anterolateral thigh, donor site closure in former one was comparatively easier than the later. One of the advantages of this flap, especially in the Indian scenario, is that the donor site is hidden as compared with the donor sites of the proximally based sural or the gastrocnemius flaps, where the donor site is on the calf, and more prone to visibility as compared to the donor site on the thigh.

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