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Outcome of reverse sural artery (RSA) fasciocutaneous flaps in Orthopaedician's hand for distal lower limb soft tissue defects caused by traumatic injuries at a peripheral tertiary care centre of northern India

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ABSTRACT:

INTRODUCTION: Coverage of soft-tissue defects in the lower limb is a common procedure due to the increased incidence of complex and high velocity traumatic injuries of lower limb. Donski and Fogdestam described a fasciocutaneous flap divided from the sural region. This was a basis for the reverse sural artery flaps (RSA). Many case series and case reports have been published about the procedure but practically doing it is not common procedure for orthopaedecians.This study was done to assess the outcome and complications faced by orthopedicians while doing reverse sural artery fasciocutaneous flaps without the help of expert hands.

MATERIALS AND METHODS:

This was a retrospective study done between time period between january 2016 and september 2021 at a peripheral tertiary care hospital in northern India by a orthopaedic surgeon where plastic surgeon availability was an issue. There were total 16 patients with mild to moderate sized soft tissue defects (3-8cm) .

RESULTS: Total 16 patients were operated, out of which 11 were male (68.75%) 5 were female (31.25%). Age of patients ranged between 16 to 62 years with average of 39.37% years. Area of soft tissue defect was distal 1/3rd leg in 7 patients, medial aspect of ankle in 4 patients, lateral aspect of ankle in 1 patient, exposed tendoachilis and retro-calcaneal portion of foot in 3 patients and heel in 1 patient. All 16 flaps healed successfully at the end of three months. Complications encountered were partial flap marginal necrosis in 3 patients, venous congestion in 4 patients, donor site partial necrosis in 2 patients, donor site full necrosis in 1 patient.

CONCLUSION: The reverse sural artery flap constitutes a reliable and versatile technique that should form part of the therapeutic arsenal of all orthopedic surgeons, facilitating the integral treatment of complex lower limb injuries with exposed defects.

KEYWORDS: reverse sural artery (RSA) fasciocutaneous flaps, Orthopaedician,s hand, soft-tissue defects

INTRODUCTION: Coverage of soft-tissue defects in the lower limb is a common procedure due to the increased incidence of complex and high velocity traumatic injuries of lower limb especially in last two to three decades. Besides fractures, soft tissue defects in the distal lower extremity represent a special challenge in deciding the operative method owing to the poor vascularity of the lower leg and the limited adjacent soft tissue. Soft tissue defects reconstruction in the leg, foot and ankle depends upon the size, location, and depth of the wound. During the last few decades, various methods of lower-limb wound coverage have been described, such as local flaps, distant flaps, and free flaps[1]. In 1983, Donski and Fogdestam described a fasciocutaneous flap divided from the sural region. This was a basis for the reverse sural artery flaps (RSA). The vascular pedicle of this reverse flap is on the septocutaneous perforating vessels that arise from the peroneal artery. These perforating arteries are most likely to be located in a region four to seven centimeters proximal to the lateral malleolus which is the the ideal pivot point for a pedicle flap[2] . One of the longest perforators is usually located in the four to five centimeter region above the lateral malleolus which allows this location to be considered a good site for a pivot point [3,4,5] . The venous drainage of this flap is important as well. Imanishi et al[6] discovered a small caliber network of veins that surround the sural nerve, which allow the bypass of valves of the lesser saphenous vein. For a long time, free flap transfer was the operation of choice in cases where the local tissues were severely damaged.

Orthopadecians encounter a large number of open fractures of distal leg and ankle. An orthopedic surgeon in the developing world sees at least 20 times the number of Gustilo III B open tibial fractures than his counterpart in developed world[7]. The numbers of open ankle and foot injuries are likely to be exponentially higher in a barefoot population. Despite these statistics, trauma care in the developing world tends to follow the developed world model with multiple teams caring for the different facets of open injuries. The financially poorer segment of society is affected[8]. This segment of society cannot afford to pay for highly specialized services, which do exist in urban centers. Although the results of single-stage reconstruction are good, timely coordination between orthopedic and plastic surgeons is often difficult[7,9,10,11].

Ideally soft tissue coverage should provide satisfactory function, reduce wound healing time, reduce complications, minimal morbidity and better cosmetic results. Skin grafting and secondary intention healing do not provide satisfactory results and also fail sometimes. Reverse sural artery fasciocutaneous flap is a simple and versatile procedure used in soft tissue coverage around distal one-third leg, ankle and foot with good results[12]. Many case series and case reports have been published about the procedure[13,14,15,16] but practically doing it is not common procedure for orthopaedecians. The literature is replete with level IV studies regarding Reverse sural artery fasciocutaneous flaps but only few case series or articles have been published when orthopedicians have performed the surgeries without help of expert hands like plastic surgeons.

The question of "who does soft tissue cover?" should have evolved from the philosophical to the practical by now. It is clear that the workforce and availability of flap surgeons has become a problem[17] . This study was done to assess the outcome and complications faced by orthopedicians while doing reverse sural artery fasciocutaneous flaps without the help of expert hands.

ISSN 2515-8260 Volume 09, Issue 07, 2022

MATERIALS AND METHODS:

This was a retrospective study done between time period between january 2016 and september 2021 at a peripheral tertiary care hospital in northern India by a orthopaedic surgeon where plastic surgeon availability was an issue. The operating orthopaedic surgeon had some exposure of flap surgeries during his senior residency period but did not had undergone specialized training or fellowship under plastic or flap surgeon at any time. There were total 16 patients with mild to moderate sized soft tissue defects (3-8cm) with exposed bone or implants in the distal third of leg or foot who were treated in our institution with reverse sural artery fasciocutaneous flaps as shown in table 1. We harvested moderate sized reverse sural artery flaps, to cover the defects. After perforator marking with Doppler, flap was planned in reverse, and procedure was performed. Factors like size of defect, flap size, width of pedicle, comorbid factors and complications following surgery were taken into account for the study.

Inclusion criteria:

Traumatic soft tissue defects in distal one third of leg, ankle or foot .

Exposed distal tibia implants

Exclusion criteria:

all patients with any scarring or wounds in posterior calf or pedicle region

tumour resection or wounds of chronic osteomyeltis.

Patients with history of diabetis mellitus, rheumatoid disease, hypothyroid disease, any immunocompromised disease, smoking.

PROCEDURE:

After obtaining fitness for surgery, an Informed consent for taken for surgery from all 16 patients. All patients were screened with Doppler ultrasonoraphy to access the venous competency and arterial patency for blood flow in the affected limb. 2-3 peroneal perforators were identified and marked.

With the patient in a prone position, parts prepared, sural nerve vascular axis was marked which consists of the median superficial sural artery, along with lesser saphenous vein as shown in figure 1. This axis courses between the heads of gastrocnemius muscle and its several cutaneous branches anastomose with approximately 3–5 septocutaneous perforators from the peroneal artery. The axis of the flap was directed towards an imaginary line which connected the midpoint of popliteal fossa, to a point which was behind the lateral malleolus. After wound debridement, the recipient raw area was measured then the flap with 1cm more than that of recipient raw area is designed, over the middle 1/3rd of calf region, and cross checked by doing planning in reverse. The pivot point of the pedicle was chosen according to the distal coverage requirement, but was limited by the lowermost perforator, about 5 cm (approximately 3 Fingers Breadth) , which is the most constant peroneal perforator from lateral malleolus tip.

The pedicle of the flap between the pivot point and proximal margin of the flap width of approximately 4 cms was maintained in all cases, the proximal and distal limits of the flap was marked. Flap dissection was started; the subdermal layer is dissected to expose the sural nerve, accompanying superficial sural vessels and short saphenous vein. At the distal end of the flap the sural nerve and short saphenous vein is identified, included in the flap and then ligated and cut and fixed to the flap paddle to prevent shearing of small perforators vessel plexuses. After complete elevation of the flap with the pedicle, and viability of the flap is assessed carefully for marginal capillary circulation. After confirmation of viability, the flap is transferred to the

ISSN 2515-8260 Volume 09, Issue 07, 2022

recipient area, due care was taken to prevent undue tension over the pedicle. The flap inset was done loosely applying few sutures without any tension. Drains are inserted under the flap as shown in figure 3b and figure 3c. The donor defect was covered with meshed split thickness skin graft taken from contralateral thigh and calf as shown in figure figure 3d. Non-adherent dressing was done over the grafted site and pedicle and over the donor site. Adequate dressing over flap region was done with a window to inspect the flap at regular intervals. The limb is elevated with care to prevent any compression over the pedicle and grafted area.

In the immediate post-operative period, the flap was monitored for any venous congestion and any flap necrosis which had occurred as shown in figure. The outcome was noted in terms of complete or partial flap survival, successful coverage of the recipient defect, and other complications.

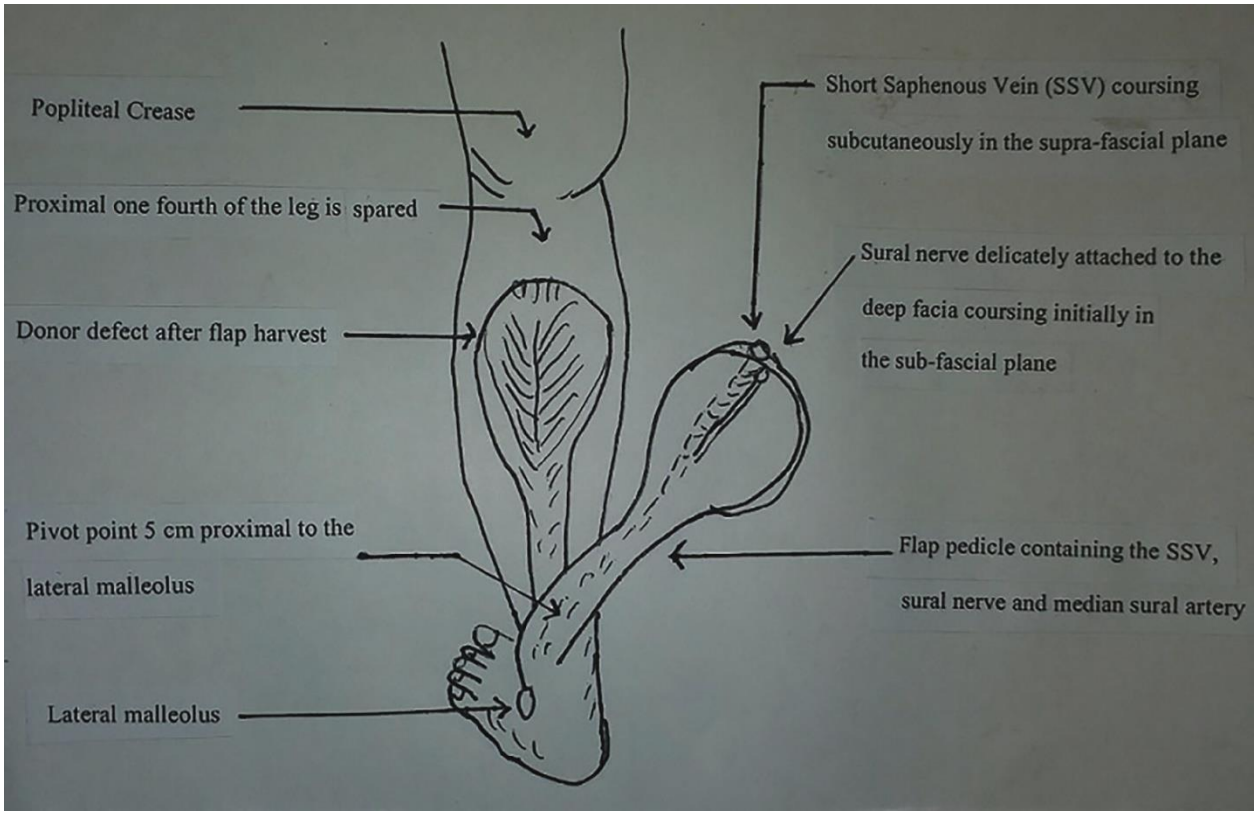

figure 1. Clinical anatomical landmarks of reverse sural artery fasciocutaneous flap.

ISSN 2515-8260 Volume 09, Issue 07, 2022

RESULTS:

Total 16 patients were operated, out of which 11 were male (68.75%) 5 were female (31.25%). (Table 1) Age of patients ranged between 16 to 62 years with average of 39.37% years. Area of soft tissue defect was distal 1/3rd leg in 7 patients, medial aspect of ankle in 4 patients, lateral aspect of ankle in 1 patient, exposed tendoachilis and retro-calcaneal portion of foot in 3 patients and heel in 1 patient. Diagnosis of patients was distal tibia open fracture with soft tissue loss in 7 patients, exposed implant in 3 patients, degloving injury in 4 patients and motorcycle spoke wheel injury in 2 cases. All 16 flaps healed successfully at the end of three months. Complications encountered were partial flap marginal necrosis in 3 patients, venous congestion in 4 patients, donor site partial necrosis in 2 patients, donor site full necrosis in 1 patient. Cases of flap partial necrosis were treated by serial debridement and dressings, antibiotics were given according to culture and sensitivity reports. One case of donor site split skin graft necrosis was managed by debridement and re-grafting. Two cases of donor site partial site split skin graft partial necrosis were managed by serial dressings. Patients with venous congestion in four cases were managed by above knee plaster back slab and strict limb elevation with active toe movements.

ISSN 2515-8260 Volume 09, Issue 07, 2022

Table 1

S. no	Age	Sex	Area exposed	Diagnosis	Flap size(cm)	Complications
1	24	M	Distal 1/3rd leg	Degloving injury	6x7	None
2	51	M	Medial maleolus	Open fracture	4x4	None
3	16	M	Tendo achilis	Degloving injury	8x7	Venous congestion
4	21	F	Retrocalcaneal	Degloving injury	5x6	None
5	42	F	Medial maleolus	Implant exposed	5x3	Venous congestion
6	48	M	Distal 1/3rd leg	Open fracture	6x8	None
7	43	F	Distal 1/3rd leg	Open fracture	5x5	Partial flap necrosis, donor site partial necrosis
8	35	M	Heel	Motorcycle spoke injury	6x5	None
9	48	M	Medial maleolus	Implant exposed	4x4.5	None
10	55	M	Distal 1/3rd leg	Open fracture	8x7	Venous congestion, partial flap (3/4th) necrosis, full donor site necrosis
11	62	F	Medial maleolus	Implant exposed	5x3	Partial marginal necrosis
12	49	M	Distal 1/3rd leg	Open fracture	5x6	None
13	18	M	Distal 1/3rd leg	Open fracture	7x6	None
14	36	M	Lateral maleolus	Open fracture	4.5x3	Partial donor site necrosis
15	40	M	Distal 1/3rd leg	Degloving injury	6x7	None
16	42	F	Tendo achilis	Motorcycle spoke injury	6x6.5	Venous congestion

ISSN 2515-8260 Volume 09, Issue 07, 2022

figure 2 A. 55 year old patient with history of open fracture distal tibia managed with hybrid external fixator showing exposed distal tibia on medial aspect

ISSN 2515-8260 Volume 09, Issue 07, 2022

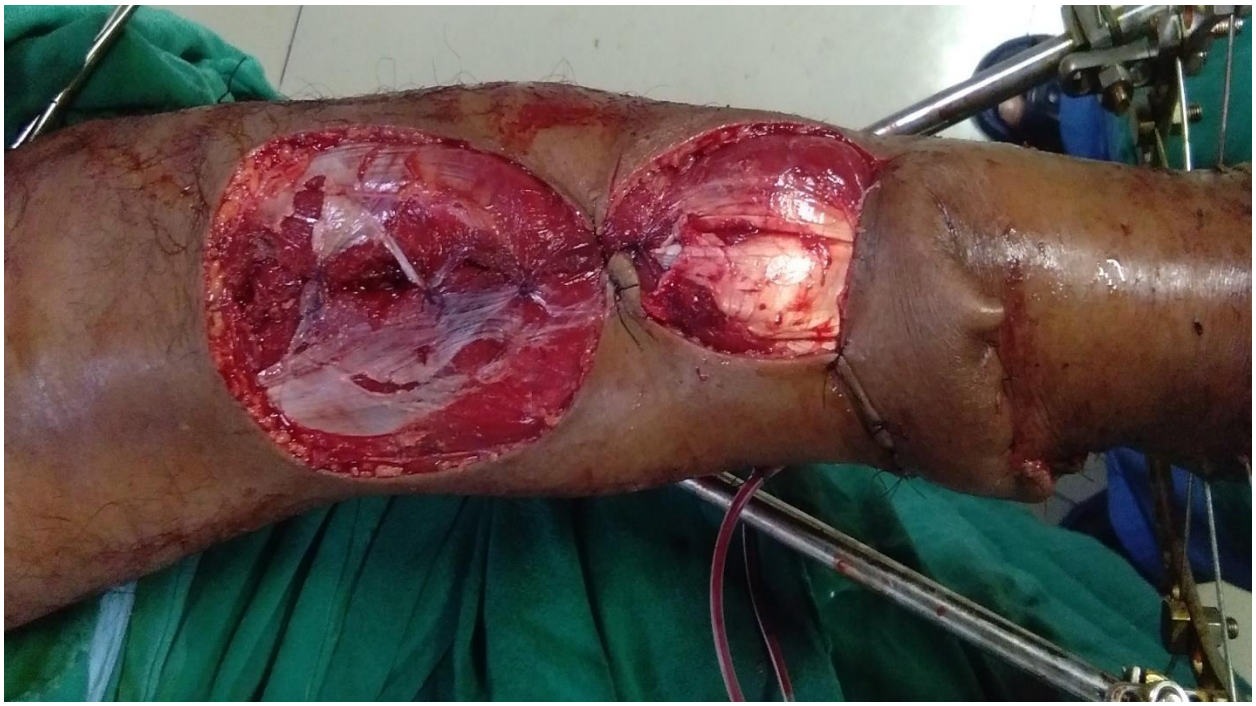

figure 2B reverse sural artery fasciocutaneous flap harvested

Figure 2C reverse sural artery fasciocutaneous flap transposed to exposed part of tibia on medial aspect with closed suction drain in situ

Figure 2D partial split skin grafting on harvesting site of reverse sural artery fasciocutaneous flap

ISSN 2515-8260 Volume 09, Issue 07, 2022

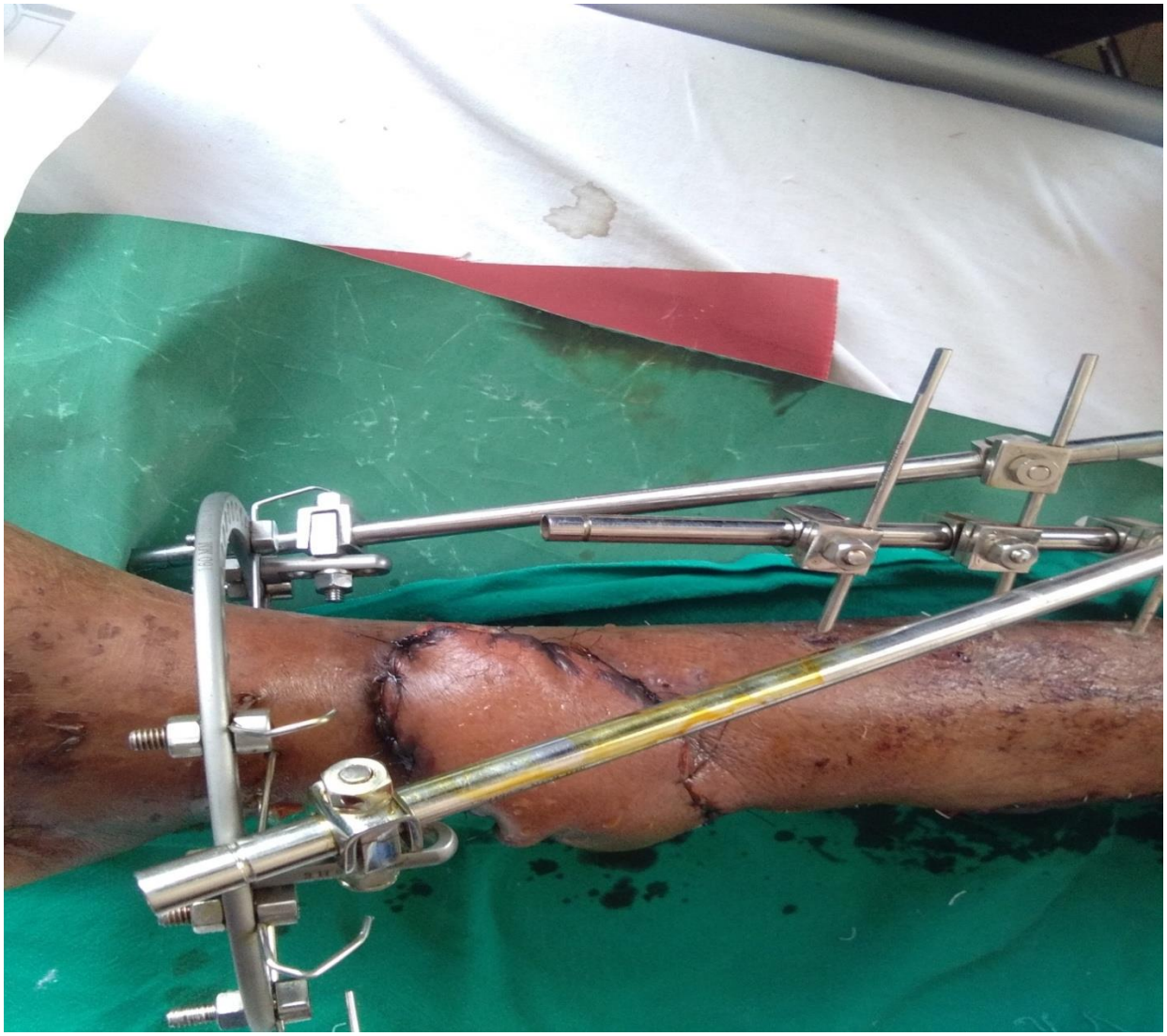

figure 2E- 5th day postoperative reverse sural artery fasciocutaneous flap showing venous congestion and marginal necrosis

ISSN 2515-8260 Volume 09, Issue 07, 2022

Figure 3A 16 year old with retrocalcaneal soft tissue defect as a result of degloving injury

ISSN 2515-8260 Volume 09, Issue 07, 2022

figure 3B- 5th day postoperative picture of reverse sural artery fasciocutaneous flap over retrocalcaneal region

ISSN 2515-8260 Volume 09, Issue 07, 2022

figure 3C- 1year follow up

ISSN 2515-8260 Volume 09, Issue 07, 2022

DISCUSSION:

Wounds around the lower 1/3rd of leg and foot are difficult to manage because of poor circulation. Often these wounds are associated with exposed bones, tendons and implants. Soft tissue defects of lower 1/3 tibia and foot used to be enigma of orthopaedic and even plastic and reconstructive surgeon.[18] Trauma due to road traffic accidents or wound dehiscence due to operative treatment account for most of the cases. Reconstruction of soft tissue defects of the leg, foot and ankle depends on the location, size, and depth of the wound. Various techniques have been developed for the reconstruction of these defects. Split skin graft remains the best option to cover superficial defects over dorsum of foot due to its faster take up and early neurotization. Various locally available options include local muscle flap, fasciocutaneous flap, perforator flap, supra-malleolar flap and sural artery flap.

The distally based superficial sural artery flap is vascularized by a median superficial artery with reverse flow as this artery has septocutaneous perforators from peroneal artery. The advantages of the flaps are that relatively large size flap can be harvested with little donor site deformity. Dissection is easy, blood loss is minimal & preservation of the major vascular structure of the lower limbs is possible. It also avoids the need for more sophisticated equipment and expertise .This flap has a wide arc of rotation on its pedicle at approximately 5cm superior to the lateral mallelolus.

In our study of 16 cases of reverse sural artery flap, all flaps healed successfully. Venous congestion with partial or complete flap loss is the most feared complication. Although there were complications post operatively but managed with early and active intervention. In this study there were three partial flap necrosis . One patient 43 years old female had deep infection with partial ischaemia of the margin, managed with debridement of necrosed part and intravenous antibiotics according to culture and sensitivity. Another patient 55 years old male with distal tibia open fracture had almost ¾ th of the necrosis. Reason for flap failure may be due to very bad soft tissue injury as in this patient donor site also failure for split skin grafting. This patient was managed with debridement and ultimately exposed bone got covered and flap healed successfully. Third patient 62 years old female had marginal necrosis which healed successfully subsequently with serial dressings.

Venous congestion is a well-known complication of the reverse sural artery flaps because of the presence of valves in the deep venous system that prevent uninterrupted retrograde venous flow. In our study 4 patients had complication of venous congestion. In one case venous congestion resulted in the almost ¾ th of the flap necrosis. Other three cases did not cause much trouble to the flap healing. All four patients of venous congestion were managed with strict limb elevation and plaster above knee back slab. We kept width of the pedicle minimum of 4 cm and corrugated rubber drain was kept beneath the harvested flap to prevent any haematoma collection which may cause venous stasis or congestion.

Jeng et al.[19] used this technique to cover exposed Achilles tendons and soft tissue defects of the ankle and the heel. Of the 22 patients described, 20 had complete success with two minor complications that were treated uneventfully. Huisinga et al[20] used this flap on 15 patients for soft tissue coverage in the lower leg malleolar and heel regions. Twelve flaps survived, two partially survived, and one flap failed due to persistent infection. Jeng et al[21] reported their

experience with the use of the distally-based sural artery flap for salvage of the distal foot. In seven out of eight patients, the flaps survived completely and only one patient had a partial necrosis of the flap.
Bocchi et al[22] used a reverse sural flap in 14 patients to successfully cover larger defects of the leg and ankle and a reverse adipofascial sural flap in 11 patients to cover moderate-size wounds in heel areas. Ferreira et al[23] reported that in 36 distallybased superficial sural artery flaps, only six partially necrosed and no major complications occurred.

The range of motion of the ankle and foot was within normal values, as recorded at six months. There were no patient complaints or complicated insensitivity (i.e., ulcer formation) related to the sacrifice of the sural nerve. Light paresthesia on the lateral border of leg and foot disappeared after two to three months.

Most authors mention the unaesthetic scar at the donor site, mainly if the closure needs a skin graft. Because the flap is harvested with the nerve, the loss of sensibility on the lateral aspect of the foot might pose certain problems[24].

The sural reverse flap is useful in the ankle and foot soft tissues reconstruction whenever we have reasons not to use a microsurgical free transfer. Drawbacks of this flap are the venous congestion, the volume of the flap, which is sometimes not suited for the reconstructed area, and thus the aesthetic appearance, and an additional unsightly donor site defect, but the mechanic properties of the integrated flap are very good.

Venous congestion with consecutive partial or complete flap loss is a common complication, so this would not be recommended in patients with obvious acute or chronic venous stasis.
Irrespective of aetiology, coverage of exposed soft tissue done in time is mandatory and essential for prevention of complications. Our clinical study recommends distally based sural artery flap as a good choice to cover soft tissue defects of lower 1/3 tibia and foot because the flap has numerous advantages. It is a one stage operation, which does not require microsurgical techniques. Elevation of the flap is easy and quick. The donor site has minimal morbidity as it can be closed primarily when small flap is raised and skin grafted when large flap is raised. The vascular supply to the arterial network of the sural area is constant and reliable, and there is no need to sacrifice any major artery and or sensory nerve. The pedicle is long, and the flap can be transferred around the lower 1/3 tibia and foot. Thus the distally based sural artery flap can be used as a good alternative to microsurgical reconstructions and can be done by an orthopaedic surgeon .

Limitation of study: Due to novice status of the surgeon in the flap surgeries, we purposefully decided to exclude any patient with associated co morbidities that can impair wound healing and may impair the homogenicity of the results. This would be considered a major limitation. However the purpose of study was to assess the feasibility of flap surgeries in orthopaedicians hand especially in acute trauma settings without expert help at hand. Our study included only 16 patient case series which is very less to generalize the results.

CONCLUSION: The reverse sural artery flap constitutes a reliable and versatile technique that should form part of the therapeutic arsenal of all orthopedic surgeons, facilitating the integral treatment of complex lower limb injuries with exposed defects . Though plastic surgeons will always be involved in extensive reconstructions and free flaps, involvement of orthopedic

surgeons in soft tissue cover of open limb injuries helps in improved and timely treatment of patients in developing countries. Soft tissue cover of lower limb injuries by a single team involved in bony stabilization and reconstruction using local flaps is an alternate and simpler solution to a difficult problem, especially when resources are limited and cooperation between two different teams is not always possible.

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