

## Superficial sural artery island flap for management of exposed achilles' tendon - Surgical techniques and clinical results

Kalam MA<sup>1</sup>, Faruquee SR<sup>2</sup>, Karmokar SK<sup>3</sup>, Khadka PB<sup>4</sup>

<sup>1</sup>Associate Professor, <sup>2</sup>Medical Officer, <sup>3</sup>HMO, <sup>4</sup>Resident, National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Sher-e-Banglanagar, Dhaka, Bangladesh

---

### Abstract

**Objective:** Superficial Sural artery island flap is a "island flap" based on vascular axis of the sural nerve which gets reverse blood flow through communication with the perforating branch of the peroneal artery situated in the region of lateral malleolar gutter. Achilles Tendon can be exposed due to trauma, post-operative wound dehiscence, infection etc. This exposed tendon requires immediate coverage to avoid complications. This versatile flap provides an excellent coverage for the exposed tendoachilles and has definitive advantages such as being easy to raise, having a wide range of arc of rotation, not compromising major arteries of the leg, requiring minimal expertise and infra-structural facilities, and having less morbidity to donor site and being a single staged surgery.

**Methodology:** Thirty patients with exposed Achilles' tendon were treated with Superficial Sural Island Flap with excellent outcome. The present study was carried out in the Department of Plastic and Reconstructive Surgery, National Institute of Traumatology and Orthopaedics Rehabilitation (NITOR), Sher-e-Banglanagar, Dhaka, Bangladesh between January 2001 to December 2004

---

The management of soft tissue defect in the lower third of the leg is considered a difficult task particularly in developing countries where infra-structural facilities are far from ideal or yet to be developed. The problem becomes worse because of the limited mobility and availability of the skin at the distal third of the leg region, unique weight bearing requirements and relatively poor circulation of the skin. This issue is further complicated when there is an exposed Achilles tendon with or without injury. This arises from the fact that the tendon itself is relatively avascular. This tendon is a vital organ of locomotion, when exposed requires early coverage to avoid impediment, like infection, desiccation and susceptibility to future tear and delay in coverage makes reconstruction of the tendon and subsequent coverage harder.

Distal third of the leg is known as the domain of free flaps like groin flap, requiring sophistication and developed infrastructure, even then bulk of the tissue hampers shoe wear. There are other methods of covering the exposed tendoachilles like distal-based fasciocutaneous flap and cross leg flap requiring large amount of tissue and two stage surgery. Some local transposition and island flaps like lateral calcaneal flap and Arteria dorsalis pedis based island flap can be utilized with constraint of size<sup>1</sup>.

To overcome these issues of difficult anatomy of the distal leg and different procedures we used island modification of the superficial sural artery flap de-

scribed by Masquelet in 1992.<sup>2</sup> The sural flaps provide good coverage of the defects, both from a functional and an aesthetic point of view. The major advantage of this flap is its easy and quick dissection. Because the major arterial axis is not sacrificed, this flap can be used in a traumatic leg with damaged major arteries. It is a versatile flap, has a wide arc of rotation and requires minimal expertise and infra-structural backup. This axial pattern flap depends on the vascular axis of the superficial sural artery which is usually constant. Duplex scan could be of added advantage in the planning, but is not mandatory.

In this paper we present our experience of island modification of this flap and its usefulness and dependability in the coverage of exposed Achilles tendon of different aetiology carried out in the Department of Plastic and Reconstructive Surgery, National Institute of Traumatology and Orthopaedics Rehabilitation (NITOR), Sher-e-Bangla Nagar, Dhaka, Bangladesh.

---

### Correspondence

Dr. Md. Abul. Kalam  
Associate Professor

Department of Plastic and Reconstructive Surgery  
National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR)  
Sher-e-Banglanagar, Dhaka, Bangladesh

## Materials and Method

Between January 2001 to December 2004 a total of 30 patients with 30 exposed Achilles' tendon were treated with superficial Sural island flap in the Department of Plastic and Reconstructive Surgery, National Institute of Traumatology and Orthopaedics Rehabilitation (NITOR), Sher-e-Bangla Nagar, Dhaka, Bangladesh, a tertiary referral hospital. (Table1).

There were 26 males, 4 females. The average age of patient was 32.03 yrs with age ranges from 3 to 65 years. The age of the defect on average was 18 days with the range of 5 to 30 days. The cause of exposed Achilles' tendon was Post-traumatic in 5 cases, Post-operative in 8 cases, Post-infective in 7 cases, Post burn in 5 cases, Breakage of Unstable Scar over the Achilles tendon in 5 cases.

## Operative procedure

The operation can be performed under regional or general anaesthesia. After giving anaesthesia the patient is positioned prone on the operating table. tourniquet was used on an average of 90 minutes.

## Anatomical landmarks (Figure-1)

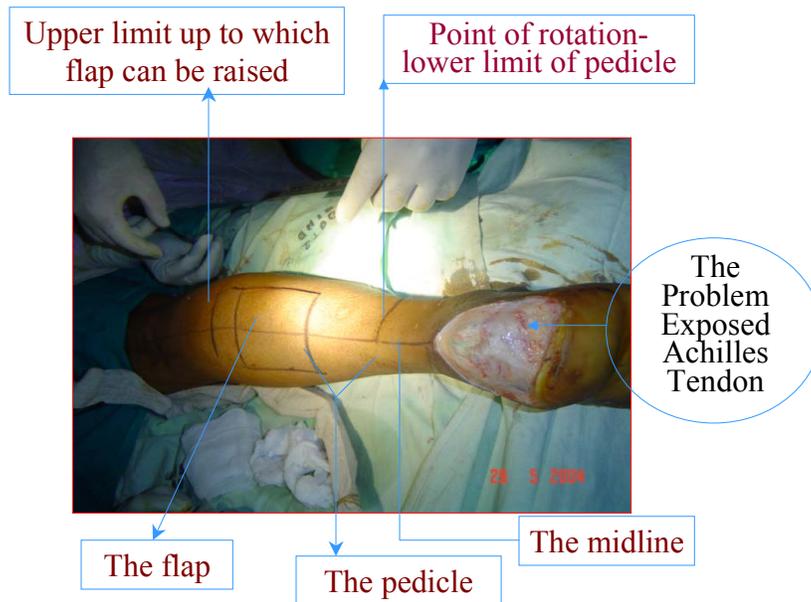
The superficial sural artery island flap is based on the superficial sural artery, which accompanies the sural nerve<sup>3,4</sup>.

The flap can be outlined and raised according to the requirement of the defect any where from the posterior aspect of lower two-thirds of the leg centred around the midline of the leg. The upper limit of the flap is the line between upper third and the lower two-third of the leg. The centre of the flap should be placed in the midline of the posterior surface of the leg with the pivot point of the pedicle located at least 6cm proximal to the lateral malleolus. Direction distal to this point risks damaging the anastomotic connection with the peroneal artery and consequently of the flap itself. The pivot point is the site of anastomosis of the peroneal artery with the suprafacial sural artery that accompanies the sural nerve. Regardless of the termination, this artery has a constant distal anastomosis with septocutaneous perforators from the peroneal artery, which will supply a reverse flow flap. To preserve the anastomosis within the supra-fascial plane, the deep fascia must always be included in the flap and pedicle. This artery has direct cutaneous branches only in its suprafacial portions that are in the lower two thirds of the leg.

**Table 1: Patient Summary**

Patient No.	Age (yr)& Sex	Cases	Defect	Flap size cm	Complications
1	24 M	Post traumatic	Skin defect over The Achilles Tendon	6x8	Nil
2	30 F			6x6	
3	18M			6x7	
4	12M			8x8	
5	42M			8x6	
6	46F	Postoperative		9x6	Tip Necrosis
7	39M			6x5	Nil
8	62M			7x6	
9	65M			5x5	
10	34F			6x7	
11	28M			8x9	Tip Necrosis
12	18M			8x10	Nil
13	19M	Post-infective		10x11	Nil
14	21M			12x14	Tip Necrosis
15	28M			12x14	Flap oedema
16	32M			6x8	Nil
17	39F			5x5	
18	44M			6x7	
19	43M			6x6	
20	45M	6x8		Infection	
21	55M	6x9		Tip Necrosis	
22	56M	8x10			
23	14M	9x11			
24	11M	Breakage of Unstable Scar		6x4	Nil
25	23M			8x5	
26	3M			11x5	
27	17M	Post burn		12x6	Nil
28	26M			12x6	Flap oedema
29	29M			12x11	Flap oedema
30	38M			Post burn	4x6

**Figure 1:** showing the anatomical landmark for raising superficial sural island flap



Length of the pedicle is the distance from the proximal margin of the wound to the line drawn 6 cm proximal to lateral malleolus. The pedicle must be at least 3 cm wide containing subdermal layer with the sural nerve, accompanying superficial sural vessels, and short saphenous vein.

The lower limit of the flap is the line drawn above the desired length of the pedicle. The size of the flap varied depending on the size of the defect. The maximum length and breadth is yet to be determined. We have risen up to 14x12 cm without any complication.

#### ***Procedure***

Skin incision is begun at the upper end of the flap to identify the sural nerve<sup>5,6</sup>. (Figure2) and then along the line in which the fascial pedicle will be taken. The subdermal layer is dissected to expose the sural nerve, accompanying superficial sural vessels, and short saphenous vein (Figure3). At the proximal margin of the flap, the vein is ligated and severed, and the nerve and accompanying vessels are also cut & the skin island is elevated as a flap with the deep fascia. (Figure 4, 5 and 6)

After raising the flap the pedicle can be rotated to cover the defect with the flap (Figure 7). The flap can be transferred to the defect either through a skin tunnel or by incising the skin bridge (Figure 7). This donor site defect can be closed directly when the flap is less than 3 to 4 cm wide, but for larger defects a split skin graft is needed. (Figure 7).

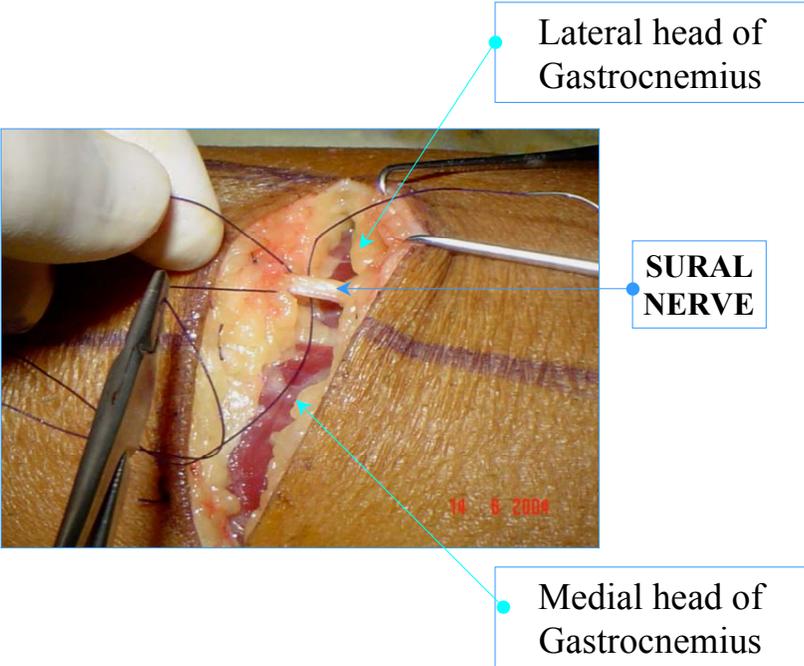
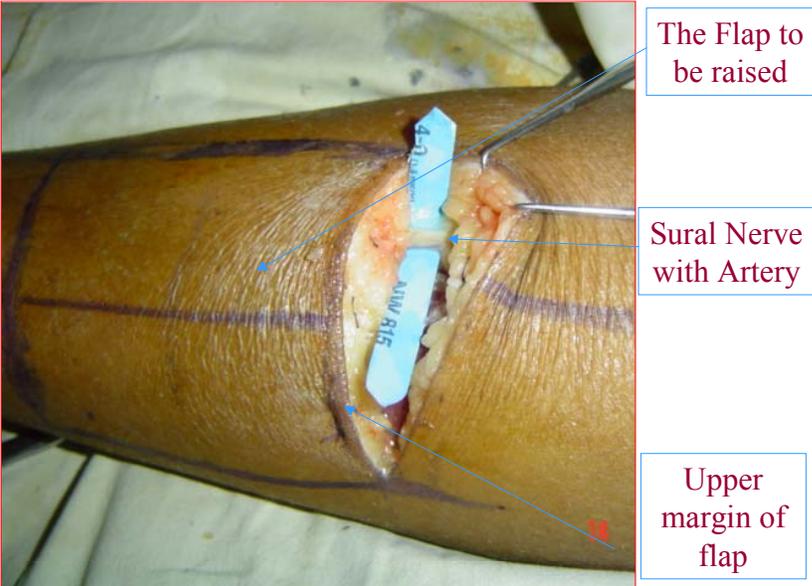
#### ***Postoperative care***

POP cast immobilized the limb for the time limit required by the pathology, which lead to exposed Achilles' tendon. Daily monitoring of the flap was done upto 1<sup>st</sup> dressing, Dressing changes were done at 3<sup>rd</sup> and 6<sup>th</sup> POD. Stitches were removed at 2 weeks.

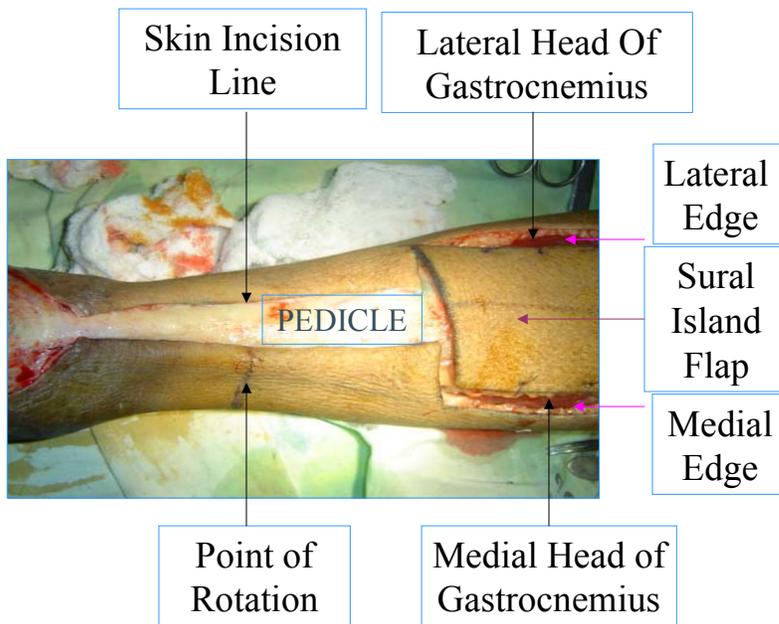
#### ***Follow-ups***

All the cases were followed-up to 9 months, and were evaluated for the healing of the flap, durability of the flap, ambulation, and sensation on the lateral side of the foot and on the flap. Donor site also was examined for scar formation, pain and neuroma.

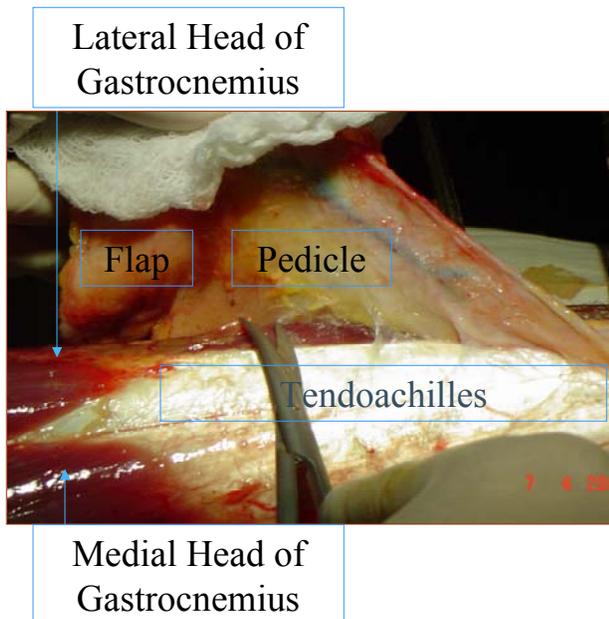
**Figure 2:** Incisions given at the upper end of the flap



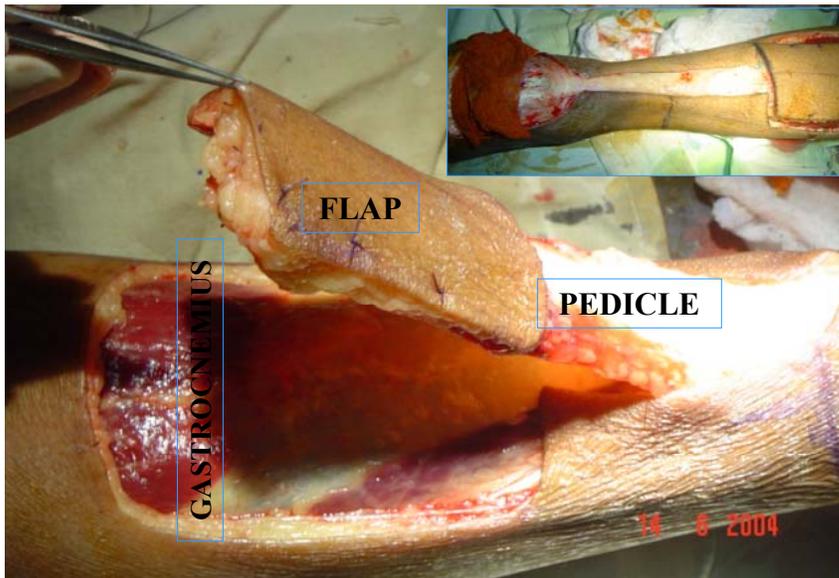
**Figure 3:** Superficial Sural nerve identified



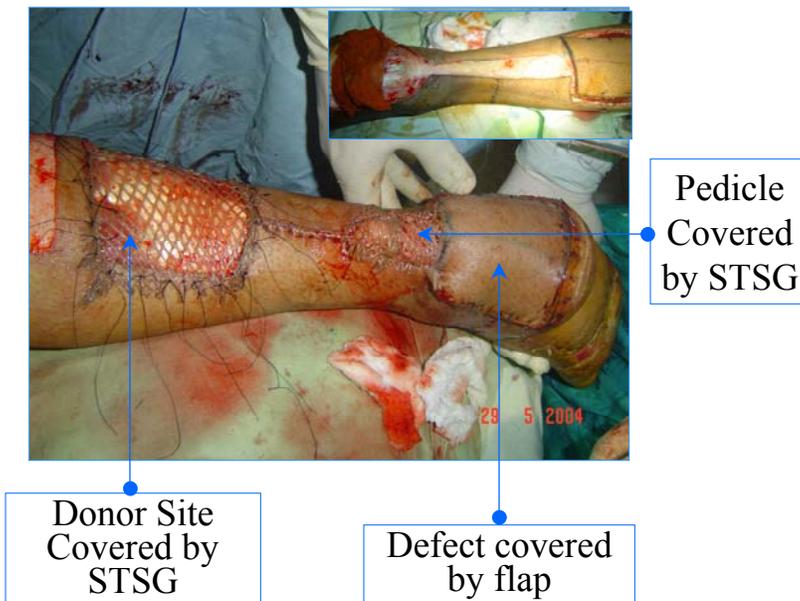
**Figure 4** Incisions for raising the Superficial Sural artery based island flap



**Figure 5:** Dissection to raise the flap and the pedicle



**Figure 6:** The flap raised along with the pedicle



**Figure 7:** Defect is covered by Superficial Sural island flap and donor site covered by split thickness skin graft (STSG)

## Results

The flap survived in 26 cases without any sorts of complications. The average healing time and hospital stay duration was 15 days and 23 days respectively. Four of the flaps had minor complications but eventually healed except one. One of the patient developed infection, which was controlled with antibiotics and daily dressing later required a small skin graft. Marginal necrosis was seen among 3 cases. It is probably because of tight suture and venous stasis and these cases were managed by secondary suture.

Out of all, four developed flap oedema which specially seen in larger flaps and relieved by elevation. Cutaneous hyposthesia was seen along the distribution of sural nerve, but this improved within 6 months. No debulking was needed in any of the flaps. One of the patients did not have any problem of wearing shoes, nor did the flaps show & any sort of ulceration during the follow up period. Donor area healed without problems like neuroma or ulceration, pain or ugly scar.

**Figure 8:** showing a failed postoperative case of exposed Achilles tendon with good functional and aesthetic covering following Superficial Sural Island Flap



Preoperative picture



Postoperative picture



follow-up picture

**Figure 9:** showing a failed posttraumatic case of exposed Achilles tendon



Pre operative picture

Pre operative picture



Follow-up picture

With good functional and aesthetic covering following Superficial Sural Island Flap

### Discussion

Soft-tissue defects of the distal third of the leg and foot are difficult to reconstruct especially when the Achilles' tendon is exposed. There are many options for coverage, including distally based fasciocutaneous flap, muscle flaps, septocutaneous flaps, axial flaps, local transposition flaps and free flaps. Each one has its own specific indications and limitations<sup>7,8,9</sup>.

Distally based fasciocutaneous flap based on perforators of either peroneal or post tibial arteries, needs to maintain length- breadth ratio, and is a two staged surgery. A huge amount of tissue is required to cover small to moderate-size defects<sup>10</sup>. Lateral calcaneal flap can cover defect of 3 cm in diameter, so it is not suitable for larger defects. Cross leg flap is cumbersome and not suitable for elderly patients due to prolonged immobilization. It is also a difficult prohibition for younger patient.

Free flaps may be an alternative but it needs expertise and special centres. Distal third of the leg is the domain of free flap. Generally, free flaps are superior to other methods because they allow reconstruction with well-vascularized tissues. However, free flaps are not without disadvantages and as they required sophisticated infrastructure, well-trained surgical team and

equipments. It is a lengthy procedure requiring general anaesthesia and it is very costly. It also becomes a big procedure when small to moderate-size defects require to be covered. Free flap has considerable percentage of failure even in the highly advanced centres. Considering these limitations pedicle flaps can be considered a first-line therapeutic option<sup>11</sup>.

The superficial sural artery flap is one of the recently introduced therapeutic modality described by Masquelet and colleagues in 1992. The superficial sural artery based island flap has many advantages<sup>12</sup>. The important advantage of the distal sural flap is that the blood supply is reliable, making this flap safe, even in patients with distal arterial-insufficiency and there is no sacrifice of major arteries or nerves. In fact, this flap can be used in traumatic legs with damaged major arteries. It is necessary to confirmed that the pedicle is at least 3 cm wide containing subdermal layer with the sural nerve, accompanying superficial sural vessels, and short saphenous vein. It should not extend beyond the line drawn 6 cm proximal to lateral malleolus.

The superficial sural island flap is a good choice to the management of exposed Achilles tendon. It has wide range of arc of rotation 180° for Achilles tendon coverage and is easy to perform by someone with less

expertise. The operative procedure is easy and can be accomplished in a short period of time with regional anaesthesia, which is very advantageous for patients with a generally poor medical condition. The success rate is high and minimal flap loss and other complications.

Because this flap is fasciocutaneous, its durability is excellent, even in weight-bearing areas at the back of the heel on tendoachilles. The under surface of the flap provides a good surface for gliding of the tendon. For reconstructions in the Achilles' tendon area, all the flaps used were fasciocutaneous, and no debulking procedure was necessary.

This flap has some limitations like maximum safe length-breadth ratio yet to be defined. There are no studies regarding maximum flap dimension (specifically, width) and safety, but usually a relatively large flap can be harvested with little donor site deformity or morbidity. Our largest flap measured 14x12 cm. This large flap healed without any complications. Larger flaps are yet to be raised and tested

The main disadvantages of this flap are the sacrifice of the sural nerve and the final scar, mainly when there is a need for skin grafts to close the donor area. This is important particularly in women. When the donor area is closed directly, the final result is aesthetically more acceptable (Fig 8 and 9). Direct closure of the donor area is possible for flaps less than 4 cm in width. In all our cases the donor site was closed by skin graft as the smallest flap was 4X6 cm. If closed primarily the final scar is linear and less obvious than the scar of grafted donor areas. It is very important to preserve the paratenon of the Achilles' tendon for a better bed for skin grafting, or there will be delayed healing in the donor area additionally, this flap is insensate.

The morbidity of harvesting this flap with the sural nerve is minimal. In our series all the cases developed hyposthesia in the distribution of sural nerve area and within six months of the harvest of this flap. All cases have recovered despite the fact that the nerve was always cut and raised with flap. There was no neuroma at the donor site as well.

Some complications which are discussed in the results of this study were related to personal variation. This was not the fault of procedure and could be overcome with ease without any further complications and limitations.

## Conclusion

Irrespective of aetiology, coverage of exposed Achilles tendon in time is mandatory and essential for prevention of complications. Our clinical study recommends superficial sural island flap as a good choice for treating exposed Achilles tendon because the flap has good number of 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 graft 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 island flap can be transferred around the ankle. This flap which can provide the pressure point on the Achilles tendon is quite stable and protective enough for mobilization. The deep fascia under the flap provides a good gliding surface for excursion of the tendon. Thus the superficial sural artery island flap can be used as a good alternative to microsurgical reconstructions.

## References

1. Grabb W. C. and Argenta L. C. The Lateral Calcaneal Artery Flap, *Plastic Reconstructive Surgery* 1985, 68: 723
2. Masquelet A. C., Romana M. C., Wolf G., Skin Island Flaps Supplied by the Vascular Axis of the Sensitive Superficial Nerves: Anatomic Study and Clinical Experience in the Leg. *Plastic Reconstructive Surgery* 1992; 89(1): 1115-1121
3. Carriquiry S., Costa M. A., Vasconaz L. O., Anatomic Study of the Septo cutaneous Vessels of the Leg, *Plastic Reconstructive Surgery* 1988; 79: 359-363
4. Bertelli J. A., Khoury Z., Neuro Cutaneous Island Flaps in the Hand: Anatomical Basis and Preliminary Results, *British Jour. Plastic Surgery* 1992; 45(8): 586-590
5. Heisinga R. L., Houpt P., The distally Based Sural Artery Flap, *Annals Plastic Surgery* 1988; 41: 58-65
6. Valmaz M., Karatas O., Barastcu A., The Distally Based Superficial Sural Artery Flap: Clinical Experience and Modifications, *Plastic Reconstructive Surgery* 1999; 99(3): 2358-2367
7. Hasegawa M., Tori S., Katoh H., Esaki S., The Distally Based Superficial Sural Artery Flap. *Plastic Reconstructive Surgery* 1993; 93(5): 1012-1020

8. Booxs M. D., Coverage Problems of the Foot and Ankle, *Orthop. Clin. North America* 1989; 20: 723
9. Rajauri V. N., Darweesh M., The Distally Based Superficial Sural Flap for Reconstruction of the Lower Leg and Foot., *British J. Plastic Surgery* 1996; 99: 383-389
10. Amavante J., Costa H, Soars R., A New Distally Based Fascio cutaneous Flap of the Leg, *British. J. Plastic Surgery* 1986; 39: 338-340
11. Honey G., Waney F. B., Reconstruction of the Lower Leg and Foot with the Removed Pedicled Posterior Tibial Fasciocutaneous Flap. *British. J. Plastic Surgery* 1989; 42: 512-516
12. Hyakasoku H., Tonegawa H., Fumirii M., Heel Coverage with a T-shaped Distally Based Sural Island Fasciocutaneous Flap, *Plastic Reconstructive Surgery* 1994; 93(9): 872-873