DOI: 10.7860/JCDR/2021/49735.15166

Original Article

Surgery Section

Functional Outcome of Weight Bearing Heel following its Reconstruction by Distally Based Sural Flaps

NEERAJ KANT AGRAWAL

ABSTRACT

Introduction: Tissue defects of the heel require resurfacing by flaps that could bear a great proportion of body weight and assist in pain free locomotion with minimum morbidity. The distally based sural flaps, also known as reverse sural flaps, have found widespread applications including reconstruction of the weight bearing heel. The durability of the reverse sural flap and its ease of resurfacing peculiar contour of the heel have encouraged its use. The evaluation of the functional aspect of this flap with regards to the pain, ulceration and ambulation is vital to establish and authenticate its use in heel reconstruction. American Orthopaedic Foot and Ankle Society (AOFAS) clinical ratings scale is one of the assessment schemes for its evaluation.

Aim: To evaluate the usefulness and versatility of reverse sural flap in reconstruction of heel as well as assessment of functional outcome of foot using AOFAS scoring system.

Materials and Methods: In this prospective study, carried out in the Department of Plastic Surgery at a tertiary care centre in Eastern Uttar Pradesh, India, 15 patients with soft tissue defects of the weight bearing heel were found who fulfilled the inclusion criteria. Reconstruction was carried out using reverse sural flap and its surgical planning as operative details were discussed. AOFAS scale was used to measure functional outcome of the reconstructed heel.

Results: Average age was 38.33±13.48 years and they presented earlier than 72 days. The dimensions of the reverse sural flap were 147.46±20.87 cm^2 to resurface heel defects of 57.75±17.08 cm^2. The largest defect was 13 cm long and 7 cm wide. Three flaps demonstrated distal necrosis as the length: width ratio was more than the well described safe limit of 3:1. They were 19-22 cm long while the width was narrowed to 5-7 cm at the base resulting in unfavourable dimensions and consequent necrosis. Other complications were persistent discharge and ulceration. AOFAS rating had a maximum score of 60, the average score being 50.2±7.39 (31-58).

Conclusion: The AOFAS clinical rating is a reliable and valid quantitative tool which is used for evaluating functional outcome in patients with reconstruction of weight bearing heel. Reconstruction of such challenging defects by the distally based sural flap proves its versatility and reliabilty. At the same time, the surgical technique of flap harvest is safe, of shorter duration and provides alternative to microsurgical reconstruction.

Keywords: Foot and ankle clinical scoring, Heel defect, Resurfacing, Reverse sural flap

INTRODUCTION

Reconstruction of heel is a tough proposition as it bears 60% of the body weight [1]. Flaps used in reconstruction of the weight bearing heel should have protective sensation and should have minimum shearing between the flap and the recipient bed. The size of the soft tissue defect of the heel determines the flap chosen for reconstruction. Local fasciocutaneous flaps are often not available while medial plantar island flap can resurface only small defects [2] often measuring 2.5×2.5 cm to 5.5×9.5 cm [3]. Some muscles reach the heel but the bulk of the muscle permits it to cover only small defects [4].

Medium (>5×5 cm) to large (>10×10 cm) defects of heel can be resurfaced by free flaps or pedicled flaps. Free flaps are preferred by many surgeons but the technical complexity, long surgical duration and immense experience are the limiting factors. Pedicled flaps are standard, more feasible and invaluable in heel reconstruction. Among these flaps posterior tibial, peroneal and sural neurocutaneous flaps have evolved as extremely useful flaps in reconstructive surgery of lower limbs. The advantages of using distally based sural neurocutaneous flap (aka revere sural flap) for heel reconstruction are that they provide adequately durable tissue that can easily be contoured to fit the defect. This flap was first described by Masquelet AC et al., in 1994 [5] and hence it became widely used. Reverse sural flaps can be further modified to make it safer like exteriorising the pedicle and a wider than usual base [6]. This axial flap has a consistent blood supply with an added advantage of sparing the major lower limb vessels [7].

The flap is an axial flap perfused by the superficial sural artery which originates from the popliteal artery or from a sural artery and travels with the lesser saphenous vein and sural nerve giving branches to the medial/lateral sural nerve, deep fascia and upper calf. The artery descends to anastomose with 3-5 distal perforators of the peroneal artery which vascularises a distally based sural neurocutaneous flap [5,8]. Venous return is ensured by the lesser saphenous vein [9] but Chang SM proposed that lesser saphenous vein may congest and compromise flap survival [10]. This may be prevented by ligation of large distal superficial veins.

The flap can safely be proposed to have reliable vascularity and acceptable complication rates as evidenced by studies that describe less than 80% of flap related complications [11].

Functional and aesthetic evaluation of the reconstructed heel is extremely vital to establish the usefulness and rationality of distally based sural flap to resurface such tricky defects. It was described by Kitaoka HB et al., as the AOFAS clinical ratings scale [12] and has also been validated by various scientists across the globe [13]. A few studies do not find it very useful but the researchers have not entirely refuted it [14]. The rating scale combined subjective and objective criteria to provide a profound outcome.

The present study was undertaken with the prime objective of understanding the usefulness and demonstrating the versatility of reverse sural flap in reconstruction of heel with appropriate follow-up. Functional outcome of foot using AOFAS scoring system [12] was vividly evaluated.

MATERIALS AND METHODS

This prospective descriptive study was carried out on 15 patients with soft tissue defects of the heel presenting to the Department of Plastic Surgery at a tertiary care centre in Eastern Uttar Pradesh, India, between April 2018 and March 2020. Medium size defects over weight-bearing heel [Table/Fig-1] varying from 35 cm^2 to 91 cm^2 were decisive in selecting the study population. The standard sampling methods were not applicable but the well-defined inclusion and exclusion criteria further helped in sample selection. The study was undertaken after approval from the Institute Ethics Committee and following consent from the subjects.

[Table/Fig-1]: Hand-drawn diagram of the plantar aspect of foot depicting a tissue defect on the weight bearing heel.

Inclusion criteria:

- Only soft tissue defects over the weight bearing heel including those associated with skeletal or Achilles tendon injury.
- Good active or passive movements of the ankle joints to facilitate aggressive postoperative physiotherapy.

Exclusion criteria:

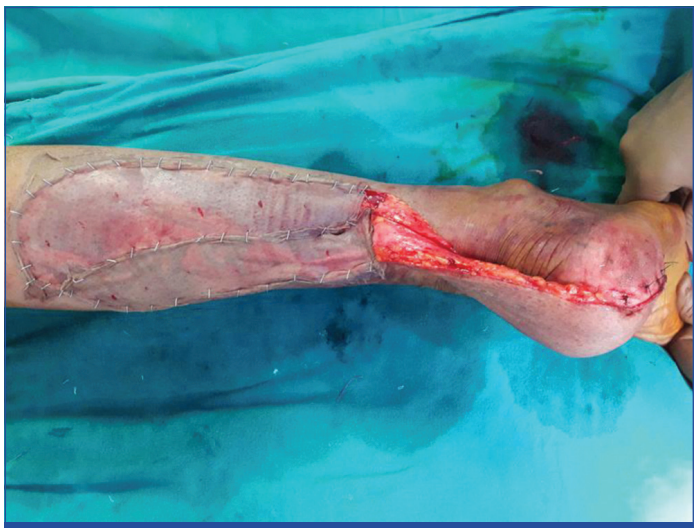
- Vascular injury.
- Purulent discharge from the wound.
- Chronic smoking which can jeopardise flap vascularity.
- Extensive scarring on the calf and adjoining area precluding the use of reverse sural flaps.
- Patients with major systemic illness and uncontrolled diabetes mellitus.
- Anticoagulants, if any, were discontinued a week prior to surgery.

Preoperative Assessment

1. Heel wound characteristics.
2. Skin condition and scarring adjacent to the heel defect.
3. Dimensions of the defect.
4. Availability of calf tissue.
5. Dimensions of the tentative reverse sural flap and the incision site.
6. Planning of a backup flap in case the reverse sural flap necrosed.

Surgical Procedure

The patients were placed in prone position. A line was drawn from the midpoint of the popliteal fossa to the lateral malleolus that indicated the vascular axis of the sural neurocutaneous flap. Hand-held audio Doppler was performed along this axis to identify perforators from the peroneal artery that were marked. 2-3 perforators were found at an average distance of 5-10 cm proximal to the lateral malleolus. A template of the defect was used to position the flap along this axis, such that the distance from the chosen pivot point to the proximal end of the flap was just greater than the distance from the pivot point to the distal edge of the heel defect. It was of utmost importance to delineate the proximal limit of the reverse sural flap 10 cm down this line of vascular axis. The perforators were marked using a hand-held audio doppler. The dimensions of the flap were carefully planned to avoid small and inadequate flap. The flap to be harvested was marked and dissection was performed from proximal to distal under tourniquet control. The initial proximal horizontal incision was used to identify the saphenous vein and sural nerve. In an exsanguinated limb, vein was found collapsed and, the sural nerve helped in identification of the lesser saphenous vein. Manoeuvres to overcome shearing of the flap over the loose subcutaneous tissue were bevelling the proximal incision to include more of deep fascia and tucking the deep fascia to the dermis at regular intervals. Dissection was performed in between the deep fascia and epimysium. The distal dissection limit of the pedicle was 6-8 cm above the lateral malleolus between the fibula and Achilles tendon. The flap was narrowed distally keeping a 5-6 cm wide base to incorporate the perforators. This resulted in smooth transfer of the flap without torsion on the pedicle. Tourniquet was deflated and the proximal edge of the flap was inspected for bleeding once the vasospasm settled. The flap was wrapped in warm saline also soaked in 2% lignocaine or papaverine to relieve the spasm. After ascertaining satisfactory vascularity, the flap was transferred to the defect and sutured [Table/Fig-2]. The limb was immobilised in an anterior plaster slab avoiding compression on the flap and the pedicle in supine position. This was extremely vital as even a trivial compression could compromise the vascularity. The pedicle was detached at three weeks for final flap inset into the heel defect [Table/Fig-3]. Thereafter, partial weight bearing was initiated whereas full weight bearing was allowed only after about six weeks of surgery. Regular follow-up visits were advised to detect the complications at the earliest.



[Table/Fig-2]: Reverse sural pedicled interpolation flap in place and sutured to the defect on the weight bearing heel. The secondary donor site over the calf covered by split skin graft.

[Table/Fig-3]: The pedicle detached after three weeks and the flap inset into the defect. The aesthetic appearance of the graft at the donor site on the calf is satisfactory with mild hypertrophy at the margins.

After 12 weeks, or when the stabilised skeletal injury had healed, functional assessment of the reconstructed weight bearing heel was done using AOFAS clinical ratings scale [12]. The parameters studied were a combination of patient's complains of pain and surgeon's assessment of ulceration, gait and details of ambulation [Table/Fig-4].

seen in five patients and iatrogenic heel defects due to various aetiologies were found in three patients [Table/Fig-5]. Three flaps demonstrated distal necrosis and were 19-22 cm long while the width was narrowed to 5-7 cm at the base resulting in length: width ratio >3:1. This resulted in necrosis of the excess length beyond the safe dimensions of 3:1 and varied from 3 to 6 cm. The width of the flap in [Table/Fig-5] demonstrated the effective width of the proximal part of flap which, when transferred, is inset into the widest part of the heel defect. Other complications were persistent discharge and ulceration. Calcaneum, distal part of Achilles tendon or both structures were exposed in nine patients [Table/Fig-5].

Functional outcome and symptomatology of the reconstructed heel were studied in detail as defined by AOFAS Ankle-Hindfoot Rating System. The weightage given to various parameters were evaluated and analysed [Table/Fig-4]. Out of maximum score of 60, the average score of the 15 patients were 50.2±7.39 (31-58).

DISCUSSION

Resurfacing of heel should take into consideration the peculiar contour of the heel as well as sensibility and durability. The heel skin is thick and robust due to the presence of stratum lucidum and, therefore, can easily withstand stress and friction [15]. The flap used for reconstruction of such weight bearing region should resist shearing forces during standing, walking and other forms of locomotion [16]. Lack of an ideal donor complicates the issue further [17]. Fasciocutaneous flaps have emerged as a viable option and alternative to muscle flaps and free tissue transfer in heel reconstruction. The enhanced reach of reverse sural flaps to resurface heel defects is largely due to proximity of the pedicle based between the Achilles tendon and lateral malleolus [Table/Fig-2]. However, the distal limit of dissection should be kept at 5 cm proximal to lateral malleolus [18]. Even more distal defect can be resurfaced by delaying the flap converting it to a three staged procedure [19].

The pedicle of the flap should be kept wide 5-6 cm to ascertain the inclusion of perforators as well as prevent venous congestion. The surgeon should learn to rely on audio doppler for localising the perforators to avoid unnecessary intraoperative dissection of perforators lest they get traumatised [20]. The sural neurocutaneous flap relies on the vascular plexus around the sural nerve with the short

Sl. No.	Heel consideration			Gait abnormality	AOFAS clinical ratings scale for function			Total score (60)
	Pain	Sensation in flap	Ulceration		Limitation of daily activities	Maximum walking distance	Walking surfaces	
1	40	Present	None	None	7	5	5	57
2	40	Present	None	None	10	5	3	58
3	30	Present	Present	Slight	10	5	5	50
4	20	Absent	Present	Obvious	4	4	3	31
5	40	Decreased	None	Slight	7	2	0	49
6	40	Present	None	None	7	5	3	55
7	40	Present	None	None	10	4	3	57
8	40	Present	None	None	7	5	5	57
9	30	Absent	Present	None	7	4	3	44
10	30	Decreased	None	Slight	7	2	0	39
11	40	Present	None	None	7	5	3	55
12	40	Absent	Present	None	4	2	0	46
13	40	Present	None	Slight	7	5	3	55
14	30	Present	None	None	10	5	5	50
15	30	Present	None	None	10	5	5	50

[Table/Fig-4]: Functional outcome of heel reconstruction by studying various parameters.
AOFAS: American Orthopaedic Foot and Ankle Society; AOFAS clinical ratings scale for function (total, 50 points, minimum 20); AOFAS ankle-hindfoot clinical ratings scale for pain: none (40 points), mild, occasional (30 points), moderate, daily (20 points), severe, almost always present (0 points); Limitation of daily activities: no limitation of activity in daily life (10 points), no limitation of daily activities, limitation in recreational activities, no support needed (7 points), limited daily and recreational activities, support with cane needed (4 points), severe limitation of daily activity, walker, crutches, wheelchair, braces needed (0 points); Maximum walking distance (1 block=150 m): >6 blocks (5 points), 4 to 6 blocks (4 points), 1 to 3 blocks (2 points), <1 block (0 points); Walking surfaces: no difficulty walking any surface (5 points), some difficulty on uneven terrain, stairs, ladders, inclines (3 points), severe difficulty on uneven terrain, stairs, ladders, inclines (0 points); Gait abnormality; None/slight, obvious, marked

STATISTICAL ANALYSIS

For interpretation of the quantitative variables mean, Standard Deviation (SD), minimum and maximum values were used.

RESULTS

Mean age of the 15 patients was 38.33±13.48 years (range 18-60 years) including 13 males and 2 females. Patients presented for plastic surgical consultation after 44.73±21.26 days but not later than 72 days [Table/Fig-5]. The mean size of heel defects was 57.75±17.08 cm^2 (35-91 cm^2). The largest defect was 13 cm long and 7 cm wide. The dimensions of the reverse sural flap to resurface defects were 147.46±20.87 cm^2 (112-180 cm^2). Non-healing ulcers of different aetiologies were the cause in seven patients, major road traffic accidents resulting in avulsion of heel pad were

Sl. No.	Age (y)/ Sex	Aetiology/effective cause heel defect	Presentation after injury (days)	Size of defect (cm×cm)	Structures exposed in addition to heel tissue	Flap dimensions (cm×cm)	Follow-up (months)	Complications
1	44/M	RTA/Avulsion	23	10×6	Distal TA	18×8	8	None
2	58/M	Trophic ulcer/Non healing ulcer	72	9×5	None	19×7	15	None
3	60/M	Discharging diabetic ulcer/Non healing ulcer	55	8×5	None	20×8	9	Small ulcer
4	50/M	RTA/Avulsion	5	13×7	Calcaneum and distal TA	22×8	12	Distal necrosis
5	21/F	Old trauma foot/Non-healing ulcer	63	9×6	Calcaneum	18×8	8	None
6	43/M	Old burn/Adherent scar	56	8.5×5.5	Calcaneum	17×7	9	None
7	45/M	Old trauma/Non healing ulcer	48	9×7	None	19×9	13	None
8	46/M	Diabetic/Non healing ulcer	72	9×6	Calcaneum with necrosed TA insertion	19×8	10	None
9	48/M	RTA/Avulsion	34	14×6	Calcaneum and TA insertion	22×7	10	Distal necrosis
10	41/M	Osteomyelitis/Non healing ulcer	64	7×5	None	16×7	15	Persistent discharge
11	31/F	Old trauma/Previous skin grafting	56	9×5	Calcaneum	20×9	9	None
12	20/M	RTA/Avulsion	12	11×5.5	Calcaneum	19×7	12	Distal necrosis
13	28/M	RTA/Avulsion	16	11×8	Calcaneum	19×9	8	None
14	18/M	Old trauma managed by flap/Local flap necrosis	39	10×6	None	18×8	16	None
15	22/M	Diabetic/Non healing ulcer	56	8×5	None	17×7	9	None

[Table/Fig-5]: Demographic data and surgical details.
RTA: Road traffic accident; TA: Achilles tendon

saphenous vein accompanying it. Therefore, precise identification and inclusion of these structures in the initial horizontal incision assures the vascularity of the flap [21]. Anaesthesia in distribution of sural nerve usually resolves with time but neuroma could be a concern. The sural nerve should be pulled distally prior to division using a scalpel to allow proximal retraction of the nerve.

Ponten's revolutionary work on fasciocutaneous flaps demonstrated length-to-width ratio of 3:1 in the lower extremity [22]. In the present study flaps that necrosed exceeded the ratio of 3:1. The length of the flap that necrosed was the part that exceeded the safe ratio and varied from 3-6 cm along the long axis. The subsequent loss of the effective flap fails to resurface the heel. Small defects were covered by advancement of the redundant flap or by alternative local flaps. Ulceration was seen in one patient with flap cover for diabetic ulcer that necessitated shaving of the calcaneal irregularity and local flap cover.

Flap is usually detached at three weeks by this time the flap is expected to develop neovascularisation from the recipient bed as well as skin margins of the recipient site [Table/Fig-3]. On the contrary, Tsur H et al., demonstrated, in experimental setting, that flaps can be divided as early as 10 days [23]. The speed with which the flap can be harvested is an indirect measure of the complexity of the flap. Injury to vital anatomical structures and consequent functional deficit is an extremely important parameter to ascertain patient safety. It may also invite unnecessary litigations and legal hassles. Aesthetics of the secondary donor site also need quantitative evaluation as perception of patients may be biased, varied and unrealistic.

Characteristics and functional outcomes of the reconstructed heel were critically evaluated by the AOFAS Ankle-Hindfoot clinical ratings scale [Table/Fig-4]. The validity of the scale in assessment of heel defects was a matter of great debate but newer studies have concluded adequate validity and reliability making it a suitable instrument for investigating functional outcome [24]. 40% of patients complained of varying degrees of pain limiting their ambulation. This was extremely crippling and was attributed to complications such as flap necrosis and ulceration as well as due to exposed peripheral nerves. Ulceration in reconstructed heels was recorded in only one patient in the present research but studies have reported 33% ulceration in fasciocutaneous flaps [25]. It usually results form a calcaneal sore or defective footwear. Protective deep sensation was regained in 66% reconstructed heels although the need of sensate flap for heel has been debated. The issue largely remains unsettled but importance of deep pressure sensation cannot be undermined [26]. It has been pointed out that muscle flaps cannot be neurotised to provide protective sensation and results in recurrent ulcers. This further justifies the use of fasciocutaneous flaps.

The AOFAS rating scale evaluated the functional outcome of reconstructed heel. Most of the patients could manage their routine work without any support except two patients who had severe limitations in carrying out their daily activities. These patients sustained necrosis of distal part of the flap and, therefore, required support to move around. The average points for daily activities as calculated by AOFAS scale was 7.6/10 with 5/15 patients absolutely normal. The average distance covered by the patients was 600-900 metres with average points 4.2/5. The mean distance traversed was less owing to the fact that three subjects, who had flap complications, could walk <400 metres with strenuous exertion. Therefore, walking on irregular surfaces was simply impossible. The crippled locomotion due to flap loss or ulcerations was easily understood.

Extensive statistical analysis was not performed as it was not extremely useful in the current study. The emphasis was on the approach and technical aspects of dissection of reverse sural flaps. The discussion was meant for the readers to appreciate the utility of the flap in reconstruction of the weight bearing heel as well as understand the scoring system to evaluate the functions of the foot.

Limitation(s)

The present study has limitation of being a single centre and a single surgeon work. Thus, demography of only one region has been studied which may be a surgical constraint. It also lacks comparison with other regional or distant flaps.

CONCLUSION(S)

In the present study, the success of reverse sural fasciocutaneous flap for heel reconstruction was achieved by proper selection of patients, locating the perforators of peroneal artery by hand held audio doppler and planning an effective flap in upper third of the leg to be able to reach the heel without tension or torsion. AOFAS clinical ratings scale, despite controversies, proves to be a useful tool for assessment of functions of the reconstructed foot.

Multicentric study could give regional variations and help us to evaluate the surgical technique related results better. The future work should compare free flaps (microvascular) and pedicle flaps for distal foot and heel reconstruction. This would establish the superiority of either of the surgical technique. The sample size should be higher to reach a definite conclusion.

REFERENCES

[1] Cavanagh PR, Rodgers MM, Iiboshi A. Pressure distribution under symptom free feet during barefoot standing. Foot Ankle. 1987;7(5):262-76.
[2] Oh SJ, Moon M, Cha J, Koh SH, Chung CH. Weight-bearing plantar reconstruction using versatile medial plantar sensate flap. J Plast Reconstr Aesthet Surg. 2011;64(2):248-54.
[3] Scaglioni MF, Rittirsch D, Giovanoli P. Reconstruction of the heel, middle foot sole, and plantar forefoot with the medial plantar artery perforator flap: Clinical experience with 28 cases. Plast Reconstr Surg. 2018;141(1):200-08.
[4] May JW Jr, Halls MJ, Simon SR. Free microvascular muscle flaps with skin graft reconstruction of extensive defects of the foot: A clinical and gait analysis study. Plast Reconstr Surg. 1985;75(5):627-41.
[5] Masquelet AC, Romana MC, Wolf G. Skin island flaps supplied by the vascular axis of the sensitive superficial nerves: Anatomic study and clinical experience in the leg. Plast Reconstr Surg. 1992;89:1115-21.
[6] Lo JC, Chen HC, Chen HH, Santamaria E. Modified reverse sural artery flap. Changgeng Yi Xue Za Zhi. 1997;20:293-98.
[7] Mojallal A, Wong C, Shipkov C, Bailey S, Rohrich RJ, Saint-Cyr M, et al. Vascular supply of the distally based superficial sural artery flap: Surgical safe zones based on component analysis using three-dimensional computed tomographic angiography. Plast Reconstr Surg. 2010;126:1240-52.
[8] Wang C, Xiong Z, Xu J, Zhang L, Huang H, Li G. The distally based lateral sural neuro-lesser saphenous veno-fasciocutaneous flap: Anatomical basis and clinical applications. J Orthop Traumatol. 2014;15(3):215-23.
[9] Imanish N, Nakajima H, Fukuzumi S, Aiso S. Venous drainage of distally based lesser saphenous-sural veno-neuradipofascial pedicled fasciocutaneous flap: A radiographic perfusion study. Plast Reconstr Surg. 1999;103(2):494-98.
[10] Chang SM, Chen ZW. Can superficial veins reverse flow through valves in distally based fasciocutaneous flaps? Plast Reconstr Surg. 1991;87:995-96.
[11] Follmar KE, Baccarani A, Baumeister SP, Levin LS, Erdmann D. The distally based sural flap. Plast Reconstr Surg. 2007;119:138e-48e.
[12] Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. Foot Ankle Int. 1994;15:349-53.
[13] Ibrahim T, Beiri A, Azzabi M, Best AJ, Taylor GJ, Menon DK. Reliability and validity of the subjective component of the American Orthopaedic Foot and Ankle Society clinical rating scales. J Foot Ankle Surg. 2007;46:65-74.
[14] Sharma S, Dhillon MS. The AOFAS Clinical Rating Systems—Time to Bid Adieu? J Foot Ankle Surg (Asia-Pacific). 2019;6(1):01-01.
[15] Crowe CS, Cho DY, Kneib CJ, Morrison SD, Friedrich JB, Keys KA. Strategies for reconstruction of the plantar surface of the foot: A systematic review of the literature. Plast Reconstr Surg. 2019;143(4):1223-44.
[16] Scheufler O, Kalbermatten D, Pierer G. Instep free flap for plantar soft tissue reconstruction: Indications and options. Microsurgery. 2007;27:174-80.
[17] Fox CM, Beem HM, Wiper J, Rozen WM, Wagels M, Leong JC. Muscle versus fasciocutaneous free flaps in heel reconstruction: Systematic review and meta-analysis. J Reconstr Microsurg. 2015;31:59-66.
[18] Talukdar A, Yadav J, Purkayastha J, Pegu N, Singh PR, Kodali RK, et al. Reverse sural flap- A feasible option for oncological defects of the lower extremity, ankle, and foot: Our experience from Northeast India. South Asian J Cancer. 2019;8(4):255-57.
[19] Erdmann D, Gottlieb N, Humphrey JS, Le TC, Bruno W, Levin LS. Sural flap delay procedure: A preliminary report. Ann Plast Surg. 2005;54:562-65.
[20] Hsieh CH, Liang CC, Kueh NS, Tsai HH, Jeng SF. Distally based sural island flap for the reconstruction of a large soft tissue defect in an open tibial fracture with occluded anterior and posterior tibial arteries-a case report. Br J Plast Surg. 2005;58:112-15.
[21] Nakajima H, Imanishi N, Fukuzumi S, Minabe T, Fukui Y, Miyasaka T, et al. Accompanying arteries of the lesser saphenous vein and sural nerve: Anatomic study and its clinical applications. Plast Reconstr Surg. 1999;103(1):104-20.
[22] Ponten B. The fasciocutaneous flap: Its use in soft tissue defects of the lower leg. Br J Plast Surg. 1981;34:215-20.
[23] Tsur H, Daniller A, Strauch B. Neovascularization of skin flaps. Plast Reconstr Surg. 1980;66(1):85-93.
[24] de Boer AS, Tjioe RJC, Van der Sijde F, Meuffels DE, den Hoed PT, Van der Vlies CH, et al. The American orthopaedic foot and ankle society ankle-hindfoot scale; translation and validation of the Dutch language version for ankle fractures. BMJ Open. 2017;7:e018314.
[25] Potparic Z, Rajac N. Long-term results of weight-bearing foot reconstruction with non-innervated and reinnervated free flaps. Br J Plast Surg. 1997;50:176-81.
[26] Tajsic N, Winkel R, Husum H. Distally based perforator flaps for reconstruction of post-traumatic defects of the lower leg and foot: A review of the anatomy and clinical outcomes. Injury. 2014;45:469-77.

PARTICULARS OF CONTRIBUTORS:
1. Associate Professor, Department of Plastic Surgery, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Neeraj Kant Agrawal,
04, Rudra Samriddhi Bhagwanpur, Varanasi, Uttar Pradesh, India.
E-mail: drneerajplasticsurgery@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Apr 04, 2021
- Manual Googling: Jun 04, 2021
- iThenticate Software: Jun 30, 2021, (8%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Apr 03, 2021**
Date of Peer Review: **May 13, 2021**
Date of Acceptance: **Jun 12, 2021**
Date of Publishing: **Jul 01, 2021**