Motorbike Spoke-Wheel Injuries of the lower limb treated with Fascio-Cutaneous Sural Artery Flap at a Tertiary Care Hospital.

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ABSTRACT

Objective: To determine the efficacy of reverse fascio-cutaneous sural artery flap in the treatment of heel pad injuries due motorbike spoke-wheel trauma.

Methods: This descriptive study was conducted in Department of Orthopedic Surgery and Department of Plastic Surgery Liaquat University of Medical and Health Sciences, Jamshoro, Sindh from 15th October 2017 to 15th December 2019. All adults patients of either gender and age with motorbike spoke-wheel injuries and heel pad defects fulfilling the inclusion criteria were graded and treated as per Zhu and Li classification with reverse sural artery flap and followed up for flap survival and ankle range of motion.

Results: A total of 15 patients with motorbike spoke-wheel injuries and heel pad defects were included in our study. Male patients were 12(80%) and female were 3 (20%). Mean age of our patients was 24.4±5.1 years (range 18 to 36 years). Right foot was involved in 13 (86.6%) cases whereas 2 (13.3%) patients had left foot injury. Mean duration from injury to flap coverage was 16 ±4 days (range 5 to 20 days).In majority (86.6%,n=13) of our patients reverse sural artery flap survived while in 2(13.3%) patients partial necrosis was noted. Normal ankle range of motion was regained in 14(93.3%) patients while 1(6.6%) had restricted dorsiflexion.

Conclusion: Reverse sural artery flap proved to be a reliable surgical technique for coverage of heel pad wound defects due to motorbike spoke-wheel injuries .We therefore, recommend this flap as a technique of choice to treat heel pad defects due to motorbike spoke-wheel injuries.

Keywords: Faciocutaneous, Flap, motorbike, Spoke-Wheel, Tendo-Achilles, Sural.

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INTRODUCTION

Spoke-wheel injuries are caused by trapping and dragging of the heel, ankle and foot of the passenger in the spokes of the wheel of bicycle or motorbike and transmission of the kinetic energy of the moving bicycle or motorbike to the entrapped limb due to sudden deceleration.[1] The first description of bicycle spoke-wheel injury was reported by Reiss[2] in 1948

while the motorbike spoke-wheel injury was first reported by Ahmed[3] in 1978.Motorbike spoke-wheel however, causes more sever injuries than bicycle spoke-wheel because of their high energy.[3] Motorbike spoke-wheel injuries are more often reported in India,[4] Pakistan,[5] Thailand[6] and china because of the fact that more people in these countries use motorbike, roads are bumpy and multi-passengers utilize single motorbike for transport.[7] The heel is commonly affected by spoke-wheel injuries and avulsion of the heel pad with exposed calcaneum or Achilles tendon with or without fracture is the usual presentation in sever cases.[8] The right foot is more commonly injured due to spoke-wheel injury than the left because chain guards are placed on right side of motorbike which protects left foot and ankle.[9] Treatment of spoke-wheel injuries is a very challenging task because of the combination of skin defect, exposed calcaneum and Achilles tendon, associated fractures and contamination.[7] These injuries are usually treated with wound debridement, fracture fixation, tendon repair and skin coverage.[8] The choice of skin coverage or flap depends upon size, location and complexity of the defect [7] and reverse sural artery flap, lateral supramalleolar flap, posterior tibial perforator flap and free flaps have been used for coverage of heel with varying success.[10] The reverse sural artery flap was first described by Donski [11] and later on popularized by Masquelet[12] It is preferable over other flaps because of its wider coverage, more reliability, short operative time, single stage, easily harvested, not needing any microsurgical anastomosis and without compromising limb vascularity or donor site morbidity.[10,13] Moreover reverse sural artery flap freely allows simultaneous use of external fixators for fracture fixation and can also be combined with other flaps like gastrocnemius muscle flap, tibial or medial plantar fasciocutaneous flaps and cross leg flaps.[10] However care should be taken to harvest reverse sural artery flap with a broad pedicle and avoid excessive rotation of the pedicle to prevent post operative congestion and ultimate flap necrosis.[14,15]

We treated heel pad injuries caused by motorbike spoke-wheel trauma in our institution with faciocutaneous reverse sural artery flap. Our objective was to determine the efficacy of this flap in covering heel pad defects. The results of our study would help us in establishing whether or not faciocutaneous sural artery flap can be used as a flap of first choice for covering hell pad defects due to motorbike spoke-wheel injuries in our set up.

METHODS

We conducted this descriptive study in Department of Orthopedic Surgery and Department of Plastic Surgery Liaquat University of Medical and Health Sciences, Jamshoro, Sindh from 15th October 2017 to 15th December 2019.All adults patients of either gender and age suffered from motorbike spoke-wheel injuries and presented to our hospital within three days of sustaining injuries were included in our study. Poly trauma patients, patients with wounds at the donor site and patients with multiple fractures were excluded. Ethical approval of the study was taken from Ethical Committee of our hospital. Informed consent for surgery and publication was taken from all participants. Complete history, physical examination, relevant laboratory investigations and radiographs were advised to all patients. Spoke-wheel injuries were graded and treated as per Zhu and Li classification. (Table I)[7] Repeated debridements of the wounds and broad spectrum antibiotics(Injection Cefuroxime) or antibiotics based upon culture sensitivity report was given to all patients until the recipient site was cleaned and ready for reverse sural flap.

Table I: Zhu and Li Grading of motorbike spoke-wheel injuries of the heel pad.

Grade of Spoke-wheel injury	Injury Detail	Plan of surgery
I	Heel skin defected, Achilles tendon exposed	Flap transfer
II	Heel skin defected, Achilles tendon ruptured and defected	Flap transfer, Achilles tendon reconstruction
III	Heel skin defected, Achilles tendon ruptured and defected, Calcaneus fractured or defected	Flap transfer, Achilles tendon reconstruction, Calcaneus reconstruction
IV	Heel mangled	Amputation

Surgical Technique

The surgery was performed in prone position under general anaesthesia. A combined team comprising of an experienced Orthopaedic and Plastic surgeon performed all the surgeries. Before surgery tourniquet was inflated. Initially wound was debrided followed by measurement of the defect. The flap pedicle was marked at 4 to 5 cm above the lateral malleolus so as to include the distal perforating branches making anastomosis with the peroneal artery. Hand held Doppler ultrasound was used per operatively to mark perforators. The flap was then marked (Fig-IA) with its width was half of the horizontal dimension and its length was twice the vertical dimension of the recipient site. The proximal end extended just short of the popliteal crease (Fig-IB). The incision was initiated in the proximal extreme of the flap down to deep fascia. Posteriorly dissection was made in such a way to reach the plane below the deep fascia. We applied multiple stitches between dermis and deep fascia to prevent shearing movement. The flap was dissected extending up to the demarcated limit of 4-5 cm above the intermalleolar line. The flap was elevated distally (after dividing the nerve, artery, and lesser saphenous vein) in the sub-fascial plane. The flap was rotated so as to reach the desired site of the recipient (Fig-IC) while taking care of not causing excessive tension. During the procedure it was ensured that pedicle was not compressed. After the procedure wound was closed in two layers. Donor site of flap was covered with split thickness skin graft taken from the thigh. In patients with associated calcaneal fractures, Kirschner wires were used for fixation while tendo-achilles ruptures were managed with repair and augmentation with flexor halluces longus tendon followed by sural flap to cover the exposed repaired tendon. Tourniquet was deflated and hemostasis was achieved followed by antiseptic dressing. The limb was then splinted with plaster of Paris and elevated postoperatively. Window was made at the flap site to look for viability of the flap. Post operatively flap survival was monitored every 6 hourly for the first 24 hours and then every 8 hourly for the next 4 days. Skin colour of the flap, capillary refill, skin turgor and colour of the blood by pin pricking the flap were used to assess flap survival. All these patients were advised follow up after every 7th day in the first post operative month and then monthly for minimum of 6 months. In each visit flap survival, progression, ankle range of motion and any complication was noted.

Data was analyzed with SPSS version 20. Frequency and percentages were calculated for gender and side of injury while mean and standard deviation for age, defect size and hospital stay. Data presented in tables where necessary.

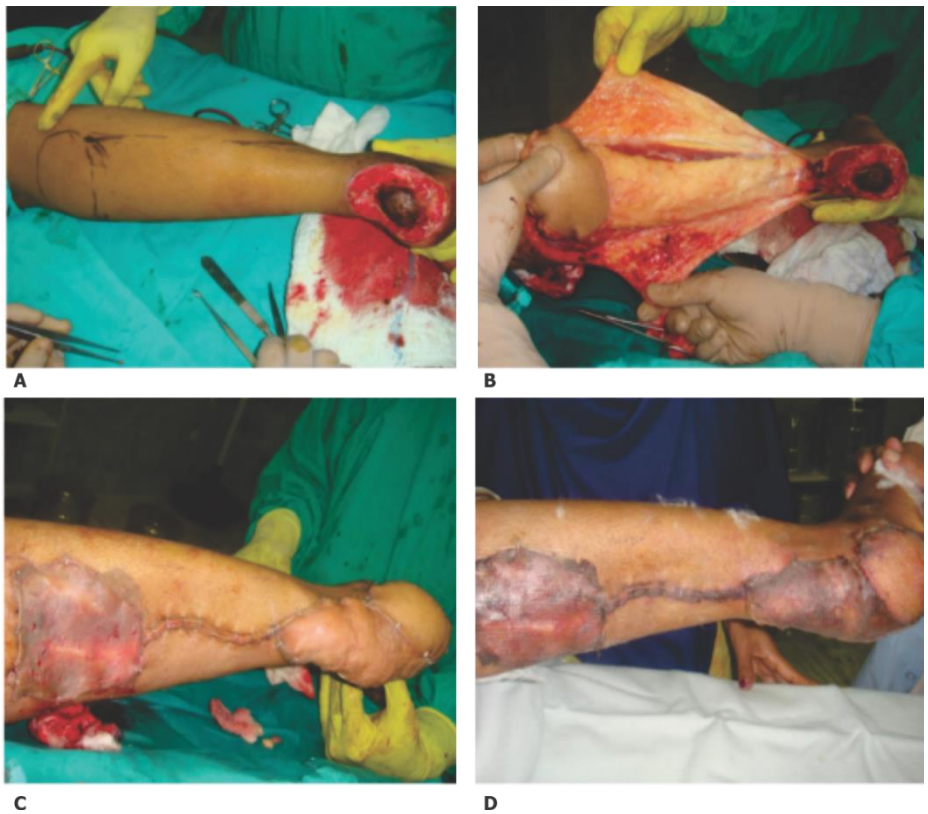

Fig. 1: A-Defect at posterior aspect of ankle and marking for sural flap. B-Sural flap with island. C-Sural flap placed at the defect while donor site grafted with SSG. D-First post-flap dressing indicating that flap and graft's acceptance.

RESULTS

In this study15 patients of motorbike spoke-wheel injuries with heel pad defects were treated with reverse sural artery flap. Majority(80%,n=12) were male patients while female were 3 (20%).Mean age of our patients was 24.4±5.1 years(range 18 to 36 years). Majority (73.3%,n=11) of patients were initially presented to Accidents and Emergency department of our hospital while 4(27.6%) patients were referred from other hospitals of our city. The demographic and clinical details of our patients are shown in table II. Right foot was involved in 13 (86.6%) cases whereas 2 (13.3%) patients had left foot injury. Mean duration from injury to flap coverage was 16 ±4 days(range 5 to 20 days). The average wound defect was10.9±3cm(range 10 to 13cm).Achilles tendon rupture was present in 3(20%) patients and treated with repair and augmentation with flexor halluces longus tendon followed by sural flap to cover the repaired tendon. Calcaneus fracture was noted in 2(13.3%) patients and treated with Kirschner wires. In majority(86.6%,n=13) of our patients reverse sural artery flap survived while in 2(13.3%) patients partial necrosis was noted. One patient with necrosis showed infection with Pseudomonas Aeruginosa as demonstrated by culture and sensitivity report of the pus obtained from the wound. This infected wound was cured with antibiotic sensitive for Pseudomonas Aeruginosa and dressing and debridement of dead tissue. Mean duration of hospital stay was 28±9(range 9 to 35 days) days.

Normal ankle range of motion was regained in 14(93.3%) patients while 1(6.6%) had restricted dorsiflexion. The mean follow up of our patients was 06±1 months(range 4 to 9 months).At final follow up all patients were ambulatory and were satisfied with the results. None of our patients experienced any difficulty in lifting up the heel or during walking. No signs of flap ulceration was noted.

Table II: Demographic and clinical details of our study participants.

Patient	Age	Gender	Foot (R/L)	Defect Site	Defect Size (cm)	Complications
1	23	M	R	Postero-lateral loss of heel pad	11x12	None
2	27	M	R	Posterior half of heel pad	10.5x13	None
3	18	M	R	Complete loss of heel pad	11x13	None
4	25	F	R	Posterior half of heel pad	10x13	None
5	19	M	R	Posterior half of heel pad	11.5x12	None
6	22	M	R	Posterior half of heel pad	11x13.5	None
7	19	F	L	Postero-lateral loss of heel pad	10x12.5	None
8	36	M	R	Exposed lacerated tendo-achilles	10.5x12.5	Edge necrosis with infection
9	31	M	R	Exposed lacerated tendo-achilles	11x12.5	Edge necrosis
10	29	M	R	Posterior half of heel pad	11.5x13.5	None
11	28	M	R	Exposed lacerated tendo-achilles	13x11.5	None
12	20	M	R	Postero-lateral loss of heel pad	11x14	None
13	21	M	R	Complete loss of heel pad	10.4x14	None
14	22	F	R	Posterior half of heel pad	12x13	None
15	27	M	L	Posterior half of heel pad	10.5x13	None

DISCUSSION

In our study reverse sural artery flap coverage was successful in 13(86.6%) patients while partial flap necrosis was noted in only 2(13.3%) patients. Zhu and Li treated[7] 31 cases of spoke-wheel injuries with reverse sural artery flaps and achieved success in all. They performed reverse sural artery flap in 12(29.2%) patients with grade I,7(30.4%) patients with grade II and 12(54.5%) with grade III defects. These authors however suggested that small defects of grade I injuries could be treated with supramalleolar flaps while reverse sural artery flaps were ideal for larger defects in grade II and grade III spoke-wheel injuries. Ignatiadis and colleague[10] treated 12 patients of traumatic heel defects with reverse sural artery flaps. All flaps survived except 4 flaps had superficial necrosis which were successfully treated with split thickness skin graft. Naumeri [16]treated 23 children of spoke-wheel injuries with reverse sural artery flap and no complication like graft rejection or necrosis was reported at one year follow up. Akhtar and Hameed[5] treated 12 patients of spoke-wheel injuries with reverse sural artery flap and reported satisfactory functional outcome at last follow up. These authors concluded that reverse sural artery flap was a reliable surgical technique to cover heel pad defects and proved to be an excellent alternative to microsurgical flaps. Farooq[17] treated 38 patients of spoke-wheel injuries with sural artery flaps and 4 patients with split thickness skin grafting. Majority(93%,n=41) of grafts were successful whereas only 3 patients had peripheral flap necrosis. One local study of 36 reverse sural artery flaps for 24 traumatic heel pad defects,8 ankle defects and 4 defects on dorsum of the foot revealed a flap success rate of 86.1%(n=31), partial flap necrosis in 3(8.3%) and complete flap necrosis in 2(5.5%) patients.[18]

Our results of reverse sural artery flaps were excellent and comparable to other studies reported from reputed national and international hospitals. One of the possible reasons were thorough repeated debridement of the recipient site before the final flap coverage. It has been reported that although spoke-wheel injuries look benign initially, they are much more complex indeed and un necessary delay in treatment, excessive wound contamination and high energy trauma are the poor prognostic factors.[1,19] Secondly, we were able to achieved the desired width of flap pedicle not less than 4 cm in all of our flaps because flap viability and venous drainage is mainly dependent on width of the flap pedicle.[14]

Our study had few limitations. The design of our study was descriptive, sample size was small and follow up period was short. We therefore recommend further well designed large scale studies with longer follow up to confirm our results.

CONCLUSION

Reverse sural artery flap proved to be a reliable surgical technique for coverage of heel pad wound

defects due to motorbike spoke-wheel injuries. We therefore, recommend this flap as a technique of choice to treat heel pad defects due to motorbike spoke wheel injuries. It should be noted that motorbike spoke-wheel injuries can be prevented by installing spoke-shields, wheel-guards and proper footrest in motorbikes. Furthermore wearing protective shoes, avoiding multi passengers on a single bike and motorbike road dividers can also reduce the frequency and degree of spoke-wheel injuries.

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