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Case Series

Repair of avulsion flap injury of heel by multiple point anchorage using Kirschner wires-a case series

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ABSTRACT

The heel pad is a dense band of fibrous tissue with complex anatomy. Injuries to heel pad are uncommon but very challenging due to its precarious blood supply. In this studywe tried fixing acute heel pad avulsion injuries using multiple Kirschner wires and results were evaluated according to the American orthopedic foot and ankle society hind foot score. Results were excellent for 3-out of 9 patients and good for 6 patients according to the AOFAHS scoring system. Anchorage of acute heel pad avulsion injuries using multiple Kirschner wires is an effective and reliable treatment modality.

Keywords: Heel pad avulsion, Kirschner wire, Debridement

INTRODUCTION

During walking and running the soft tissue of the sole is exposed to extreme stress. Because ofits unique anatomical structure, it is able to withstand high mechanical loading. The epidermisand especially the cornification of the sole is thicker than in every other region of the body. The fat pad is up to 2 cm thick on the heel, often compared informally to a water cushion.

The heel fat pad is between the heel derma and plantar fascia, which is a dense band of fibrous tissue that originates from the medial calcaneal tuberosity. The structure of the heel pad is complex, with collagenous elements connecting the plantar fascia to the heel derma and collagen-reinforcedchambers filled with fatty tissue restricting its displacement when subjected to compressive loading and maintaining the integrity of the heel pad that can be considered an independent hydrostatic structure that supports, buffers, absorbs shock, and prevents sliding.[1-4]

Heel pad is supplied posteriorly by the medial calcaneal branch of the posterior tibial artery with a variable contribution from the lateral calcaneal branch of the peroneal artery. The anterior part of the heel is supplied primarily by the lateral plantar artery with a reliable contribution from the medial plantar artery (Figure 1).[5]

There is rich anastomosis between these vessels at 2 levels in the heel-subdermal and periosteal but the compartments of fat confined between the fibrous septa were almost avascular and thus prone to develop liquefactive necrosis after injury.[3]

Degloving injuries of heel pad are uncommon with incidence of 2.26% of all foot injuries but are very difficult to treat. The modalities of the management of a degloving injury of the sole and heel are as follows.[6,7]

Simple suturing, K wire fixation, pressurized vac application, split skin graft but flap cover below-knee amputation, which is obviously undesirable.

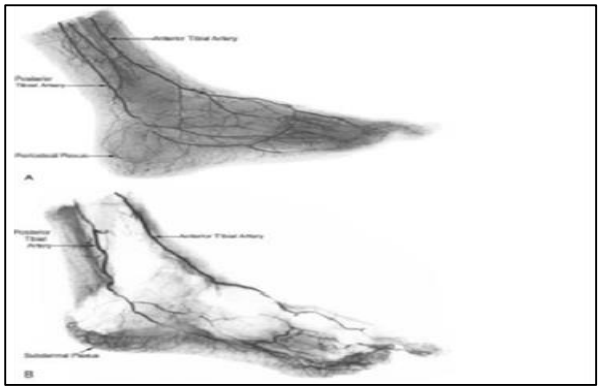

Figure 1 (A and B): Radiographs of arterial supply of foot demonstrating the periosteal plexus and sub-dermal plexus, following removal of underlying bones.

Complete avulsions of heel pad will require replantation using microvascular techniques or reconstructions but in cases where heel pad is partially avulsed and viable it may be possible to reattach the flap after proper debridement and approximation of the edges.[7] In this study we use multiple K-wires to approximate edges and reattach the heel pad.

Aim

To determine the functional outcome for heel flap avulsion injuries fixed using multiple Kirschner wires and its effect on heel pad viability.

CASE SERIES

Data collection

This is a case series of patients with heel pad avulsion injuries who visited in department of orthopedics over a period of 3 years from 2017 to 2020 in tertiary referral center. Data was collected and nine patients out of 12 who were admitted withheel pad avulsion were included in our study based on inclusion criteria and three of them were excluded from the study because of non-viability of heel pad and other associated injuries. Informed consent was taken from all the patients. These were then evaluated to assess the clinical outcome and determine the efficacy of this treatment modality for this injury.

Inclusion criteria included adult patients with acute injury of the heel pad.

Exclusion criteria excluded non-viable heel pad midfoot and forefoot skeletal injuries, avulsions associated with calcaneal fractures requiring surgical management uncontrolled diabetes mellitus with neuropathy, peripheral vascular disease.

The initial assessment and resuscitation of the patient was done according to advanced trauma life support protocols. Following resuscitation acutely presenting partial heel pad avulsion injuries were assessed for the extent of the degloving, soft tissue loss, wound contamination, skeletal injury, and viability of the degloved flap (Figure 2). Viability of heel pad was assessed before anesthesia on the basis of localtemperature, colour of skin, punctate bleeding on pin prick and edge necrosis. A third-generation cephalosporin antibiotic, along with metronidazole, was administered intravenously. Procedure and its potential complications were explained to the patient. Radiographs were obtained to identify any skeletal injury.

Figure 2 (a-d): Pre-operative images of acute heel pad avulsion injuries case no. 4, case no. 5, case no. 2 and case no. 1.

Surgical procedure

The wound was assessed prior to any anesthesia. Tourniquet was not used. Thorough debridement and copious wound lavage were performed. After debridement, we squeezed the haemorrhage and effusion, and the heel pad was securelyanchored to the calcaneus with multiple 1.8-mm K-wires with an aim to grossly secure the avulsed flap in the correct anatomical position (Figure 3a and b). The distance of the K wires was kept approximately 1.5-2 cm from the skin edge in order to prevent the developmentof wound tension and k wires were placed about a distance of 2-3 cm from each other. To prevent further damage to blood circulation, the use of only local pressing haemostasis at the bleeding sitewas done and clamping, ligation, or electrocoagulation was avoided. Excessive clearing of the injured fat tissue was also avoided.[3] The skin wound was not sutured and a light compressive dressing was then applied.

The foot was protected in a plaster splint in neutral ankle position. Iv antibiotics were given for 48 to 72 hours post operatively and oral antibiotic, a third-generation

cephalosporin was given for one week. Dressing was done on alternative day for the first two week and was changed if there was any soakage in between.

Figure 3 (a and b): Intra-operative images after debridement and K wire fixation of acute heel pad avulsion case no. 1 and 2.

Splint was removed after two weeks and patient was allowed toe-touch weight- bearing withthe use of walking supports. The K-wires were removed after six weeks once the wound was healed, and the patient permitted full weight-bearing as tolerated by eight weeks. Patients were followed up at an interval of 2 month and assessment was done using American orthopaedics footand ankle hind foot scoring system (AOFAHS). Figure 4 shows follow up at different intervals. We entered the data in excel sheet and assessed according to SPSS. AOFAHS scoring system was used to assess the functional outcome and the score were entered into data sheet. Those patients having score of 0-50 were classified as having poor outcome, 51-74 as fair, 75-95 as good and >95 as excellent outcome

Case 1

A 38-year-old man presented to us with right heel pad avulsion after injury by drill machine. Avulsion of heel pad was fixed using multiple Kirschner wires within 8 hours of injury Figure 3 (A). Patient showed excellent result according to AOFAHS scoring system (98) and returned to his work at 4 month post-operatively.

Case 2

A-52-year-old man presented to us after road traffic accident. He has partial avulsion of his right heel pad with fracture of right both bone forearm. Heel pad avulsion was fixed using multiple k wires and both bone forearm fracture was fixed using dynamic compression plating. He was a chronic smoker and developed necrosis of heel pad margin Figure 4a. Debridement was done to remove the necrotic margin and thereafter healing went uneventful Figure 4b. He returned to his work at 4 month post-operatively with good results according to AAOFAHS scoring system.

Figure 4 (a and b): Arrow showing edge necrosis as one of the observed complications; arrow showing healthy wound image after debridement of the necrosed edges.

Case 3

A-46-year-old farmer presented with injury to heel pad with avulsion of skin of anteromedial aspect of his ankle after an injury by machine. Primary debridement was done, heel pad was fixed using multiple K wires and vac was applied for wound over anteromedial aspect. Later on, skin grafting was done for wound over anteromedial aspect of left ankle. Patient was able to bear weight after 8 week and returned to his work 3-month post-surgery with AOFAHS score of 94, Figure 5a and b.

Figure 5 (A and B): Skin grafting done for wound over medial aspect of left ankle along with fixation of heel pad avulsion using multiple Kirschner wires pre-operative image; post-operative image.

Table 1: Showing various factors affecting the outcome of heel pad avulsion injuries and theirresults as measured using AOFAHS of case number one to five.

Factor / case no.	Case 1	Case 2	Case 3	Case 4	Case 5
Age (years)/sex*	38/M	52/M	46/M	26/M	54/M
Side	Right	Right	Left	Right	Right
Mechanism of injury	Machine injury	RTA**	Machine injury	RTA	RTA
Occupation	Industrial worker	Driver	Farmer	Student	Industrial worker
Risk factor	None	Smoking	Diabetes	None	None
Flap viability	Viable	Viable	Viable	Viable	Viable
Other injuries	None	Rt. both bone forearm fracture	None	Lt. Distal radius fracture	None
Time to procedure (hours)	08	10	06	06	06
Operative time (minutes)	40	45	40	30	30
Follow up duration (month)	20	16	15	12	10
Wound healing problems		Edge necrosis			
Weight bearing status	Full and painless	Full with some pain	Full and painless	Full and painless	Full with some pain
AOFAHS	98	88	94	100	87
Returned to work at	4 month	4 month	3 month	3 month	4 month

*M = male and F=female, **RTA=Road traffic accident.

Table 2: Various factors affecting the outcome of heel pad avulsion injuries and their results as measured using AOFAHS of case number six to nine.

Factor / Case no.	Case 6	Case 7	Case 8	Case 9
Age (years)/sex*	58/M	36/M	56/F	42/M
Side	Left	Right	Right	Left
Mechanism of injury	Machine injury	Fall in a shallow well	Run over by a bike	Fall of heavy object on heel
Occupation	Industrial worker	Farmer	Housewife	Labour
Risk factor	Smoking	None	Diabetic	None
Flap viability	Viable	Viable	Viable	Viable
Other injuries	None	Undisplaced left calcaneus fracture	None	None
Time to procedure (hours)	12	08	06	10
Operative time (minute)	60	45	30	30
Follow up duration (month)	10	10	08	04
Wound healing problems	Edge necrosis	None	None	None
Weight bearing status	Full and painless	Full with some pain	Full and painless	Full with some pain
AOFAHS	94	81	97	84
Returned to work at	4 month	3 month	--	3 month

*M=male and F=female.

DISCUSSION

8 out of 9 patients included in our study were male. Mean age of patients was 45.33±10.10 years, 3 of them were Industrial worker injured usingceramic tile cutter machine and others were injured after Road traffic accident. We assessed for risk factors like diabetes mellitus, smoking, DVT, peripheral neuropathy which can affect the outcome of our procedure. The surgical procedure took about an average 40 minutes and most of them were operated within 10 hours of injury. The anatomy of heel vascularization implies that there is a high risk of necrosis if degloved soft tissue is only sutured back to its former position.[2] Mohammed et al suggested that simple suturing to reattach the heel edges may not be secure enough, and can lead to increased wound pressure, resulting in woundbreakdown, infection, and flap necrosis.[8]

Split skin graft does not provide a stable weight bearing surface and is prone to recurrent ulcerations but a flap cover provides a full cover of skin and subcutaneous fat and is durable on a weight bearing area as eventual sensation and mobility are superior to those of split skin cover.[7]

The literature regarding such heel pad degloving injuries is rather limited. In general, the majority of studies reported poor prognosis leading mostly to amputations particularly when there is a complete subcutaneous detachment.[9]

The mechanism of injury is an important factor affecting treatment outcomes. The external forces of injury are initially concentrated on the back of the heel when a retrograde avulsion injury occurs, but as the shear stress decreases, the surrounding vascular network and chambers filled with fat are less severely affected. Furthermore, the injured heel fat pad and skin benefitfrom the abundant surrounding blood supply and collateral circulation. Additionally, the pedicle of the retrograde avulsion flap can still provide a certain amount of blood supply.[10] These are important factors leading to high survival rates after the first stage of retrograde avulsion injury repair. However, with roll-off, falling, and crush-related injuries, the surrounding vascular network and fat tissue are extensively damaged. Complete or partial necrosis and secondary surgery are inevitable.[3]

Two patients in our study who were chronic smokers developed skin edge necrosis that wasdebrided and healing thereafter went uneventful (Figure 4). There were two patients with recently diagnosed diabetes that was controlled on medications and did not cause any wound healing problems. One of the patients also had large skin loss over anteromedial aspect of leg for which skin grafting was done (Figure 5). There were no complications in remaining patients and head ling went uneventful, (Figure 6). Four out of nine patients were able to bear weight with some pain whereas five patients had a painless heel allowing complete weight bearing. Most of the patients returned to work at 4 months after surgery. According to AOFAHS, excellentresults were found in 3 patients and 6 patients had good results.

'Meticulous care of the sole and heel is essential for their preservation'. Compressed fixation using K wire provides a safe environment by preventing the fat pad from sliding and extruding, thus reducing the chance of shearing movements between the fat pad and the plantar fascia. Also keeping the fixation loose by not suturing the wound could efficiently remove the haemorrhage, effusion, and necrotic tissue, thereby greatly reducing the risk of infection and necrosis.[11,12]

The salvaged original heel tissue enabled a physiologic pressure distribution beneath the heel and a more physiological rollover process of the foot, comparable to the contralateral foot.

Figure 6 (A-C): Post-operative follow up of acute heel pad avulsions fixed using Kirschner wires 6 week follow up of case 4; 12 week follow up of case 1; 6 month follow up of case 1.

CONCLUSION

Heel pad flap avulsion injuries are rare injuries and very difficult to treat. Multiple point anchorage of heel pad flap using K wires is an atraumatic procedure that does not compromise vascularity of heel pad and is secure enough. It is a good, reliable and easy surgical fixation option for treatment of these rare injuries and gives fairly good to excellent functional outcomes.

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