Original Research Paper

Volume -10 | Issue - 4 | April - 2020 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Surgery

LIMB SALVAGE IN MINE BLAST INJURIES OF FOOT

Brigadier Surajit Basu SM — Mch(Plastic Surgery), Consultant Surgery & Reconstructive Surgery Command Hospital (WC),Chandimandir

Dr Gurjot Singh* — Resident, General Surgery Command Hospital (WC),Chandimandir*Corresponding Author

ABSTRACT The mine blast injury of foot is extremely devastating both psychologically and physically for soldiers deployed in remote localities. The soldiers are mostly young. Management of mine blast injury of foot is extremely challenging and the decision whether to salvage the limb by foot reconstruction or do an amputation depends on consideration of several factors like the patient's desire, part of foot involved i.e. weight bearing vs non-weight bearing area, satisfactory skeletal stabilization of foot and ankle, sensate and viable toes with intact vascularity, no injury to the Tibial or Common Peroneal nerves and no involvement of the contralateral leg. 15 soldiers with mine blast injuries of foot were managed in a forward military tertiary care centre between March 2006 and June 2008. 13 out of them underwent limb salvage by foot reconstruction. 04 cases were managed with cross-leg medial Gastrocnemius musculo-cutaneous flap, 02 cases with vacuum assisted closure followed by Distally based Superficial Sural artery flap , 02 cases with Distally based Superficial Sural artery flap, 04 cases with skin grafting and 01 patient with fillet flap from forefoot . All these patients made excellent functional recovery and were ambulant and pain free at the end of treatment.The remaining 02 patients were treated with below knee amputation as they had a mangled foot with vascular injury.

KEYWORDS : Mine blast injury of foot ; Limb salvage

INTRODUCTION

Mine blast injury of foot caused by anti-personnel mines is a common injury in soldiers deployed in remote localities. The injured soldiers mostly are young. Anti-personnel mines are small explosive devices of between 5 and 15 cm in diameter that can be laid either by hand in theground just below the surface or scattered from dispensers. Although some mines are triggered by trip wire, the majority are activated by the mine being stepped upon by the unwary. The damaging effects of the anti-personnel mines can be categorised as resulting from:

i. Stress waves entering the limb,
ii. Penetrating injuries from fragments, footwear and soil,
iii. Dynamic over pressure loads on tissues,
iv. Shear produced by the flow of products.[1]

Mine blast causes a complex injury of footwith loss of anatomical details, extensive soft tissue maceration, comminuted fractures and disarticulations , gross contamination and difficult demarcation of the dead tissue.

Although there's no universally acceptable classification of mine blast injuries, in a recent study published in 2019, the authors have classified mine blast injuries of foot into four types based on the extent and severity of involvement.[2] These are as follows:-

i. Type I - Only the heel was involved with comminuted fracture of calcaneum. The heel pad was well preserved.

ii. Type II- These injuries involved only a part of the foot with one or multiple ray amputation. The rest of the foot including the heel pad was well preserved.

iii.Type III- They are very severe injuries with a deep longitudinal lacerated wound extending from the heel to almost fore foot with charred soft tissue at the margins and associated with complete loss of anatomical stratification, extensive soft tissue damage and bone comminution. The foot was flail with loss of anatomical integrity between fore-mid and hind foot due to damage to joint capsules, ligaments and tendons. The tissues were deeply impregnated with vegetation, dust, cloth pieces, shrapnel, splinters and were grossly contaminated.

iv.Type IV - These are a combination of type III injury plus complete traumatic amputation of a part of the lower limb.

Management is needed urgently, surgery is difficult, and amputation is often inevitable. It is however, extremely devastating both physically and psychologically for the soldier. Most soldiers are not married and are constantly disturbed by the thought that they may not get social acceptance and may never get married and have a family because of their disability. They also have lot of expectations from military surgeons at tertiary hospitals and demand that their their foot be saved at whatever cost. Their desire for salvage of the foot is re-inforced even further when they find there's some sensation and movement in the toes of the injured foot.

The treatment in such cases is very challenging especially in deciding whether to salvage the limb by foot reconstruction or to treat the case by means of an amputation.

Some studies have reported that patients undergoing a transtibial amputation following initial salvage of their hindfoot injury have significantly higher physical outcome scores than those retaining their limb and they demonstrated that three key variables, identifiable at time of injury, are associated with profoundly poorer functional outcome: negative Böhler's angle on initial radiograph; coexisting talar and calcaneal fracture; and fracture of the tibial plafond in addition to hindfoot fracture.[4]

In another paper published in 2016 based on experience during the current conflicts inIraq and Afghanistan,the authors found that American survivability continues to improve, though the rate of extremity injury remains quite high. The decision to proceed with amputation versus limb salvage remains controversial. Exposure to combat wound with severe high-energy lower extremity trauma during the previous 14 years at war has incited important advances in limb salvage technique and rehabilitation.[5]

In the present article , foot reconstruction and limb salvage in 13 cases out of a total of 15 cases of mine blast injuries of foot received at a forward military tertiary care hospital during the period March 2006 to June 2008 is presented. The remaining 02 patients were treated with Below Knee amputation as they had a mangled foot with vascular injury.

MATERIALAND METHODS

15 cases with Mine blast injuries of foot were managed at a forward military tertiary care hospital between March 2006 and June 2006.The age of the soldiers varied between 22 and 42 years. All patients were air evacuated from forward localities by helicopters and had reached the tertiary care hospital within 12 hours of injury.

They had received initial treatment by a surgical team at a forward hospital. There, the patients were resuscitated and their vitals stabilized, concurrent injury to other vital body parts were attended to, initial wound lavage and toileting was carried out for the injured limb,

affected limb was immobilized in a splint,broad spectrum antibiotics were started and opiates were administered for pain relief. After ensuring fitness for transfer, the patients were air evacuated to the tertiary hospital.

Upon arrival, at the tertiary hospital,the patient's vital parameters were reassessed, he was examined for concurrent injuries to any other vital body parts, necessary radiographs of chest, abdomen,spine and limbs (especially lateral film of ankle and foot to study the Böhler's angle) were taken and required investigations sent for pre anaesthetic assessment.

There after, wound inspection was carried out in the operation theatre itself.[2] Following a thorough wound lavage with copious saline, a surgical wound debridement was diligently carried out with removal of all dead and devitalized tissues , bone , foreign materials , shrapnels embedded in the wound till a healthy bed of tissue was visible. All fractures of the foot and ankle were fixed with external fixators /K-wires applied in a mannerto achieve satisfactory alignment of bones of the foot, preserve the architecture of the ankle joint to the extent possible and allow reconstruction of foot at a later date. All patients received broad spectrum antibiotics in form of a third generation Cephalosporin, aminoglycoside and Metronidazole from the time of arrival to the tertiary care hospital and antibiotics were continued till 5thpost operative day.A second relook surgical wound debridement was done after 48 hours wherein necrotic tissues were removed and this was followed by definitive surgery in the form of foot reconstruction or amputation.The decision to reconstruct the injured foot for limb salvage wastaken after consideration of a number of factors criteria like the patient's desire for foot reconstruction, part of foot involved i.e. weight bearing vs non-weight bearing area , satisfactory sketetal stabilization of foot and ankle, sensate and viable toes with intact vascularity, no injury to the Tibial or Common Peroneal nerves and no involvement of the contralateral leg.

13 cases out of a total of 15 cases with Mine blast injuries of foot underwent limb salvage surgery with foot reconstruction at themilitary tertiary care hospital. The patient profile of those who underwent limb salvage is shown in Table 1.The remaining 02 patients underwent Below knee amputation as they had a mangled foot with vascular injury .Wound swab / pus swab for bacterial culture and antibiotic sensitivity was taken from the wound at the time of arrival to the tertiary care hospital and repeated after 01 week and,02 weeks if required.

04 cases were managed with Cross-leg medial Gastrocnemius musculo-cutaneous flap, 02 cases with vacuum assisted closure followed by Distally based Superficial Sural artery flap , 02 cases with Distally based Superficial Sural artery flap, 04 cases with skin grafting and 01 patient with fillet flap from forefoot . At the end of hospitalization period all patients were given 6 weeks leave for convalescence and thereafter underwent extensive physiotherapy with graded ambulation lasting 2-3 weeks.The goal of foot reconstruction were :-

(i) To achieve satisfactory tissue reconstruction.
(ii) Restoration of function of foot i.e. pain free ambulation and weight bearing.
(iii) Restoration of local aesthesis acceptable to the patient.

Table 1. Profile of patients who underwent Limb salvage.

Case S No.	Sex (M/F)	Age (yrs)	Cause of injury	Defect size(cm²)	Method of foot reconstruction	Length of stay in hospital
1	M	23	Stepping on anti-personnel mine	15x10	Cross-leg Medial Gastrocnemius musculocutaneous flap	7 weeks
2	M	22	,,	14x10.5	,,	7 weeks
3	M	25	,,	16x12	,,	7 weeks
4	M	42	,,	13x10	,,	6 weeks
5	M	22	,,	9x7	SSG	2 weeks
6	M	30	,,	12x10	VAC +Sural artery flap	5 weeks
7	M	28	,,	10x10	,,	5 weeks
8	M	23	,,	10x9	Distally based superficial sural artery flap	3 weeks
9	M	30	,,	9 x7.5	,,	4weeks
10	M	23	Accidental tripping on a trip wire	Distal ½ of foot with viable dorsal skin flap	Fillet flap by using dorsal viable skin flap	5 weeks
11	M	24	Stepping on anti-personnel mine	9x8	SSG	3 weeks
12	M	23	,,	7x6	SSG	12 days
13	M	30	,,	8x7	SSG	3 weeks

Cross-leg Medial Gastrocnemius Musculocutaneous flap :
04 cases with Type III mine blast injuries underwent foot reconstruction by this method. The defect size varied between 16x12 and 13x10 cm² (Fig 1).

The advantages of this musculocutaneous flap are,
(i) Reliable flap with anatomically defined blood supply i.e. Medial Sural Artery
(ii) Provides excellent padding with weight bearing capacity and matches the thick and glabrous skin of sole of foot.
(iii) Can be performed easily in forward combat areas in a short time without requirement of microvascular skills.
(iv) Reduced wound infection.
(v) Excellent patient compliance and satisfaction in terms of restoration of function.

A delay procedure was carried out at 04 weeks and the cross leg flap was divided after 02 weeks of delay.

The disadvantages of this musculocutaneous flap are,
(i) Uncomfortable position of immobilization after surgery.
(ii) Unaesthetic flap donor site of contralateral calf area.
(iii) Only protective sensations present over the flap.

Vacuum assisted closure followed by Distally based Superficial Sural artery flap :
02 cases with extensive Type I / Type II mine blast injury with comminuted fracture of Calcaneum were treated by this method (Fig 2) . The defect size varied from 12x10 to 10x10 cm². The V.A.C device was applied for 10-14 days after wound debridement and skeletal fixation. When the wound contracted and bed became healthy, distally based Superficial Sural artery flap cover was applied.

Distally based Superficial Sural artery flap :
02 cases underwent limb salvage by Distally based Superficial Sural artery flap. They had Type I injury(Fig 3). The defect was limited to the heel and the defect size varied from 10 x 9 to 9 x 7.5 cm² .

Skin Grafting :
04 caseswith injury to non-weight bearing areas of foot were managed with skin grafting.

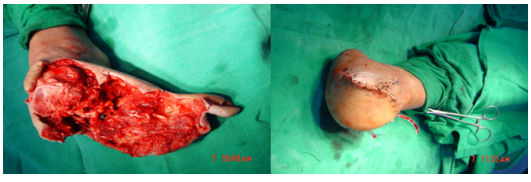
Reconstruction using viable skin flap of dorsum of foot as Fillet flap
In one case with Type IV injury, the entire fore foot and mid foot were blown off, but there was a viable remnant skin flap from dorsum of foot which was used to provide skin cover for the amputation stump of hind foot with preserved heel pad (Fig 4).

Fig 1. Foot reconstruction in mine blast injury foot using Cross-leg Medial Gastrocnemius Musculocutaneousflap

Fig 2. Limb salvage in mine blast injury of foot using Vacuum Assisted Closure followed by Distally based Superficial Sural artery flap

Fig 3. Distally based Superficial Sural artery flap for reconstruction in mine blast injury foot

Fig 4 . Reconstruction using viable skin flap of dorsum of foot as Fillet flap in mine blast injury of foot



RESULTS

We managed15 patients with mine blast injuries of foot between between March 2006 and June 2008. 13 out of them underwent limb salvage by foot reconstruction. The remaining 02 patients underwent Below knee amputation as they had a mangled foot with vascular injury.

The results of limb salvage in mine blast injury of foot is summarized as below :-

1. Age of soldiers: Out of the 13 soldiers who underwent limb salvage surgery , 12 were of age 30 years or below. They were all unwilling for amputation of limb.

2. Functional Recovery: All 13 cases who underwent limb salvage surgery made good functional recovery with restoration of weight bearing and ambulation . All patients were were given 06 weeks leave for convalescence after hospitalization period followed by 02/03 weeks of extensive physiotherapy and graded ambulation.

3. Tissue Reconstruction and local aesthesis: The foot reconstruction surgery in all cases provided thick , glabrous , well padded flap capable of bearing stress in weight bearing areas and a stable skin cover to non-weight bearing areas. In all cases the reconstruction was aesthetically satisfactory for the patients.

4. Length of Hospital stay : In cases with Type III mine blast injuries who underwent foot salvage by Cross - leg medial Gastrocnemius musculo- cutaneous flap, the length of hospital stay was 6-7 weeks. In patients with Type I/II injuries in whom foot reconstruction was done using V.A.C in combination with Distally based Superficial Sural artery flap or, by using only Distally based Superficial Sural artery flap the length of hospital stay varied from 2-5 weeks. In one case with Type IV injury who had undergone reconstruction using fillet flap from the dorsum of foot , the hospitalization period was 5 weeks.

5. Pain : All patients were pain free and ambulant after completion of treatment.

6. Wound infection : With adequate antibiotic cover , none of the 13 cases developed wound infection or had any loss of flap or skin graft loss.

7. Follow up : All 13 patients who had undergone limb salvage surgery were followed up for 1 yr and all patients were ambulant and pain - free at end of 1 year.

DISCUSSION

Experiences gained by Surgeons in last few decades in management of war casualties in battle fields across the world has changed the management strategy of mine blast injuries of foot. In a paper published in 2016 , the authors state that exposure to combat wound with severe high-energy lower extremity trauma during the previous 14 years at war has incited important advances in limb salvage technique and rehabilitation[5].Because the extremities remain vulnerable, military orthopaedic surgeons are treating a larger number of severe extremity injuries, including traumatic amputations and mangled extremities at risk for amputation.[6,7]Anatomic and physiologic conditions, surgeon experience, and patient wishes and expectations influence the decision to pursue early amputation or limb salvage, which remains controversial. Repeated wound debridements and stabilization by plaster of Paris or external fixator can save a large number of feet and limbs.8Locked intramedullary nails, external fixators (uniplane, multiplane, or ring), and plate fixation have all been used to definitively treat lower extremity fractures from wartime injuries.Historically, management of soft tissue defects has been based on an algorithmic “reconstructive ladder” designed to help surgeons identify the simplest method of wound closure. In the setting of massive soft tissue devitalization or loss from projectile and blast injuries, soft tissue transfer procedures- including regional/rotational flaps and free flaps-are being used for increasingly complex extremity injuries.

Conflicting data exist about the role of rotational versus microvascular free flaps for the coverage of lowerextremity injuries.[5] Early wound coverage is important because if the wound coverage is delayed, wound infection develops and healing is impaired.[9]

In present series of cases ,at the forward military tertiary care hospital, all the 13 cases who had undergone limb salvage surgery for mine blast injuries of foot as mentioned earlier received a thorough wound lavage and underwent a thorough surgical debridement of their wound with skeletal fixation on Day 1 and a relook wound debridement after 48 hours with definitive surgery in the form of flap cover or skin grafting. In 02 cases, V. A. C. negative pressure therapy was started after relook wound debridement after 48 hours and Sural artery flap cover was provided after 10 – 14 days after the wound had contracted and the wound showed healthy granulation tissue. Other studies have also reported usefulness of negative pressure wound therapy in preventing proximal amputations due to mine blast injury.[10]

CONCLUSION

The lessons learnt from battlefields across the world in past decade has sparked off important advances in limb salvage techniques. Management of mine blast injuries of foot is extremely challenging especially in a young soldier. In such cases all efforts should be made to salvage the limb for the psychological and physical well-being of the soldier.

REFERENCES

[1] Anti-Personnel Mine Injury; Mechanism and Medical Management.K Trimble, J Clasper. J R Army Med Corps, 2001;147:73-9.

[2] Surgical options in the management of landmine blast injuries of lower limb: a randomised prospective study. RohitVarma, NareshChander Arora, Sanjay Rai, Amit Chaudhary, SunitWani .ActaOrthop. Belg,2019 ; 85 : 21-34 .

[3] Below knee long stump guillotine amputation for mine blast injury foot: a safe need to do primary management in war zone: an experience in 18 cases over 10 months. M. S. Ray, B. S. Deepak .IntSurg J, 2017 Mar;4(3):971-6.

[4] Outcomes following limb salvage after combat hindfoot injury are inferior to delayed amputation at five years . P. M. Bennett, t. Stevenson, I. d. Sargeant, A. Mountain, J. G. Penn-Barwell .Bone Joint Res , 2018;7:131–8.

[5] Lower Extremity Limb Salvage: Lessons Learned From 14 Years at War .James A. Blair, MD, Emmanuel D. Eisenstein, MD, Sarah N. Pierrie, MD, Wade Gordon, MD, Johnny G. Owens, MPT, and Joseph R. Hsu, MD . J Orthop Trauma, 2016;30:S11–5.

[6] Combat orthopaedics : a view from the trenches . Covey D C . J AmerAcadOrthop Surg ,2006 ; 14 : S10 – 7 .

[7] Combat wounds in operation Iraqi freedom and operation enduring freedom. J Trauma , 2008;64: 295–9.

[8] Primary Surgical treatment of war injuries of foot .NikolicD ,Jovanovic Z , VulovicR ,Mladenovic M . Injury 2000 ; 31 :193-7

[9] Mine Blast Injuries – Our Experience .Lt Col MM Harjai, Col DC Agarwal, Lt Col P Dave, Brig SS Jog, Lt Gen P Arora, SM, VSM .,Med J Armed Forces India,2005;61 : 143-7.

[10] Negative pressure wound therapy in the management of mine blast injuries of lower limbs: Lessons learnt at a tertiary care center. Maurya S et al .Med J Armed Forces India. 2017 Oct;73(4):321-7.