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ORIGINAL PAPER

Risk factors and failures in the management of limb injuries in combat casualties

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Abstract

Introduction Treatment of war wounds is based on a sequential surgical strategy, which frequently faces therapeutic failures, which then burden the final functional result. The aim of this study was to identify risk factors of failure of the different treatments to prevent the therapeutic failure.

Methods A monocentric case–control study was done on French war-wounded soldiers treated for an open fracture caused by an invasive war weapon. The primary end point was the treatment failure three months after the injury. The risk factors of failure studied were the traumatic mechanism, the general and local lesional assessment, and the surgery performed.

Results Between January 1, 2004 and December 31, 2016, 57 soldiers were included, with an average follow-up of 3.42 years. On 81 limb segments studied, the most injured segment was the leg (37.0%). A vital or urgent surgery requirement (OR = 1.56; $p = 0.02$) and bone loss substance (OR = 5.45; CI95% = 1.54–20.09) were risk factors of failure for limb salvage treatment. Improvised explosive device traumatic mechanism (OR = 1.56; $p = 0.02$) and the persistence of surgical site contamination after two debridement procedures (OR = 1.20; $p = 0.04$) were risk factors of failure for amputation procedures.

Conclusions Two main risk factors of treatment failure are highlighted: those in relation to traumatic mechanisms and general lesional assessment and those in relation to surgical site conditions. There is no over risk of failure in relation to surgical procedure and treatment.

Keywords War-wound · Open fracture · Risk factor of failure · Combat-related injury

Introduction

The therapeutic coverage of the servicemen in war context rests on three fundamental pillars, ranked in this order:

- To save the life
- To save the limb
- To preserve or to restore the function of the limb.

War-related injury (gunshot wound—GSW, explosion, blast) is a high-energy traumatism, which causes multiple tissue damage, injuring soft tissues, bone, and periosteum. It is frequently associated with injuries to other organs. With regard to open fractures, environmental conditions are conducive to a high contamination of wound and an increase of the infectious risk. The combination of these parameters renders wound management and the definitive care more complex and jeopardizes the final functional result.

Limb salvage and amputation are both based on a sequential surgical strategy. They face therapeutic failures in different temporal stages of the reconstruction, which then burden the final functional result [1, 2]. An objective identification of risk factors of failure of the different functional restoration strategies could improve the war wound assessment, helping surgical teams prevent the therapeutic failures.

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The aim of this study was to identify risk factors of failures of initial treatment, conservative or radical, provided for open war wound limb injuries.

Methods

A retrospective observational case–control study was done on French war-wounded, who had surgery for an open fracture at Percy's Military Teaching Hospital (MTH), between January 1, 2004 and December 31, 2016.

Patients with at least one open fracture occurring by an invasive war weapon were included. The secondarily open fractures (due to fasciotomy) were also studied. Isolated soft tissues injuries, closed fractures, and non-combat related injuries were excluded.

The minimum follow-up needed was 12 months.

The primary end point was the treatment failure three months after the injury. Sequential treatment strategy (Fig. 1), described by Rigal [1, 3, 4], was taken as reference for the treatment. All surgical procedures done within the three first months were considered as initial treatment. Any surgical procedure done three months after the traumatism was considered a therapeutic failure. Two groups were set up, one without any therapeutic failure, and the other group concerned with all therapeutic failures.

The risk factors of failure studied were the following: a New Injury Severity Score (NISS) [5] upwards to 16, the mechanism injury (improvised explosive device—IED, mortar or rocket, GSW), a number of iterative debridement procedures upper to two, the necessity for a life-saving or urgent surgery, the necessity of a soft tissue repair procedure, the bone loss attendance, the persistence of wound contamination after the second debridement procedure, the use of an external fixator as definitive treatment, and a local nervous or vascular injury associated.

Three kinds of failures were analysed: infection, non-union, and pain or joint stiffness for the limb salvage; infection, neuroma or pain, and prosthetic fitting default for amputation. Non-union was defined on radiological criteria. Infection included all of bone and joint infection, which required a surgical debridement and shaving procedure associated to an antibiotic delivery. The treatment was considered a failure for joint stiffness when a surgical procedure (arthrolysis or arthrodesis) was performed. Failures due to prosthetic fitting defaults included soft tissues surface finishing, problems with muscles balance, and skin trophic disorders.

Hand, ankle, and foot injuries were excluded from the study, as they are specific injuries.

The data collected were treated in accordance with the reference methodology MR 003, according to the

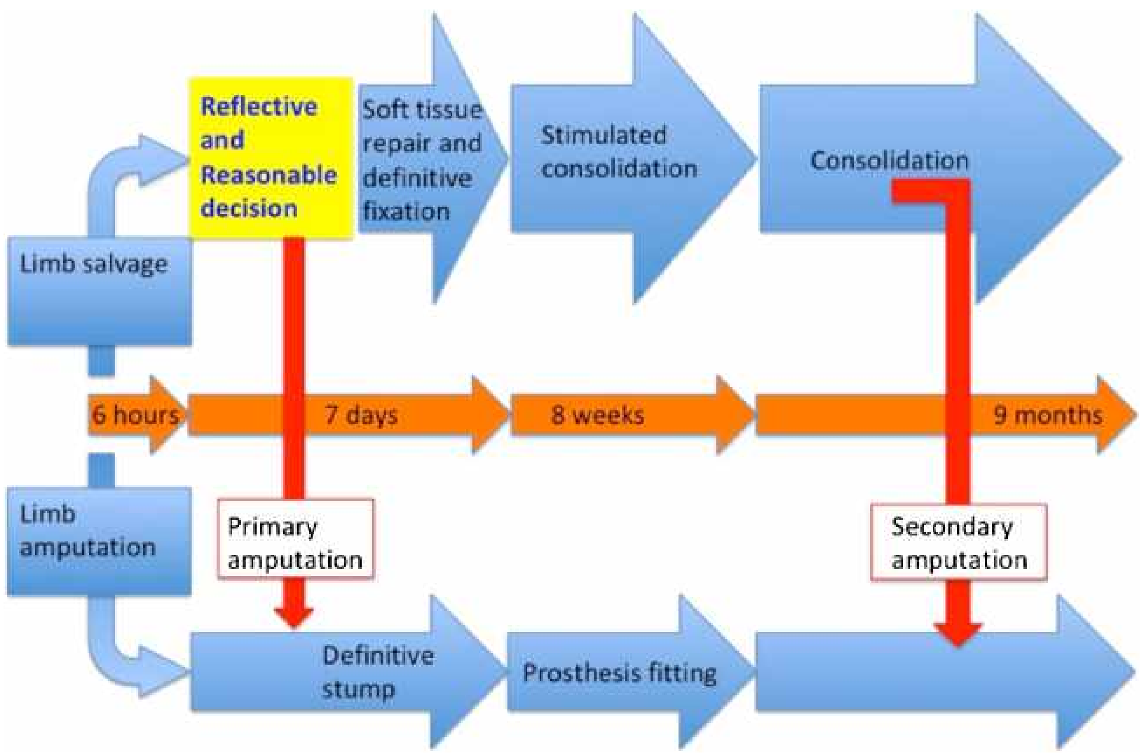

Fig. 1 Sequential treatment strategy

requirements of the French National Commission for Information Technology and Civil Liberties.

The data were collected using Excel (Microsoft® Office 2010). StataIC® 15.1 (STATACORP LLC) software was used for contingency table analysis. Potential risk factors for therapeutic failure were examined through univariable logistic regression model. Odds Ratios with their interval with a 95% confidence were calculated for each risk factor of failure studied. Risk factors with an overall p value < 0.05 were retained.

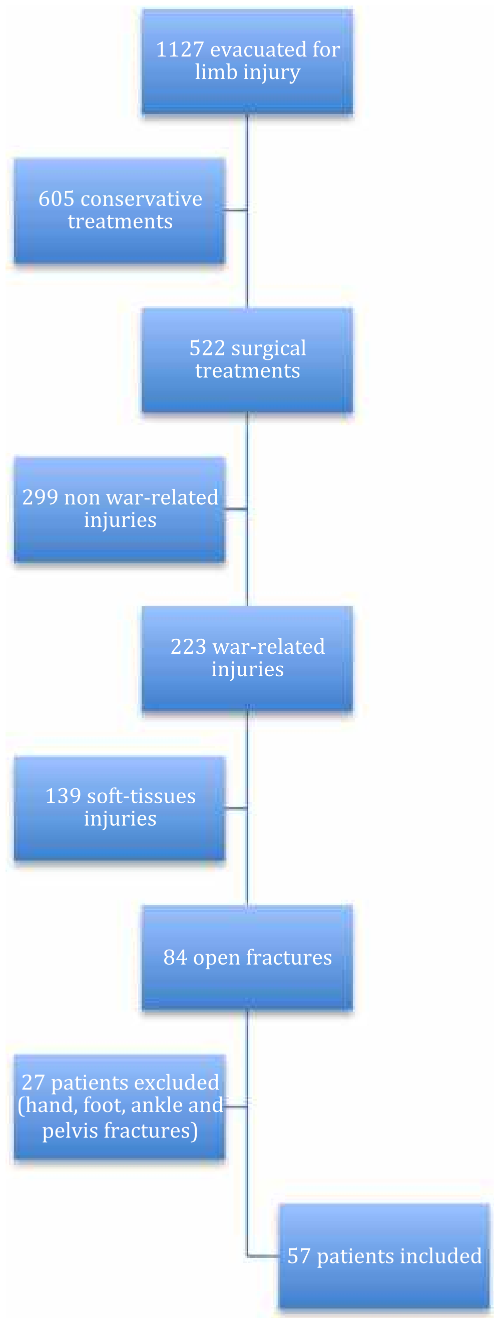

Fig. 2 Flow chart

Results

Between January 1, 2004 and December 31, 2016, 1127 servicemen were evacuated to Percy's MTH for limb injury (Fig. 2). Among them, 84 have been operated upon for a combat-related open fracture, and 57 were included. The mean follow-up was 3.42 years (range 1 to 11 years).

Patients were predominantly male (Table 1). The mean age at the traumatism time was 29.8 years (range 20 to 52 years). Most of them (30/57) came from the Middle East.

IED (29/57) was the most common cause of injury.

Out of 32 patients who had an associated injury of other organ, 24 required a life-saving or urgent surgery. Median NISS was 17 (range 4 to 59).

Most of the patients (36/57) had one limb segment injury. Median number of limb segment injured was one per patient (range 1 to 6 per patient). An overall of 81 injured limb segments were studied.

Forearm and leg injuries were the most frequent, regardless of the treatment (Table 2). Amputations proceeded on the upper limb were quasi-exclusively traumatic amputations, which appeared on mine-clearing squad members.

Delayed amputation was performed on three patients who had a severe leg injury which was not salvageable.

Table 1 Demographic data

Characteristic	Population $n = 57$
Sex, M/F	56/1
Mean age, years (range)	29.8 (20.4–52.4)
Median NISS (range)	17 (4–59)
Associated injuries, *n* (%)	31 (54.4)
ENT	17 (31.5)
Abdomen	10 (17.5)
Neurosurgical	9 (15.8)
Thorax	7 (12.3)
Vascular	7 (12.3)
Burn	3 (5.3)
Eyes	3 (5.3)
More than 2 limbs injured, *n* (%)	21 (36.8)
Evacuation origin, *n* (%)	
Middle East	30 (52.6)
Africa	25 (43.9)
Europe	2 (3.5)
Injury mechanism, *n* (%)	
IED	29 (50.9)
Mortar/rocket	15 (26.3)
GSW	13 (22.8)

NISS New Injury Severity Score, *GSW* gunshot wound, *IED* improvised explosive device

Table 2 Limb segment management

	Upper limb				Lower limb			
	Arm	Elbow	Forearm	Wrist	Hip	Femur	Knee	Leg
Lesion, *n* (%)	7 (8.6)	6 (7.4)	12 (14.8)	7 (8.6)	3 (3.7)	9 (11.1)	7 (8.6)	30 (37.0)
Limb salvage IT, *n*	7	6	7	5	3	8	7	21
Amput. IT, *n*	0	0	5	2	0	1	0	9
Delayed amput., *n*	0	0	0	0	0	0	0	3
Limb salvage DT, *n*	7	6	7	5	3	8	7	18
Ext. Fix., *n* (%)	4 (57.1)	1 (16.7)	1 (14.3)	1 (20.0)	0	3 (37.5)	4 (57.1)	14 (77.8)
Int. Fix., *n* (%)	3 (42.9)	5 (83.3)	6 (85.7)	4 (80.0)	3 (100)	5 (62.5)	3 (42.9)	4 (22.2)
Flap, *n* (%)	0	0	0	0	0	0	0	4 (22.2)
Tact. B.G., *n* (%)	0	0	1 (14.3)	0	0	0	0	6 (33.3)
Ind. Memb, *n* (%)	0	0	1 (14.3)	0	0	1 (12.5)	0	2 (11.1)
Contamin., *n* (%)	4 (57.1)	2 (33.3)	3 (42.9)	2 (40.0)	1 (33.3)	6 (75.0)	5 (71.4)	12 (66.7)
Debrid. > 2, *n* (%)	3 (42.9)	1 (16.7)	4 (57.1)	3 (60.0)	2 (66.7)	6 (75.0)	4 (57.1)	15 (83.3)
Vasc. inj., *n* (%)	2 (28.6)	1 (16.7)	3 (42.9)	1 (20.0)	0	1 (12.5)	2 (28.6)	3 (16.7)
Nerve inj., *n* (%)	6 (85.7)	2 (33.3)	4 (57.1)	2 (40.0)	1 (33.3)	3 (37.5)	2 (28.6)	4 (22.2)

IT initial treatment, *amput.* amputation, *DT* definitive treatment, *Ext. Fix.* external fixation, *Int. Fix.* internal fixation, *Tact. B.G.* tactical bone graft, *Ind. Memb.* induced membrane, *Contamin.* contamination, *Debrid > 2* more than two debridement procedures, *Vasc.* vascular, *inj.* injuries

The use of external fixation as definitive osteosynthesis was significantly associated with the persistence of wound contamination after the second debridement procedure and one of those parameters: NISS upper 16, bone loss, skin loss, and necessity of over than two debridement procedures ($\chi^2 = 10.54$, $p = 0.0012$).

Definitive external fixation was the most common technique used for tibia fractures (Fig. 3), and the use of definitive internal fixation was most frequent for upper limb and femur fractures. All being well, flaps were only used in the case of leg injuries.

Pain or joint stiffness was the main cause of limb salvage failure (21%), followed by non-union (15%) and infectious (7%) failures.

On the lower limb, the most common complication was pain or joint stiffness. There was no infectious failure in the upper limb fractures' treatment.

There was significant difference in treatment failure neither between diaphyseal and metaphyso-epiphyseal fractures nor between upper and lower limb fractures.

There was no failure for treatment of forearm fractures. There was no significant difference in salvage failure between humeral and forearm fractures, neither between elbow and wrist fractures.

There were statistically more salvage failures due to non-union in leg fractures than in femur fractures (27.8% versus 0; $p = 0.05$).

There was no salvage failure due to non-union in lower limb metaphyso-epiphyseal fractures.

There was no symptomatic neuroma in patients amputated. Amputations were successful in 75% of cases (Fig. 4). The main cause of failure was infection (15%), followed by prosthetic fitting default (10%).

There was no failure for traumatic amputation or surgical amputation in upper limb. There was no prosthetic fitting default for surgical amputations.

Mortar and rocket injury mechanism was not a risk factor of failure (Table 3). IED injury mechanism was a risk factor of failure of salvaging diaphyseal fractures. The need for life-saving or urgent surgery of a patient having an open fracture was a risk factor of failure to salvage limbs, especially in the case of lower limbs and diaphyseal fractures.

The use of an external fixation as definitive osteosynthesis was a risk factor in the failure to salvage limbs, especially for lower limb, diaphyseal fractures, and metaphyso-epiphyseal fractures (Table 4).

The persistence of wound contamination after the second debridement and the necessity of a soft tissue repair procedure were risk factors of failure to salvage the limb.

Bone loss was a risk factor in failing to salvage limb, particularly for lower limbs, and diaphyseal and metaphyso-epiphyseal fractures.

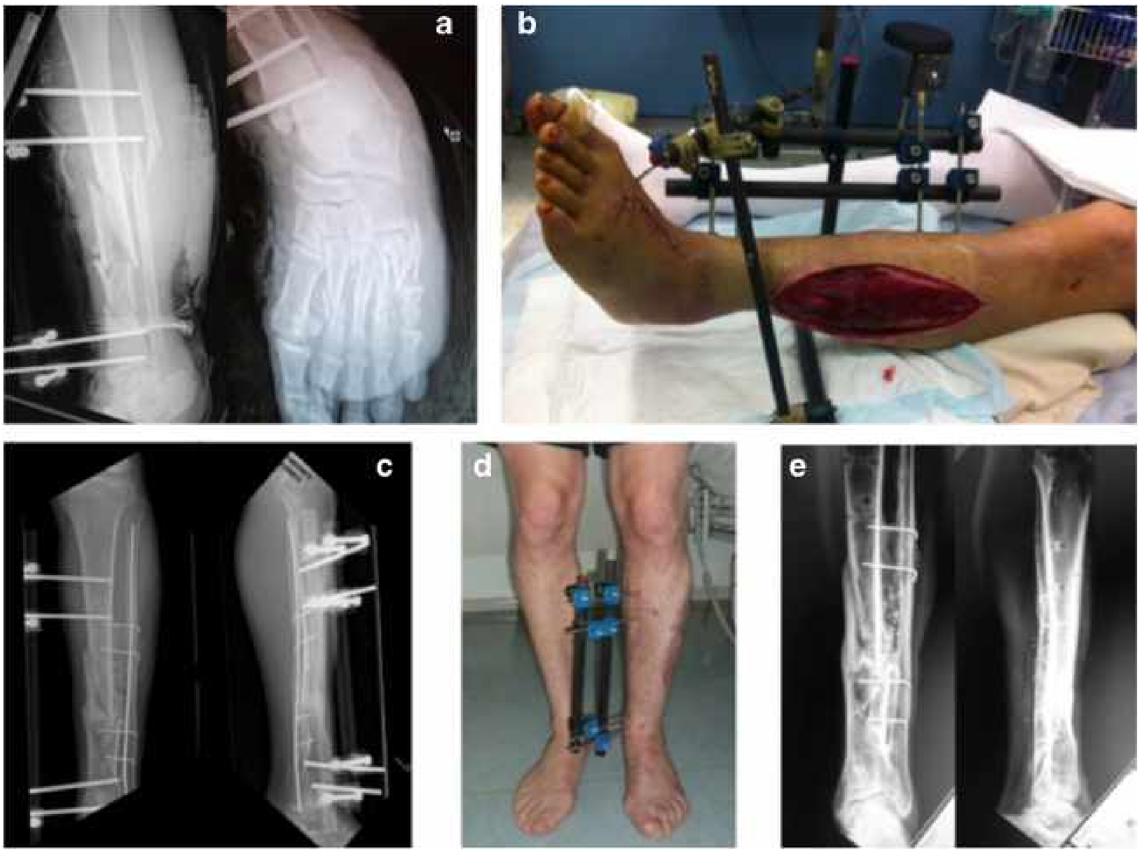

Fig. 3 Case report no. 1. Patient repatriated from Mali, suffering from a compartment syndrome after a leg closed fracture following an IED injury and forefoot closed fractures. **a**, **b** DCO procedure done at role 2: external fixation and fasciotomy. **c**, **d** External fixation modification and progressive closure of fasciotomy with split skin grafting done at role 4. A tactical bone graft was realized 2 months after the injury (inter tibiofibular bone grafting). **e** X-rays results at 9 months; the patient has returned to sport after metatarsophalangeal arthrodesis of the hallux

IED injury mechanism and persistence of wound contamination after the second debridement were risk factors of amputation failure (Table 5).

Discussion

Patient's demographic data are representative of servicemen deployed on war theatres. They are usually young men, without any comorbidity, hence why the medical histories, which were non-discriminating, were not studied.

The use of IED, car bombs and human bombers, by enemy forces, causes multiple organ injuries. Injury mechanism repartition is similar to British and American studies. During Operation Iraqi Freedom and Operation Enduring Freedom, part of injuries due to cluster weapons was estimated to 60% by Chandler et al. [6] versus 23% for injuries due to GSW.

The use of cluster weapons explains the frequency of associated non-orthopedic injuries. The ENT lesion, by eardrum perforation, is the most frequent lesion, but it is only seen with a blast lesion. Vital organs and hollow organ-associated injuries, which require urgent surgery, and burn-associated injuries complicate and delay the orthopaedic management.

The median NISS value underlines the gravity of the injuries sustained by the wounded: indeed, it is higher that British and Americans series. Penn-Barwell et al. [7] have found a median NISS at 12 (range 4 to 48) for GSW injured who survived and ten wounded with NISS at 75. In Ramasamy et al.'s [8] series, NISS's IED wounded is distributed in two parts: one part for lower serious war wounded with NISS value lower than 4 and the second part for NISS's war wounded greater than 14. The first part concerns war wounded with isolated orthopaedic injury, which can be quickly managed, without delay, whereas war wounded with a NISS value greater than 14 have usually an associated vital injury, requiring an urgent surgery life-saving procedure. Orthopaedic management takes a back seat. For that reason, orthopaedic procedures for war-related limb injuries differ from orthopaedic procedures under poor conditions, and results could not be compared [9].

Management procedures for limb injuries are based on sequential surgical strategies used for complex hand injuries in a war context [10]. Initial management of open war wound fractures requires DCO procedures, which is enforced for every

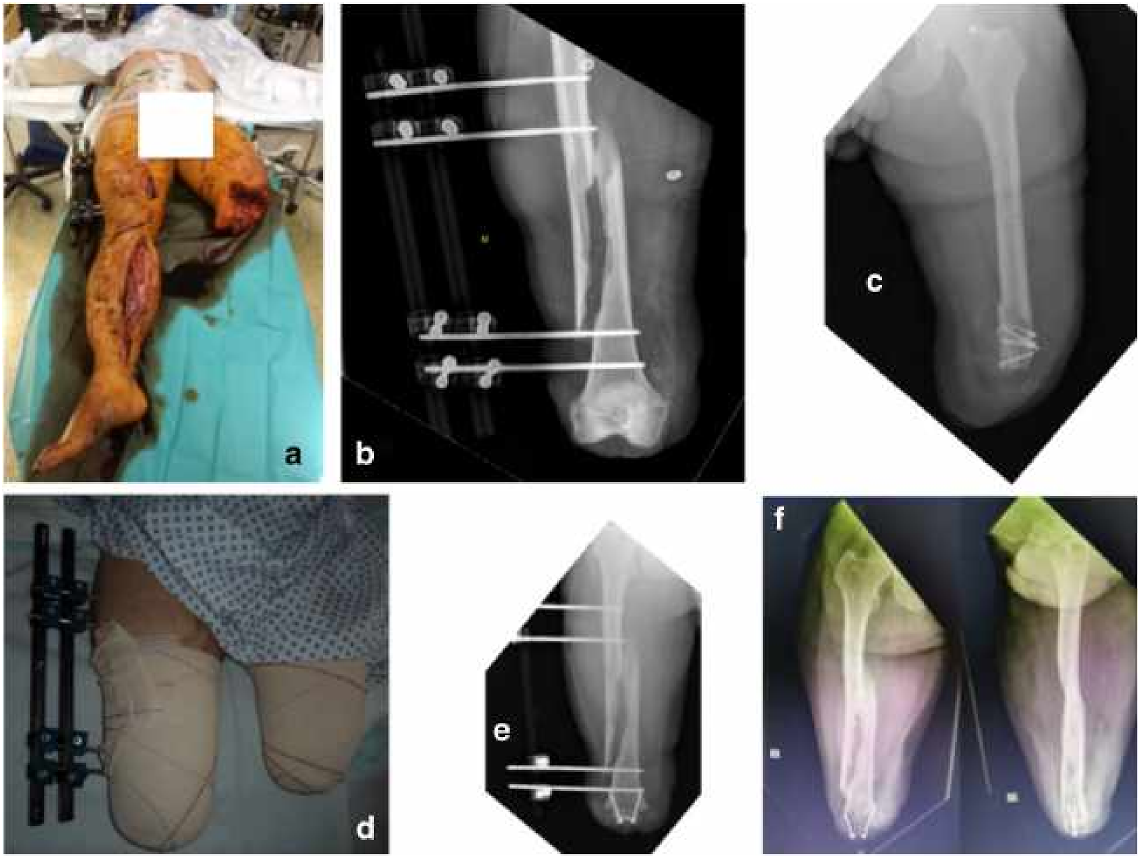

Fig. 4 Case report no. 2. Patient repatriated from Middle East after rocket explosion, who suffered from a traumatic left femur amputation, an open fracture on right femur, and a closed fracture of tibial plateau complicated of lower limb ischemia. **a** DCO procedure was done at role 2: external fixation, prophylactic fasciotomy after revascularization attempt, and debridement of the right thigh. The patient is repatriated to role 4 with left thigh amputation left open. **b**–**d** Sequential surgical procedure done in role 4 in France, modification of the external fixation, disarticulation of the right knee due to irreversible ischemic injuries on the leg, and delayed closure of the left thigh amputation. **e** Modification of the amputation, according to Gritti's amputation procedure, and tactical bone graft on the femur, performed during the 3 months following the traumatism. **f** X-rays results on the right side. No revision surgery was needed afterwards; the patient had returned to sport 9 months after the traumatism

patient in the study. This management is facilitated with a role two deployed near combat zones. It is essential to consider evacuation delays in combat theatres, in order to reduce infectious risk and tissue ischemia duration. NATO recommends an evacuation delay inferior to 90 minutes. Though this figure was improved upon during Operation Enduring Freedom (mean 60 minutes) [11], geographical constraints and role two repartition in Sahelo-Saharan war theatres make enforcing these delays difficult today. Dubost et al. [12] have evaluated the mean evacuation delay from combat zone to role two to 390 minutes on Malian territory and 120 minutes in Central Africa.

Despite this constraint, the salvaging of the limb is the priority of the initial management. Urgent life-saving amputations are performed the most distal as possible. In this series, the three delayed amputations show how the decision to amputate is taken after repatriation in role four in France away from the war theatre and the confusion and doubt that characterize it. Surgical indications for limb amputation were not performed using a mangled score such as New Ganga Score or Mangled Extremity Severity Score, but they were always the subject of discussion between two experienced surgeons.

Traumatic amputation and urgent life-saving amputation rates are higher than Chandler et al.'s series (11%; [6]) and Owens et al.'s series (4%; [13]). The population studied explains this difference. Only open fractures were studied, and NISS's wounded is higher. Penn-Barwell et al. [14] show that NISS is associated to traumatic amputation and urgent life-saving amputation risk and also associated to surgery recovery on the first days.

In this context of high-energy injuries, external fixation is the most used method to achieve definitive osteosynthesis, for upper and lower limb injuries. Lerner et al. [15] have raised a 9% non-union rate in their study and a 6.3% infection rate. However, Ware et al. [16] had shown long-term results have a rather more bleak outlook, with a median SF-26 score at 46.4 for chronic pain (versus 73.39 in the general population) and

Table 3 General risk factors of salvage failure

Factors	Failure, *n* (%)	No failure, *n* (%)	OR (IC 95%)	*p*
Mortar/rocket				
All limb	2 (7.7)	10 (28.6)	0.21 (0.02–1.15)	0.04
Diaphysis	0	5 (28.8)	0 (0–1.01)	0.05
GSW				
All limb	6 (23.1)	8 (22.9)	1.01 (0.25–3.95)	NS
Epiphysis	4 (40.0)	0	1.53	0.02
IED				
All limb	18 (69.2)	17 (48.6)	2.38 (0.73–8.02)	NS
Diaphysis	14 (87.5)	11 (45.8)	8.27 (1.34–86.09)	0.008
Upper than 2 limbs injured				
All limb	14 (53.9)	12 (34.3)	2.24 (0.70–7.19)	NS
Lower limb	10 (55.6)	4 (22.2)	4.38 (0.85–24.85)	0.04
NISS > 16				
All limb	20 (76.9)	20 (57.1)	2.5 (0.72–9.42)	NS
Lower limb	14 (77.8)	8 (44.4)	4.37 (0.85–24.85)	0.04
Life-saving or urgent surgery needed				
All limb	17 (65.4)	12 (34.3)	3.6 (1.10–12.12)	0.02
Lower limb	14 (77.8)	3 (16.7)	17.5 (2.69–131.83)	0.0002
Diaphysis	12 (75.0)	8 (33.3)	6 (1.23–32.72)	0.0098

GSW gunshot wound, *IED* improvised explosive device, *NISS* New Injury Severity Score, *OR* odds ratio, *IC* interval of confidence, *NS* not significant

52.4 for physical limitations in daily activities (versus 81.21 in the general population). The number of revision operations associated with these problems was not studied.

Part of infectious failure is similar to that of Murray et al. [17], which describe an infectious rate included between 2 and 15%. While Murray et al. [17] advise a transition from external fixation to external hybrid or circular fixation for metaphyso-epiphyseal fracture treatment to prevent infections, Horst et al. [18] propose two algorithms to turn external fixation into internal fixation. The transition depends on wound contamination and the implantation time of the external fixation. Respecting this rule, the transition from external fixation to internal fixation does not involve more infectious failure. This surgery is usually used for forearm fractures and joint factures treatment, with the aim of reducing pain and joint stiffness.

Results for upper limb and femur fractures salvage are satisfying: no infection case, only 32% of failure at three months for upper limb fractures treatment, and only 37.5% of failure for femur fractures treatment. These results are explained by the lack of flap use and a lesser infectious risk.

Results of debridement of traumatic and surgical amputations are satisfying. No failure was observed for upper limb amputations. Failures related to prosthetic fitting and infectious failures are attributable to lower limb amputations, but they remain low. Tintle et al. [19] recorded in their series an infectious rate of 27%, a prosthetic bracing default rate of 42%, and a neuroma rate of 11%. Forty percent of these complications required a revision surgery 70 days after the first amputation surgery. Delayed primary closure of traumatic and surgical amputations performed on the field is effective [20].

For limb salvage, two kinds of risk factors of failure are highlighted:

- General risk factors related to patient's general health or injury mechanism
- Local risk factors related to wound's local injury or surgery provided

IED mechanisms increase the risk of failure for salvaging diaphyseal fractures. Ramasamy et al. [8] showed a higher complication rate in IED injuries, with a 42% infectious rate, 22% non-union rate, and 33% post-traumatic arthritis.

The need of a life-saving or urgent surgery is a risk factor of failure to salvage limbs. The number of injured segments is a risk factor of salvage failure for lower limb fractures.

The necessity to repair soft tissue and reconstruct lost bone is a local risk factor of failure. They require a longer and more complex reconstructive management. Neuropathic pain, chronic infection, the wish for an improved function of the limb, and the reluctance of patients for a long and complex treatment are influencing factors for a late resignation amputation [21].

The use of external fixation appears as a risk factor of failure of open combat–related fractures. However, this result

Table 4 Local risk factors of salvage failure

Factors	Failure, *n* (%)	No failure, *n* (%)	OR (IC 95%)	*p*
Vascular injury				
All limb	5 (19.2)	8 (22.9)	0.80 (0.18–3.28)	NS
Nervous injury				
All limb	10 (40.0)	14 (40.0)	1.0 (0.31–3.21)	NS
Upper than 2 debridement procedures				
All limb	17 (65.4)	21 (60.0)	1.26 (0.39–4.16)	NS
External fixation				
All limb	20 (76.9)	8 (22.9)	11.25 (2.94–45.28)	> 0.001
Lower limb	16 (88.9)	5 (27.8)	20.8 (2.85–225.28)	> 0.001
Diaphysis	14 (87.5)	8 (33.3)	14 (2.18–145.27)	> 0.001
Epiphysis	6 (60.0)	0	3.27	0.002
Persistence of wound contamination after the second debridement				
All limb	18 (69.2)	17 (48.6)	2.38 (0.73–8.03)	NS
Lower limb	15 (83.3)	9 (50.0)	5 (0.88–34.77)	0.03
Diaphysis	13 (81.3)	12 (50.0)	4.33 (0.83–28.75)	0.05
Soft tissue repair procedure				
All limb	5 (19.2)	1 (2.9)	8.10 (0.80–393.80)	0.03
Diaphysis	5 (31.3)	1 (4.2)	10.45 (0.94–515.28)	0.02
Bone loss				
All limb	15 (57.7)	7 (20.0)	5.45 (1.54–20.09)	0.002
Lower limb	11 (61.1)	4 (22.2)	5.5 (1.06–31.53)	0.018
Diaphysis	12 (75.0)	7 (29.2)	7.29 (1.45–40.44)	0.005
Epiphysis	3 (30.0)	0	1.003	0.05

OR odds ratio, *IC* interval of confidence

is biased: the most severe fractures are more often treated with external fixation. The extension of the damage does not allow the selection of the best position for the pin insertion, and the mobilization is delayed. The combination of the persistence of wound contamination after the second debridement procedure with very poor general health or severe local wound parameters is a risk factor of failure of in trying to salvage limbs damaged by combat-related open fractures.

The number of serial debridements does not seem to be a risk factor of failure nor a protective factor with regard to salvaging limbs. Associated to antibiotherapy, it reduces wound contamination, which is an infectious risk [17, 22]; therefore, debridement would be a protective factor. But the aggressiveness of this procedure could increase the risk of non-union or pain. This study does not enable to highlight the increased risk of failure related to non-union or pain.

This study has limits. Its retrospective characteristic limits the power of the study and the statistical analysis.

Confusion bias could exist in the description of the three principle failures. They are similar and are muddled. They are

Table 5 Risk factors for amputation failure

Factors	Failure, *n* (%)	No failure, *n* (%)	OR (IC 95%)	*p*
Mortar/rocket	0	9 (60.0)	0 (0–0.64)	0.02
GSW	0	0	/	/
IED	5 (100)	6 (40.0)	1.56	0.02
NISS > 16	5 (100)	14 (93.3)	0	NS
Life-saving or urgent surgery	2 (40.0)	8 (53.3)	0.58 (0.04–6.94)	NS
Upper than 2 injured limbs	0	3 (20.0)	0 (0–3.90)	NS
Upper than 2 debridement procedures	5 (100)	10 (66.7)	0.52	NS
Persistence of wound contamination after the second debridement	5 (100)	7 (46.7)	1.20	0.04
Soft tissue repair procedure	2 (40.0)	4 (26.7)	1.83 (0.11–22.88)	NS

GSW gunshot wound, *IED* improvised explosive device, *NISS* New Injury Severity Score, *OR* odds ratio, *IC* interval of confidence, *NS* not significant defined by clinical exam and with biological, radiological, or microbiological exams.

The patient's follow-up is time-limited, and long-term future is unknown. Evaluation of residual disability is impossible. Reentrance into society and occupational reintegration necessitates not only a functional musculoskeletal system but also wound acceptance, viewable or not. Limb loss could be harder to accept, which could explain the number of recovery operations done before amputations, with the aim to save the limb and give it a satisfactory function.

The end point chosen for the study could be debatable. Procedures done three months after the injury are frequently efforts of reconstruction. Wounded's expectations on functions recovery explain the choice of this three months limit performed. The presence of joints stiffness in such injuries is frequent, and there is a high incidence of amputation in affected limbs. The main goal in management of such patients is life saving and limb preservation from amputation.

Conclusion

Two main risk factors of treatment failure are highlighted. Those related to a patient's general health (NISS, need of life saving, or urgent surgery) and injury mechanism (IED) and those related to local injury: bone loss and a combination of the persistence of wound contamination after the second debridement procedure with poor general health or severe local wound parameters.

There is no over-risk of failure related to surgical procedure.

The opinions or assertions contained herein are solely those of the authors and do not necessary reflect the official policy or position of the FMHS.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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