Open Upper-Limb Fractures Secondary to Animal Bites: Epidemiology, Management and Outcomes in a 10-Year Retrospective Series

Mohamed Mokhtar Jmal[1], Mohamed Ben Jemaa[1], Wassim Zribi[1], Olfa Chakroun[2], Emna Elleuch[3], Abdesselem Naceur[1], Mohamed Zribi[1], Hassib Keskes[1]

[1]Department of Orthopedic Surgery and Traumatology, Sfax University Hospital Center, University of Sfax, Tunisia

[2]Emergency Department, Sfax University Hospital Center, University of Sfax, Tunisia

[3]Department of Infectious Diseases, Sfax University Hospital Center, University of Sfax, Tunisia

***Corresponding author:**

Mohamed Mokhtar Jmal, MD,

Department of Orthopedic Surgery and Traumatology, Sfax University Hospital Center, University of Sfax, Tunisia, E-mail: medmoktar.jmal@gmail.com

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ABSTRACT

Background: Upper-limb open fractures resulting from animal bites represent an unusual yet severe constellation of injuries. Their dual mechanism — skeletal disruption combined with heavily contaminated bite wounds — exposes patients to high infectious risk and often leads to prolonged rehabilitation and delayed professional reintegration. Such injuries require urgent, coordinated medical and surgical management. **Objective:** To define the epidemiological profile of victims, evaluate acute medical and surgical management, assess functional and radiological outcomes, and identify prognostic factors associated with these complex injuries. **Methods:** A retrospective review was conducted over ten years (2008–2017) in the Department of Orthopaedics and Traumatology of Habib Bourguiba University Hospital, Sfax. Twenty patients presenting with open upper-limb fractures due to animal bites were included. Minimum follow-up was 12 months. Data included demographics, circumstances of injury, anatomical distribution, management protocols, complications and outcomes. **Results:** Twenty patients were included (12 men, 8 women; mean age 55 years). Occupational accidents predominated (35 percent). Donkeys and horses were the most frequent aggressors, consistent with previous reports from rural and agricultural regions. Fifteen patients sustained hand injuries, predominantly involving the phalanges; the remaining cases involved the wrist and forearm. Emergency management consisted of meticulous wound decontamination, dressing, immobilization, tetanus and rabies immunization, and broad-spectrum antibiotic prophylaxis, in accordance with WHO and international recommendations. Surgical

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exploration revealed vascular lesions in eight cases, nerve injuries in two, and tendon lesions in eight, highlighting the polymorphic and destructive nature of equine and donkey bites described in prior literature. Fracture stabilization involved external fixation in 10 patients, K-wire fixation in 7, and orthopaedic treatment in 3, reflecting accepted strategies for contaminated open fractures. Outcome was favourable in 19 patients. One case of nonunion was observed. No cases of tetanus or rabies occurred. No clinically documented deep infection was recorded during follow-up. **Conclusion:** Open upper-limb fractures caused by animal bites constitute severe surgical emergencies. Their management demands a multidisciplinary approach integrating trauma surgery, infectious disease expertise, and rehabilitation. Prevention remains paramount, particularly through education of agricultural workers and vaccination of domestic and working animals.

INTRODUCTION

Animal-related injuries constitute a significant public health concern worldwide, particularly in rural and agricultural environments where close and repeated human–animal interactions are common. While dog and cat bites account for the vast majority of reported animal bite injuries, bites inflicted by large domestic animals such as donkeys, horses and camels represent a distinct and far more severe subset of trauma [1-7].

Unlike small-animal bites, which typically cause puncture wounds with limited kinetic energy transfer, large-animal bites are characterized by high-energy crushing, tearing and avulsion mechanisms. These forces result in extensive soft-tissue destruction, vascular and tendon injuries, and complex open fractures with unstable patterns. The magnitude of energy transfer and tissue devitalization significantly complicates fracture management, compromises local vascularity, and may delay bone healing [8-14].

In addition to mechanical severity, large-animal bites are associated with heavy polymicrobial contamination. The oral flora of equines and other herbivorous animals contains a mixture of aerobic and anaerobic bacteria, including *Pasteurella species, streptococci, staphylococci,* anaerobes, and environmental organisms [15-18]. When combined with open fractures, this contamination markedly increases the risk of superficial and deep infections, osteomyelitis, and nonunion, making early antibiotic therapy and meticulous surgical debridement essential components of care [11,18].

Despite these distinctive characteristics, most published studies focus on bite epidemiology or infection risk in isolation, while reports specifically addressing open upper-limb fractures caused by large-animal bites remain scarce. The present study aims to contribute to this limited body of literature by analysing a 10-year retrospective series of such injuries, focusing on epidemiology, management strategies, complications, and outcomes.

METHODS

A retrospective observational study was conducted in the Department of Orthopaedics and Traumatology of Habib Bourguiba University Hospital, Sfax. All patients presenting with open fractures of the upper limb secondary to animal bites between January 2008 and December 2017 were included.

Inclusion criteria were:

(1) open fracture of the upper limb,

(2) injury directly caused by an animal bite,

(3) minimum follow-up of 12 months.

Exclusion criteria included closed fractures, bites without skeletal involvement, and incomplete medical records.

Data were collected from hospital medical records, emergency department reports, operative notes, and follow-up outpatient files. Recorded variables included demographic data, type of animal involved, mechanism and anatomical location of injury, fracture classification, medical and surgical management, complications (including infection and nonunion), and functional outcomes.

Open fractures were classified according to the Gustilo–Anderson system [19]. Infectious complications and fracture healing were assessed based on clinical, biological and radiological criteria commonly used in orthopaedic practice.

RESULTS

Epidemiological Characteristics

Twenty patients were included. Mean age was 55 years, consistent with the predominance of agricultural and manual labourers in the affected population. This profile

aligns with prior epidemiological studies from rural settings [6,13].

Donkeys and horses were responsible for most injuries, echoing similar reports from North African, Middle Eastern and Mediterranean regions where these animals are widely used in labour [15].

Injury Patterns

The hand was the most frequently affected anatomical region (75 percent), particularly the phalanges, replicating patterns described in mammalian bite injuries where hands are exposed during defensive gestures [8,12]. Vascular, nervous and tendon involvement was common.

Management

Emergency care followed international protocols involving copious irrigation, debridement, immobilization, and anti-rabies and tetanus prophylaxis [2]. Surgical management varied depending on injury severity: external fixation for grossly contaminated or unstable fractures, K-wire fixation for phalangeal injuries, and conservative treatment where appropriate. These approaches align with current orthopaedic recommendations for open fractures [16,17].

Outcomes

Nineteen patients evolved favourably with satisfactory fracture healing and functional recovery. One patient developed nonunion, requiring prolonged follow-up.

No cases of tetanus or rabies were observed. No clinically documented deep infection or osteomyelitis was identified during follow-up. Minor superficial wound complications were managed successfully with local care and antibiotics when necessary (Figure 1-11, Table 1-8).

Figure 1: Animal bite opposite the 2nd MCP of the right hand

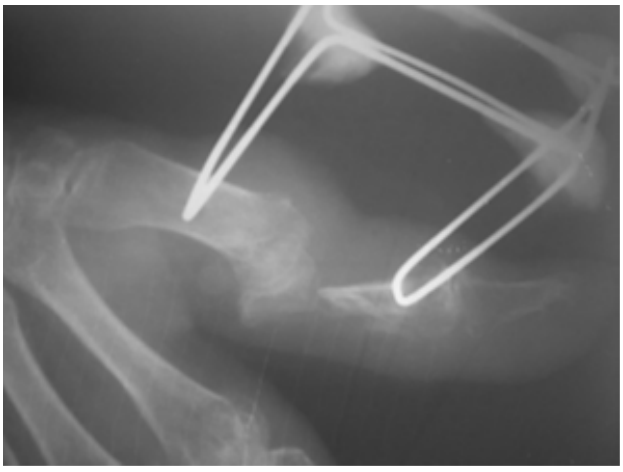

Figure 2: Postoperative X-ray of an open fracture caused by an animal bite opposite the 1st MCP, treated with a "Beaubourg" type external fixator

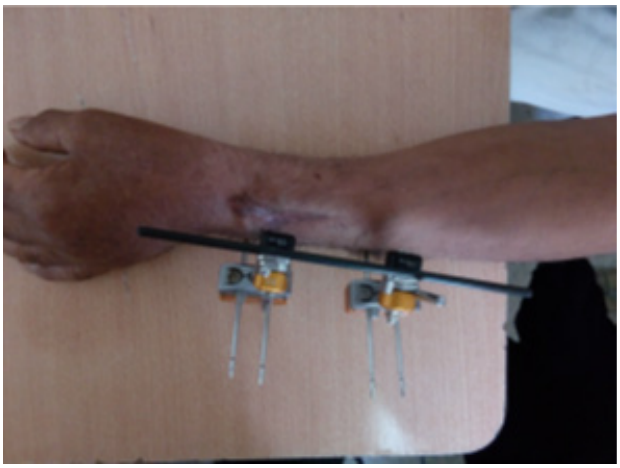

Figure 3: Uniplanar external fixator (Hoffman II type) for an open fracture of both forearm bones with good wound healing

Figure 4: Images showing complete healing of an animal bite on the dorsal aspect of the wrist and forearm: A: Before / B: After

Figure 5: Necrosis of the 5th finger following a bite

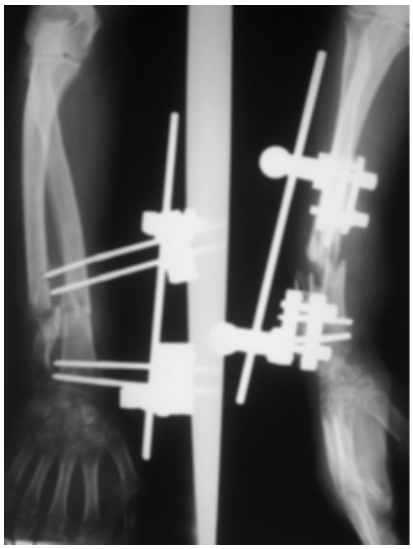

Figure 6: X-ray of a fracture of both forearm bones complicated by pseudarthrosis

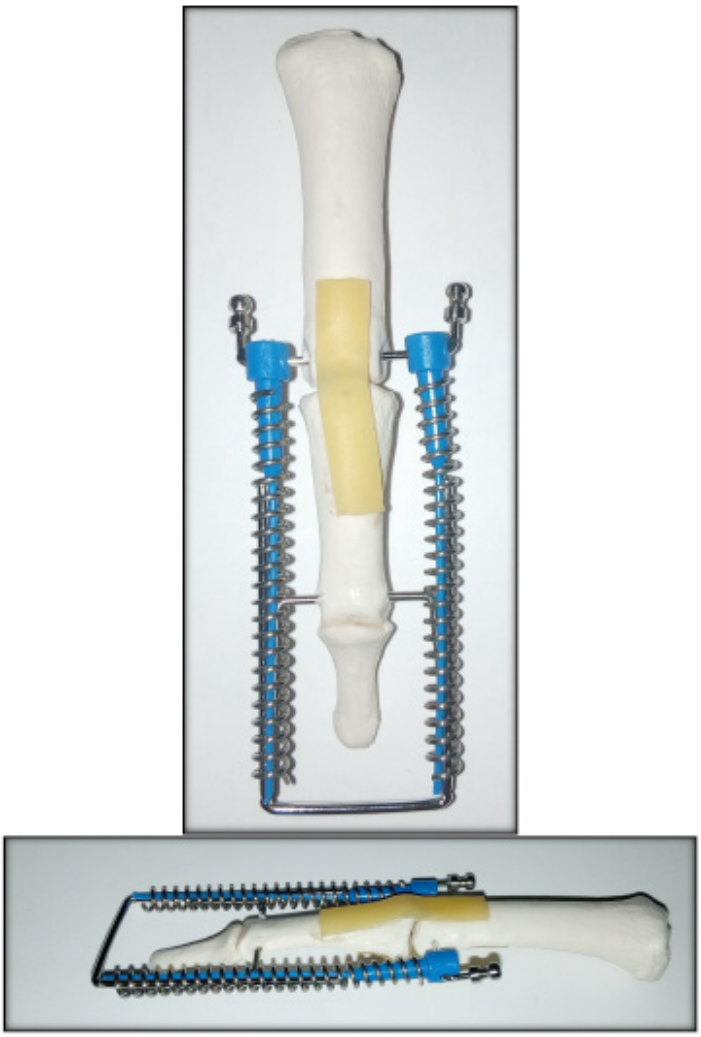

Figure 7: Dynamic external fixation devices (SUZUKI type)

Figure 8: Complete healing of a palmar wrist bite: intraoperative image (A) / follow-up image (B)

Figure 9: Complete union of a distal-quarter ulna fracture treated with axial pinning

Figure 10: Complete union of a proximal phalanx fracture of the index finger treated with a "Beaubourg" type external fixator

Figure 11: Fracture of both forearm bones (A) initially treated with an external fixator (B), complicated by pseudarthrosis (C), and revised with internal fixation and bone grafting leading to union (D)

Minimum Maximum	Maximum	Mean
30	81	55

Table 1: Mean Age of the Study Population Minimum Maximum

Occupation Number	Number	Percentage
Farmer	9	45%
Driver	1	5%
Housewife	4	20%
Worker	6	30%
Total	20	100%

Table 2: Population Distribution by Occupation

	Right	Left	Right-handed	Left-handed
Number	15	5	17	3
Percentage (%)	75%	25%	85%	15%

Table 3: Side of Lesion and Hand Dominance

Animal	Number	Percentage
Donkey	13	65%
Dog	6	30%
Sheep	1	5%
Total	20	100%

Table 4: Etiology of Animal Bites

Type	Location	Number	Percentage
Isolated	Forearm	2	10%
	Wrist	2	10%
	Hand	13	65%
Staged	Forearm + Hand	1	5%
	Forearm + Wrist	1	5%
	Shoulder + Forearm + Wrist	1	10%
Total		20	100%

Table 5: Soft Tissue Lesion Locations

Affected Bone	Number	Percentage
Humerus	0	0%
Radius	3	10%
Ulna	4	14%
Metacarpal 1	2	7%
Metacarpal 2	2	7%
Metacarpal 4	1	4%
Metacarpal 5	2	7%
Phalanx 1	8	29%
Phalanx 2	3	11%
Phalanx 3	3	11%

Table 6: Bone Lesions According to the Affected Bone

Number of Days	Number	Percentage
0	3	15%
30	1	5%
45	6	30%
50	2	10%
60	8	40%
Total	20	100%

Table 7: Time to Fracture Consolidation

Bacteria	Frequency
Pasteurella (aerobic)	50%
Streptococcus (aerobic)	46%
Staphylococcus (aerobic)	46%
Neisseria (aerobic)	32%
Corynebacterium (aerobic)	12%
Moraxella (aerobic)	10%
Enterococcus (aerobic)	10%
Bacillus (aerobic)	8%
Fusobacterium (anaerobic)	32%
Porphyromonas (anaerobic)	28%
Prevotella (anaerobic)	28%
Propionibacterium (anaerobic)	20%
Bacteroides (anaerobic)	18%
Peptostreptococcus (anaerobic)	16%

Table 8: Main Bacterial Species Isolated from Dog Bites

DISCUSSION

This study underscores the severity of upper-limb injuries caused by large-animal bites, particularly equine-related trauma, which combines high-energy crushing forces with extensive polymicrobial contamination. These characteristics clearly distinguish such injuries from more common dog or cat bites and justify their consideration as a specific clinical entity.

Although polymicrobial contamination is inherent to animal bite injuries, no deep infections or osteomyelitis were observed in our cohort. This favourable outcome may be explained by early presentation, systematic surgical debridement, and the use of broad-spectrum antibiotic prophylaxis in accordance with international recommendations [2,18]. Similar studies have reported variable infection rates, particularly when bone exposure is present or initial management is delayed [12,13].

External fixation played a key role in managing severely contaminated or unstable fractures in our series. Its advantages include minimal additional soft-tissue insult and facilitation of wound care, consistent with previously published reports on open upper-limb fractures [16,17]. The occurrence of nonunion, although limited to one case, highlights the persistent risk of impaired bone healing in contaminated high-energy injuries and supports the need for prolonged follow-up.

Despite its limitations, notably the small sample size inherent to the rarity of this condition, this study provides valuable insight into the management and outcomes of a poorly documented injury pattern.

CONCLUSION

Open upper-limb fractures caused by animal bites, though uncommon, represent severe traumatic emergencies. Their treatment requires a blend of orthopaedic, infectious disease and rehabilitation expertise. Prevention — through public education, safer handling of working animals, and systematic vaccination programs — remains the most effective measure to reduce incidence.

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