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Original Article

A review of upper limb injuries in bear maul victims: Consistent pattern and inverse relation in severity with facial and scalp injuries

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ABSTRACT

Purpose: Bear maul injuries are the most common wild animal inflicted injuries in India. More than 300 bear maul injuries report to our hospital per year.
Methods: Twenty-one consecutive patients over a period of 1 year reported to our department for orthopaedic management of bear maul injuries. All the patients were referred either from peripheral hospitals or from other surgical departments of our hospital.
Results: All the patients had facial/scalp injuries of variable severity. In all the patients the severity of limb and facial trauma was inversely proportional to each other. Pattern of upper limb trauma in most of the patients was similar. Fifteen patients had either fractures of distal humerus or mid shaft/proximal forearm bone fracture. Two had distal forearm bone fracture, 2 had carpal/metacarpal fractures and 1 had clavicle fracture. Only 1 had lower limb fracture. Thirteen out of 21 patients had associated neurovascular injury of the involved limb. The characteristic feature was extensive soft tissue involvement of the affected limb.
Conclusion: Upper limb injuries in bear maul patients usually have similar pattern. The severity of upper limb and facial/scalp trauma is inversely proportional to each other. Multistage orthopaedic surgeries are needed for such complex limb injuries.

Introduction

Worldwide dog bites are the most common form of mammalian attack injuries reported.[1] A wild animal inflicted injury is rare but usually a severe form of trauma with very high morbidity and significant mortality.[2] Human wildlife conflict is showing an increasing trend in the Himalayan states of India due to ecosystem changes and encroachment of forest land by people.[3] Among the wild life injuries bear maul injuries are the most common wild life injuries reported.[4] The Himalayan region is the natural habitat of Asiatic Black Bear (Ursus thiabetanus) so all the injuries due to bear attacks in this region are due to black bear. It is a strong agile animal with average weight of 250 pounds and height of 1.5 m. It attacks with paws, claws and teeth causing tearing, crushing, cutting and penetrating injuries.[5] Since bear is a tall animal and during its attack it stands on its hind limbs and attacks with fore legs, usually upper part of human body has to bear the brunt of bear attack. Human beings show a natural reflex action of covering the face using upper limbs while being attacked. This reflex action makes injuries of upper limbs a common presentation.

Materials and methods

After approval from ethical committee the study was conducted at Post Graduate Department of Orthopaedics SKIMS Medical College, Bemina Srinagar over a period of 1 year between June 2015 and June 2016.

Totally 21 bear maul patients reported to our department for orthopaedic consultation during this period. All the patients were

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received in emergency room. All the patients were either from peripheral hospitals or from other departments of our hospital for orthopaedic consultation and were in a stable condition. Complete history was taken about type of attack (defensive or predatory), defense used and time taken from the attack site to the hospital. Complete examination of all the injuries was done. Wounds were thoroughly cleaned, debrided and washed with povidone iodine and normal saline. Post exposure prophylaxis for rabies vaccination and tetanus prophylaxis was made sure in all the patients. Plastic surgery consultation was sought for injuries over face and scalp. None of the wounds over limbs was closed primarily. All the wounds over limbs were thoroughly debrided one or multiple times till the time all the dirt and devitalized tissue were removed. Empirical Triple antibiotic cover using injectible cefazolin, amikacin and metrogyl were used in all the patients before shifting to antibiotics on the basis of culture reports. All the open wounds were classified as per the Gustilo and Anderson classification and managed depending upon the type.

Results

A total of 21 bear maul patients reported to our department for orthopaedic consultation between June 2015 and June 2016. Sixteen were males and 5 were females. The average age of the patients was 37 years (range: 15–65 years). All the attacks were defensive which happened due to sudden encounters, mostly during early morning period when people were going towards their fields for work. Eighteen attacks happened near foot hills, 3 happened in the residential areas. Nineteen attacks were reported in the harvesting season (July–September). One attack was reported in the month of November and one in the month of April.

All the 21 patients had various degrees of multiple injuries. Injuries around the head and neck region were seen in all the 21 patients, 20 patients had upper limb injuries, 1 patient had lower limb injuries and 4 had associated injuries involving trunk and abdominal viscera.

Total number of fractures in 21 patients was 27 with 24 open and 3 closed fractures (Table 1). All the bony injuries due to direct bear attacks were open (Fig. 1), while as closed fractures were mostly of the adjacent bones of open fractures due to torsional effect or high energy impact of bear attack. None of the patient had isolated closed fracture.

The severity of upper limb injuries and facial/scalp injuries was inversely proportional in the same patient. Patients with distal humerus or proximal/mid shaft forearm bone fractures had less severe facial/scalp injuries like abrasions and small lacerations (Case 1, Fig. 1). A patient with extensive facial/scalp injuries had less severe upper limb injuries and vice versa (Case 2, Fig. 2). Upper limb injuries were more severe in men and facial/scalp injuries were more severe in women (Fig. 2A), as shown in Table 2.

All the 21 patients needed multistage orthopaedic surgical intervention as shown in Table 3. Patients with extensive facial/scalp and neurovascular injuries were managed by plastic and cardiac, vascular & thoracic surgery (CVTS) surgeons respectively. Two patients with abdominal injuries were already managed in general surgery department before referring to orthopaedic department. 5 patients had wound infection in the follow up, 2 patients ended up with chronic osteomyelitis which was managed by Masquelet technique.

Out of 15 patients with injuries 12 had posterior interosseous nerve (PIN) or radial nerve palsy. This was because around distal humerus and proximal forearm radial nerve and PIN most prone to injury. Nerve injuries recovered spontaneously in 4 patients and another 8 patients because of irreversible PIN palsy patients were referred to plastic surgery for tendon transfer. One Patient with brachial artery damage was managed by CVTS surgeon.

Table 1
Pattern of bony injuries in the patients.

Musculoskeletal injury pattern	No of injury site
Distal humerus fractures	7
Both bone fractures (mid shaft and proximal)	13
Distal forearm fractures	2
Metacarpal/carpal/phalangeal fractures	4
Clavicle fractures	1

Discussion

Wild animal inflicted injuries are showing an increasing trend worldwide though the exact incidence of animal inflicted injuries is not known.[6] In India bear maul injuries constitute only 0.1% of animal attacks, although they are most common wild animal inflicted injuries.[7] In our mountainous state bear maul injuries are quite common, about 300 attacks are reported per year. Himalayan region is the natural habitat of Asiatic Black Bear and all the injuries reported in this region are due to black bear attacks. Asiatic Black Bear is a large and powerful animal with average weight of about 130 kg, average height of about 3 feet and body length of 4–6 feet. It attacks with paws, claws and teeth. The pattern of injuries is crushing injuries due to forceful impact, penetrating injuries due to powerful paws and claws and cutting injuries due to teeth.[8]

Most of the victims in our study were young men, almost all the attacks happened in far flung rural areas, most of attacks the took place in the early morning period, all the attacks were defensive, due to sudden encounters between victim and bear which followed in response to perceived threat to food, individual space or cubs by bear. None of the attack was predatory which could be attributed to the fact that most of the attacks either terminated spontaneously or the surrounding people came to the rescue of the victim. All these observations are consistent with the findings of previous studies.[9,10]

Observations from our study showed that all the 21 patients with musculoskeletal injuries had associated facial or scalp injuries of variable severity. The severity of upper limb injuries and facial/scalp injuries was inversely proportional in the same patient. A patient had either severe upper limb injuries or extensive facial/scalp injuries but not both. This could be attributed to the fact that bear stands on hind paws and usually attacks with the fore paws making head and neck region the most vulnerable area for injuries. Under such attack natural reflex action of covering the face with the help of upper limbs by the patients made them equally vulnerable for injuries. The patients who managed to block the initial impact of bear attack with their upper limbs had severe upper limb injuries and less severe facial/scalp injuries and vice versa. The one patient with lower limb injuries was at a higher level when bear attacked the victim's leg causing severe injuries. None of the study reported so far have observed such findings. Multiple studies on craniofacial injuries by bear attacks have published their results however no comparisons has been made with musculoskeletal injuries.[11–13]

We also observed that facial/scalp injuries were more severe in women as being physically weak compared to men they were not able to defend themselves and protect their face with the help of upper limbs. Reverse was the case with men who had more severe upper limb injuries as compared to facial/scalp injuries as in most of the cases they tried to protect themselves and used upper limbs for self defense, causing injuries to upper limbs. No such observation has been reported in any previous study. None of the men in our study had severe facial injuries while as 3 out of 5 women had severe facial injuries which ended up with permanent face

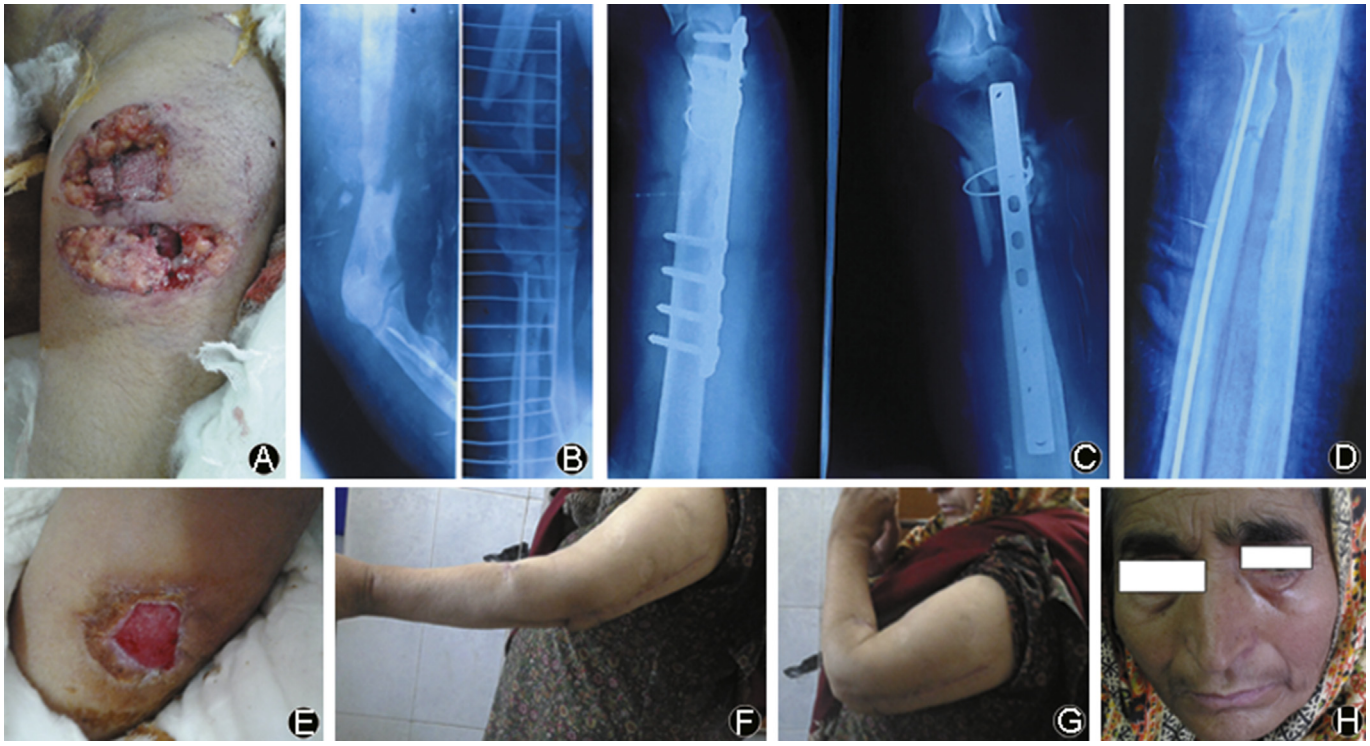

Fig. 1. Case 1: A patient with severe upper limb injuries and milder facial/scalp injuries. **A:** Wound over proximal forearm (claw maks); **B:** X-ray showing shattered distal humerus and proximal radius fracture; **C:** Open reduction and internal fixation with plating, cerclage and bone grafting done; **D:** Square nail in situ for radius fracture; **E:** Wound healed (secondary intension); **F** and **G:** Healed wound and healed surgical scar with good range of motion at elbow; **H:** No gross facial injury (a small healed scar under left eye lid).

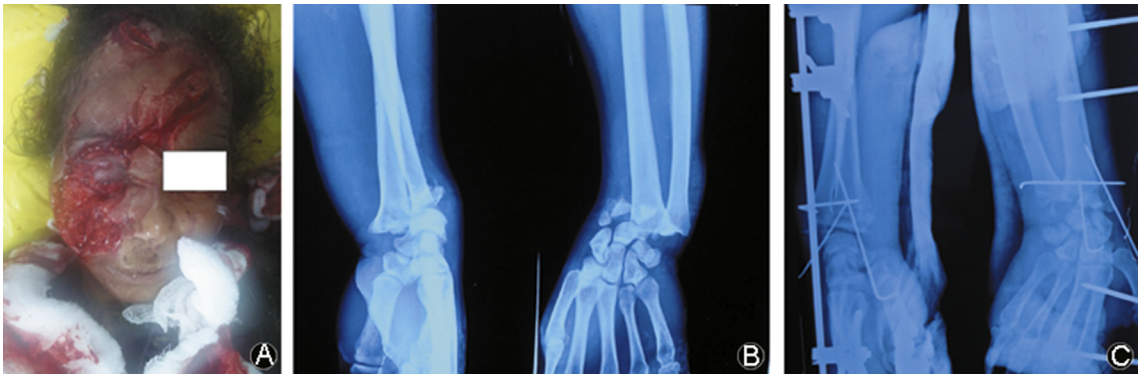

Fig. 2. Case 2: A patient with extensive facial injuries and less severe upper limb injuries. **A:** A female patient with disfigured face with ruptured right eye ball; **B:** X ray of the same patient showing distal end radius fracture; **C:** Fracture stabilized with k wires and external fixator.

Table 2
Correlation between severity of upper limb and facial/scalp trauma.

Upper limb fractures	Facial/scalp injuries	No of patients
Distal humerus fractures	Abrasions/small lacerations, no bony injury	7
Proximal/mid shaft forearm bone fracture	Abrasions/small lacerations, no bony injury	10
Metalcarpal/carpal/distal forearm	Extensive facial injuries/eye ball damage/bony fractures (all were female patients)	4

disfigurement or permanent eye damage or needed multiple reconstructive surgeries for facial/scalp trauma.

The most eye catching observation of our study was that upper limb injuries had almost a consistent pattern. The injuries were mostly (17 patients) around elbow involving proximal or mid shaft of forearm bones or distal humerus. The soft tissue damage was extensive in all the cases. A significant number of patients had associated neurovascular injuries of the upper limbs. Radial nerve and posterior interosseous nerve were the most commonly involved nerves in 12 patients. One patient had brachial artery injury. The consistent pattern of bony injuries of upper limbs observed in our study has not been reported in the literature. Dhar eta al in their study have observed the orthopaedic injuries in their study however they haven't stressed on any consistent pattern.[14]

Out of 21 patients 18 patients needed multistage surgeries for upper limb injuries. Nine patients needed plastic surgery and 1

Table 3
Multi-stage management of open bony injuries.

Injury	Primary management	Definitive management
Humerus fractures ($n = 7$, open = 4, closed = 3)	Wound washing with saline and iodine, debridement, external fixation for open fractures.	ORIF with plating ($n = 5$)
	ORIF with plating in closed fractures	POP cast ($n = 2$)
Forearm bone fractures ($n = 8$) (all open)	Debridement, external fixator/rush nailing/K-wire fixation	POP cast (after soft issue healing) ($n = 9$)
		ORIF with plating ($n = 4$)
Distal forearm fractures ($n = 2$)	Debridement, external fixator/K-wire fixation	POP cast/K-wire fixation
Small hand bone fractures ($n = 2$)	Debridement and K-wire fixation and tendon repair when needed	Continued as definitive management
Clavicle fracture ($n = 1$)	Clavicle brace and arm pouch	Continued as definitive management
Both bone leg fracture ($n = 1$)	Wound debridement and external fixation	Patellar tendon bearing cast

ORIF: Open reduction and internal fixation; POP: Plaster of paris.

needed CVTS surgery intervention. Seventeen patients with injuries around elbow and one patient with lower limb injury needed multiple orthopaedic surgeries. Single stage definitive surgery was not possible in any of the patients because of extensive musculoskeletal injuries. Nine patients with PIN palsy after one year of follow up had no functional recovery were referred to plastic surgery for tendon transfer. Geetha et al[15] in their study have recommended multistage and multidisciplinary surgeries in their study for bear maul injuries.

In our study we observed that since most of the attacks occurred near foot hills, patients had to travel a long distance (10–40 km) to reach the nearest medical centre and 65–150 km to reach the tertiary hospital. Besides the struggle by the victim at the time of attack makes the contaminated with dust, grass and, also the oral cavity of bear is contaminated with numerous bacteria. All these factors make the wounds severely prone to infection. Thorough wound irrigation, extensive debridement of devitalized soft tissue and temporary fixation with external fixation or k wire fixation was done in all the cases as the first step. Multiple debridements were done in some cases till wound had healthy granulation tissue. Definitive fixation was done only when soft tissue healing was adequate. The time taken from primary fixation to definitive fixation varied from 3 weeks to 12 weeks. In our study 5 patients had surgical site or wound infection after definitive surgery. Among them 2 patient ended up with chronic osteomyelitis and were managed by Masquelet technique.[16] The culture reports of all the 5 patients showed mixed organism. Various studies has proved high infection rates in animal bite cases with mixed flora as the common cause of infection.[17,18]

There was zero mortality in our study. This could be attributed to the fact that study was done in orthopaedic department and all the major injuries were already taken care of by the respective departments before sending to our department for orthopaedic treatment. Also black bear is considered to be less aggressive compared to grisly or polar bear. Many studies have shown mortality of 2.0%–2.5% in black bear maul injuries.[19] Studies on grizzly and polar bears have shown more mortality and morbidity.[20–24]

In conclusion, musculoskeletal injuries due to direct bear mauling involve mostly upper limbs. The bony and extensive soft tissue injuries usually are usually often around elbow and are associated with neurovascular involvement. Multistage orthopaedic surgeries, triple antibiotic cover and extensive debridement are needed to get the satisfactory results.

Appendix A. Supplementary data

Supplementary data related to this chapter can be found at https://doi.org/10.1016/j.cjtee.2017.11.001.

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