Sideswipe elbow injuries in Egypt: management and functional evaluation

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Purpose
The aim was to show the causes of sideswipe injury and to evaluate functional outcome of these injuries.
Patients and methods
A total of 16 patients presenting with sideswipe injuries around the elbow were managed, and functional results were evaluated between June 2014 and June 2017. Eleven of these patients were males and five were females. The injuries were sustained in the age group between 20 and 50 years. Thirteen patients were affected on the right side and three patients were affected on the left side. Road traffic accident was the cause in all patients. Principles of management followed were first, debridement and stabilization of fractures; second, vascular repair; third, repeated debridement; fourth, nerve repair; and fifth, soft tissue cover. Internal fixation was used as a stabilization modality in all patients ranging from minimal fixation to plating and graft. Primary nerve and tendon repair was carried out in two cases. Skin graft was done in two cases. Mayo elbow performance score was used for evaluation of the results.
Results
The average follow-up period was 23.3 months (12–36 months). A total of 12 cases underwent internal fixation for open injuries of the humerus, radius, and ulna, and four required extraoperative interference, including nerve repair in two cases and skin graft in two cases.
The functional outcome according to Mayo elbow performance score was excellent (score $>$90) in two cases (12.5%), good (score 75–89) in 11 cases (68.75%), fair (score 60–74) in two cases (12.5%), and poor (score $<$60) in one cases (6.25%).
Conclusion
Sideswipe should be managed timely, aggressively, and an algorithmic procedure should be followed to attain best results. The injury pattern is different for which a multispecialty approach is needed, and an orthopedic, vascular and plastic surgeon must be implicated. Limb salvage is possible in most cases. Educational programs, appropriate legislation, traffic condition improvements, and car design improvements should be encouraged to prevent these complex and devastating injuries.

Keywords:
clinical outcomes, prognostic factors, sideswipe injuries around the elbow

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Introduction

Passengers or drivers protruding their arm from an open window or resting their elbow on the car window edge can be exposed to severe elbow sideswipe injuries either from a fixed object on the road or a collision with a coming vehicle [1]. This injury commonly happens with mismatch between wider cars and narrower roads and represent a challenging clinical situation to orthopedic surgeons [2–7].

The sideswipe injuries have created a different subdivision of complex elbow trauma in which all the tissues of the elbow region can be affected [1,8,9]. Most of the sideswipe injuries result from high-energy trauma [10]. Majority of these are open injuries and can be prevented by keeping the limbs inside the vehicles [8,10–12]. This extreme injury is commonly encountered in countries where the transportation methods have open unprotected windows [1].

Although these injuries are now rare in the developed countries, they are not uncommon in Egypt and other underdeveloped countries [1] owing to the absence or lack of control of legislations that regulate passengers and driver's safety and prevent them from protruding any part of their body outside the vehicle.

Although sideswipe injuries are rarely fatal, they result in severe soft tissue damage with comminuted open fractures of the elbow and are frequently complicated by associated neurovascular injuries and soft tissue and bone loss [9].

A multidisciplinary team approach involving orthopedic, plastic, and vascular surgeons is needed to successfully manage these difficult injuries. Management of sideswipe injuries is challenging and may require multiple operations and prolonged rehabilitation periods to regain satisfactory elbow function [9].

A specific treatment algorithm is required for the ideal management of sideswipe injuries to maximize the functional outcome and minimize the time needed to regain useful elbow function. A careful evaluation of the magnitude and the component of the injury should be done urgently when patient arrives at the hospital. A carefully planned staged multidisciplinary surgical protocol should be followed. Initially soft tissue debridement and fracture fixation should be done followed by the vascular repair when needed [8,9,11].

Coverage of the wound is of paramount importance in the successful management of sideswipe injuries. Primary coverage is only possible in cases where soft tissue contamination is limited and primary tension free closure of the wound is feasible [8]. In cases of soft tissue loss, secondary coverage using split-thickness skin graft and flaps are used to adequately cover the injuries tissues and metallic implant used for fixation. The sideswipe injuries are notorious for their high complication rate and poor functional outcome. Stiffness, joint and soft tissue contractures, fracture nonunion, deformity, and loss of elbow function are common complications [8,9,11].

The sideswipe injuries have a growing high incidence in passengers or drivers in different rural areas of Egypt. This study aimed to show the etiology of increasing the incidence of sideswipe injury and to show up the complexity of these injuries.

Patients and methods

Patients

Between June 2014 and June 2017, 16 patients presenting with sideswipe injuries around the elbow were managed in Mansoura Emergency Hospital by immediate open reduction and internal fixation with minimum follow-up of 12 months. The study was approved by the institutional ethics committee in the Orthopedic Department of Orthopaedic Surgery, Mansoura University, Egypt. Eleven of these patients were males and five were females. The average age at the time of injury was 36 years old (range: 20–50 years). The right elbow was affected in 13 patients and the left was affected in three patients.

Detailed documentation of the accident was done, including site of the accident, road logistic condition, rural or urban, location of the patient in the vehicle, and whether he or she was a passenger or a driver. The form of the vehicle was also noted and whether the seatbelt was used at the time of the accident or not. Road traffic accident was the cause of injury in all patients.

In patients with right elbow injuries, eight had their injury while resting the elbow out of the car window and hit by vehicles traveling in the opposite direction and five had their injury while protruding the elbow out of the tok-tok (a three-wheeled poorly protected open motorcycle used for transportation with no safety measures) and hit by metal poles, trees, or a wall. In patients with left elbow injuries, two of them were drivers protruding the elbow out of the car window and hit by vehicles traveling in the opposite direction, and one lost the control over the car and the protruding elbow hit a wall.

All fractures were open with bone loss in 10 patients, nerve injury in two patients, and extensor mechanism injury in all cases.

Surgical management

On arrival to the hospital, all patients were managed according to the guidelines of the advanced trauma life support protocols [13]. This injury should be followed by immediate operative interference by an orthopedic team, involving plastic or vascular surgery. The principal sequences of management followed were initial debridement and stabilization of fractures, followed by vascular or nerve, then adequate soft tissue coverage, and finally, multiple debridement if needed.

Information about associated injuries and their management, including antibiotic, medication, and repeated procedures was documented.

All patients were managed surgically and subjected to limb salvage. All patients were given intravenous antibiotics, antitetanus, and antigas gangrene serum at their arrival to the hospital. Wound lavage was done using 4–5 l of normal saline in these open fractures, followed by aseptic dressing and splinting.

Primary debridement was followed by redraping and rescrubbing of the same operating team and then followed by stabilization of fractures with internal fixation. All fractures were internally fixated using stabilization modality in ranging from minimal fixation by wires up to plating and graft. External fixator was not used for fracture fixation in any of our patients.

Primary bone grafting including iliac bone and free fibular grafting was carried out in 10 cases. Extensor mechanism repair was carried out in all cases using nonabsorbable Ethibond suture. Primary nerve repair was done in two cases (one radial and one ulnar nerve). Partial-thickness skin graft was needed in two cases.

Postoperative radiographs were carried out to assess the fixation and reduction. A second-look debridement was carried out after 24–48 h before proceeding for any kind of soft tissue cover in cases with skin loss.

Rehabilitation

Elbow rehabilitation began early in most cases, especially with stable internal fixation. Rehabilitation aimed to prevent development of fixed elbow deformity and improving the elbow range of motion.

Postoperative above-elbow splint was applied for an average of 3 weeks as an initial immobilization, especially with the use of minimal internal fixation. A hinged elbow brace was used in cases with stable internal fixation. After this period, passive and active exercises (flexion–extension) of the elbow were encouraged, with progressive increase in the range of motion. Pronation and supination movements were allowed 8–14 weeks postoperatively, when fracture healing formation was evident. This program was modified in cases with great intra-articular comminution.

During follow-up visits, detailed clinical and radiographic examinations of all patients were done. Final clinical examination included assessment of elbow pain, active and passive elbow range of motion, elbow and hand grip strength, elbow stability, and ability to perform daily activity. Mayo elbow performance score (MEPS) was used for functional evaluation of the reconstructed elbow [14] (Table 1).

Table 1 Mayo elbow performance score (MEPS)[14]

Pain (45)
None (45)
Mild (30)
Moderate (15)
Severe (0)
Range of motion (20)
>100°→20
50–100° →15
<50°→10
Stability (10)
Stable (10)
Moderate unstable (5) (<10 varus/valgus)
Grossly unstable (0) (>10 varus/valgus)
Function (25)
Able to comb hair (5)
Able to eat only (5)
Able to on shirt (5)
Able to put on shoes (5)
Able to perform hygiene (5)

Results

The mean follow-up period was 23.3 months (range: 12–36 months) after the initial injury. Depending on the severity of the fracture and the needed surgical interventions, 12 patients required open reduction and internal fixation for open fractures of the humerus, radius, and ulna, and four underwent additional surgical procedures including nerve repair in two cases and skin graft in two cases.

Limb salvage was possible in all patients. Fracture healing occurred postoperatively between 8 and 16 weeks, except in patient 7, who had type IIIB open fracture. This patient was managed by open reduction internal fixation (ORIF) and with iliac and fibular autograft application for the fracture, and healing occurred 5 months later (Figs 1 and 2).

The average MEPS was 77. MEPS was excellent when greater than 90, good 75–89, fair 60–74, and poor less than 60. Excellent results (score ≥90) were seen in two patients (12.5%), good results (score 75–89) were seen in 11 patients (68.75%), fair results (score 60–74) were seen in two patients (12.5%), and poor results (score <60) were seen in one patients (6.25%) with fused elbow.

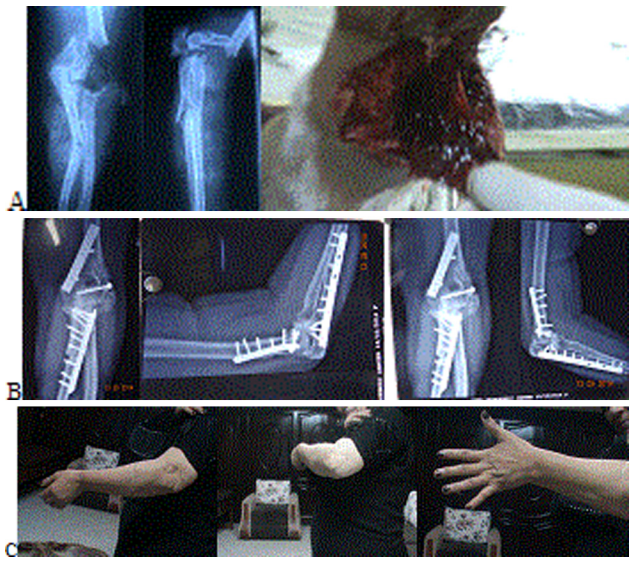
No deep infection or heterotopic ossification complicated the fracture management. Superficial infection was seen in two cases and was managed by wound lavage and intravenous antibiotic. Fused elbow occurred in one case.

Neuropraxia was seen in six cases, and function was restored within 3–6 months after the initial injuries. In one patient, although radial nerve exploration did not show any important lesion, the nerve did not regain function during the 2 years of follow-up. Partial median nerve repair was done, with restoration of the function 6 months after trauma. Ulnar nerve repair was done, with restoration of the function 1.6 years of follow-up with some wasting of hand muscles (Table 2).

Figure 1

(a) Preoperative; (b) One and two years postoperatively; (c) clinical movements.

Figure 2



(a) Preoperative; (b) One and two years postoperatively; (c) clinical movements.

Discussion

The term 'sideswipe injuries' is grossly insufficient, as it describes only the mode of trauma and gives little information about the nature of the injury. This particular injury around the elbow often involves multiple bone fractures and variable injury patterns. In most cases, it is associated with serious soft tissue damage and associated nerve palsies with unpredictable functional outcome [15–17].

They are defined as complex elbow injuries, as standardized concepts usually do not apply [8,10–12]. Few investigators, in relatively small series, have reported sideswipe injuries [15–21], and their interest was focused on management patterns and clinical outcomes.

In Egypt, sideswipe elbow injuries still happen despite improvements in road conditions and recently introduced legislation. Wider roads, divided highways, car air conditioning, and increased public awareness have decreased the incidence of sideswipe accidents. However, these measures have failed to fully prevent this life-changing and devastating injury, especially in rural areas. Several measures have been shown to decrease the incidence of opposing-direction sideswipe injuries in rural areas, including centerline rumble strips (a relatively low cost), warning signs, and barriers to separate opposing traffic flow [22].

Male predominance among our patients is probably owing to multiple factors: young men are more likely exposed to serious motor car trauma than young women. Differences in behavior, maturity, and social

Table 2 Details of our study

Patient	Sex	Age	Side	FU (M)	Fr	Injury	MEPS	Functional outcome
1	M	20	R	20	HC	BL	85	G
2	M	25	R	30	HC and Olecranon	NI	80	G
3	F	40	L	24	HC and HR	BL	70	Fa
4	M	50	R	16	HC and Radius	NI	75	G
5	F	45	R	18	HC and BB	BL	70	Fa
6	F	30	R	22	HC	BL	80	G
7	M	50	L	36	HC and Olecranon	BL	75	G
8	F	35	R	20	HC	SL	90	E
9	M	35	R	24	HC	BL	80	G
10	M	45	R	36	HC and HR	SL	75	G
11	M	40	R	12	HC	BL	80	G
12	F	40	L	30	H, HC and Ulna	BL	90	E
13	M	30	R	18	HC	Open only	80	G
14	M	32	R	16	HC	BL	55	P
15	M	50	R	20	HC and Ulna	Open only	75	G
16	M	26	R	32	HC	BL	85	G

F, female; L, left; M, male; MEPS, Mayo elbow performance score; R, right.

restrictions are commonly quoted reasons [23,24]. The results of the current study might suggest that men are more expected to have their arm outside the widow of a moving vehicle.

The goal of treatment is stable fixation and pain-free motion [9,25–27]. The most frequent combination fracture pattern was a supracondylar fracture of the humerus associated with intra-articular extension and fracture of radius and ulna. Internal fixation should be the preferred stabilization modality of choice in clean open fractures [9,11]. External fixation should be limited to extensive soft tissue damage and multiple injured patient [1,20,28–30]. We used internal fixation in all our patients.

Wound coverage was needed in two cases of this open injuries with skin loss. The early wound coverage with skin grafts or flaps decrease the infection rate, tissue edema, and exposed tissue necrosis and allows early mobilization [27,31]. Some authors believe that tissue hypoxia in the early postoperative period delays wound healing and increases chances of infection [32]. We have successfully skin grafted open wounds, within 24–48 h after a second-look debridement. Plastic surgeons believe that early split skin graft acts as a biological dressing and prevents tissue death and helps control infection.

In our study, radial nerve palsy was found in one patient of our injured patients, but radial nerve palsy was the most common nerve deficit as opposed to the ulnar nerve lesions found commonly in some series [11]. Ulnar nerve injury was found in one patient, and median nerve injuries was found in one patient. Ulnar nerve lesions recovered after a period of observation of 1 year. Median nerve injuries recovered after 6 months after trauma. Some authors have reported a 50% [32] and 63.5% [11] neural complications. We did not encounter any brachial plexus injuries or vascular injuries in our series.

Primary acute bone grafting was used in 10 cases and primary union was achieved in all cases after internal fixation. Wild *et al.* [30] achieved primary union with the external fixator in 5 of 16 patients. The functional results did not correlate with the injury severity score of the individual patients. In the study by Wild and colleagues, open fractures, associated nerve injuries, soft tissue loss, bone loss, primary method of fracture stabilization (external fixation), and poor rehabilitation, all had poor results and did correlate with poor functional results. All the above factors had a negative effect on the end results of their study. Seekamp *et al.* [33] have evaluated prognostic criteria for poor functional results in elbow injuries and found that nerve lesions are the most significant factor for poor outcome. They also found the method of primary treatment to be of prognostic implication, with external fixator application correlating with a poor functional outcome.

The functional outcome in our series was good results (score 75–89) in more than 68% of the patients. This is better than other series [1,21,34–36], in which poor results occurred in more than 70% of their patients (score <60). This may be owing to delayed surgery, use of external fixators, delayed grafting, delayed rehabilitation, and use of four-step operation in the management. The analysis of our series and the

literature shows that the prognosis of these lesions is more severe with vascular and nerve complications. No patient in our series had regained a completely normal elbow mobility.

Conclusion

Sideswipe elbow injuries unfortunately still occur in Egypt. Increased public awareness of the magnitude of this problem and instructions to keep the arms within the vehicle, improved road conditions, and traffic legislation, particularly in rural areas, are issues that most likely can decrease the incidence of this devastating but easily preventable injury. Limb salvage is possible in most cases if an aggressive approach is used in the acute stage, and multiple procedures may be used if needed to achieve good functional results.

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Conflicts of interest

There are no conflicts of interest.

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