



## FUNCTIONAL OUTCOME OF IPSILATERAL FRACTURES OF HUMERUS AND FOREARM BONES (FLOATING ELBOW INJURY) IN ADULTS

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### ABSTRACT

Floating elbow injury is one of the rare injury ranges from simple diaphyseal fracture to complex intraarticular fracture of ipsilateral humerus and forearm bones associated with neurovascular injury and other polytrauma. This Prospective observational study aimed to evaluate functional outcome in adults with floating elbow injury. 24 patients with floating elbow injury were treated in Indira Gandhi Government Medical College and Hospital, Nagpur from December 2020 to December 2022 with minimum followup of 6 months. The functional outcome was assessed by the Khalfayan score. Most common cause of injury were found out to be road traffic accidents (62.5%). All patients were managed surgically and out of 24 patients, 4 had excellent outcome, 12 had good outcome, 5 had fair outcome and 3 had poor outcome. Floating elbow injury required operative management for optimum result and early range of motion. Though the type of operative fixation depends upon the location of fracture, operative management has good result. Patients with intraarticular involvement, neurovascular and soft tissue injury have poor outcome.

**KEYWORDS :** Floating elbow injury, Functional outcome, adults, polytrauma

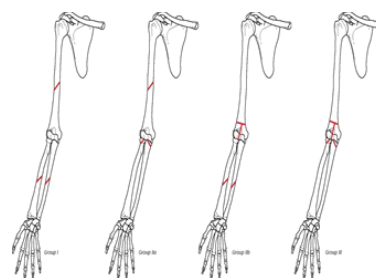
### INTRODUCTION

Floating elbow is an injury pattern involving a fracture of the humerus and a fracture of the radius and/or the ulna in the same extremity. It ranges from simple diaphyseal fractures to complex intraarticular fractures. This injury may be associated with an elbow dislocation in patients who sustain high-energy injuries. The term floating elbow was first introduced in 1980 by Stanitski and Micheli to describe an injury pattern in children involving concomitant fractures of the forearm axis and supracondylar humerus in the same extremity [1]. In 1984 this description has been extended to adult patients by Rogers et al. who sustain ipsilateral fractures of the humerus and forearm [2,3]. The likely mechanism of injury is a fall on the outstretched arm with the forearm pronated and the wrist hyperextended [4,5,6,7]. Direct trauma and other positions of the arm and forearm in space after fall also can cause similar constellations of injuries. In adult patients, the usual mechanism is direct high-velocity trauma (sideswipe injuries, crush-type injuries, or falls from extreme heights) [3,8]. The nature of treatment of these injuries is dictated by the location of fracture, condition of the soft tissues and neurovascular bundle in the affected extremity. It may lead to complications like infection, neurovascular injury, malunion or non union, elbow stiffness, compartment syndrome, etc.

### MATERIAL AND METHODS

This was a prospective interventional and observational study, which included patients presenting with a floating elbow injury and its variants to IGGMC, Nagpur from December 2020 to December 2022. Patients with age group 18-70 years with no previous surgeries in the ipsilateral limb were included in the study. Patients with pathological fracture and vascular injury (Gustilo Anderson type 3c) were excluded from study.

This patients were classified into four groups according to Ditsios classification [9]. For open fractures, Gustilo-Anderson classification [10,11] was used. Standard X-Ray of the humerus and ipsilateral forearm bones showing the upper and lower joints remains the first choice for diagnosis. CT scan was done in cases of intra-articular fracture patterns for better delineation of fracture pattern.



**Figure 1: Ditsios classification of Floating elbow injury**

All the patients presented with floating elbow injury were initially stabilized vitally according to the guideline by Advanced Trauma Life Support Protocol (ATLS). Throughout examination were done to rule out neurovascular injury and compartment syndrome. Appropriate analgesics were given and temporary stabilization of fracture done with the help of splint. In case of open fracture immediate debridement done along with intravenous antibiotics. All the patients were managed surgically depending on location of fracture, condition of the soft tissues and neurovascular bundle in the affected extremity. The range of motion exercises were started from day one of the postoperative period wherever feasible.

On each visit, clinical evaluation and X ray radiograph were done to see the progress of bony union, implant status, and any complication. The functional outcome was assessed by the Khalfayan Score [12]. The Khalfayan score were categorized into four categories of excellent (90-100), good (80-89), fair (70-79), and poor (<70).

### RESULTS

In the series of operated cases, out of 24 patients, 18 cases (75%) were male and 6 cases (25%) were female. The incidence of fracture in age group 30-40 was maximum, which was 41.66%. Right side were involved in majority (2/3rd) of the cases. The incidence of fracture in right side was 62.5% and in left side was 37.5%. Out of 24 fractures, 12 patients (50%) had extra-articular fracture and 12 patients (50%) Intra-articular fracture. 12 patients (50%) had

Ditsios type I fracture followed by type IIB with 6 patients (25%) followed by type IIA and III with 3 patients (12.5%) each. The intra-articular fractures had poorer functional outcome than extra-articular fractures due to elbow joint involvement in the former.

The nature of injury was high velocity injury, in which 15 patients (62.5%) sustained road traffic accident, 7 patients (29.16%) fall from height and 2 patients (8.33%) had history of assault. As most of the floating elbow injuries occurred due to high velocity trauma, the incidence of the associated injuries were also high. In our study, there were 11 patients (45.83%) with associated injury to other organs. For humerus, we had the mean union time of 5.8 months with a range of 4-8 months and for forearm fractures the mean union time was 4.5 months with a range of 3-6 months, respectively. In this study 2 patients had delayed union of humerus. One patient had non union of humerus for which revision surgery with bone grafting was done.

Among the 24 patients, 4 (16.66%) patients had excellent functional outcome, 12 (50%) had good functional outcome, 5 (20.83%) had fair outcome and 3 (12.5%) had poor functional outcome due to neurovascular injury, assessed with the khalfayan score. The average khalfayan score is 81.52, which is good score.

**COMPLICATIONS**

Floating elbow injuries were associated with multiple complication due to its complex nature of injury, intra-articular involvement, risk to neurovascular bundles and implant related complications. In our study out of 24 patients, three (12.5%) patients had infection, in which two (8.33%) patients had superficial infection and one (4.16%) patient had deep infection. Three (12.5%) patients had joint pain due to impingement. Two (8.33%) patients had delayed union of humerus while one (4.16%) patient had non union of humerus. Five (20.83%) patients had elbow stiffness and three (12.5%) patients had radial nerve palsy.



**Figure 2: Preoperative and postoperative radiograph of patient with type III floating elbow injury**

**DISCUSSION**

With advances in the automobile technology, the incidence of road traffic accident (RTA) is also increasing. In this study, the most common mode of injury was RTA (62.5%). Our findings are comparable to the studies made by Rogers et al. (52.63%)

[2], Jimenez Diaz et al. (69.56%) [13], Ditsios et al. (78.94%) [9], Lange et al. (77.77%) [14] and Ibrahim et al. (25%) [15].

Floating elbows mostly associated with other injuries such as other bony injuries, head/chest/abdominal injuries, face and eye injuries. Associated injuries were seen in 45.83% of the cases in our study. There were varying percentages of associated injuries with other studies done by Jimenez-Diaz et al.- 86.95% [13], Solomon et al.- 73.07% [16], Lerner et al.- 57.14% [17], Chul-Hyun Cho et al.- 50% [18] and Verma et al.- 46.7% [19].

The closed injuries were more common than the open injuries. In this study there were 17 (70.83%) closed fractures, while remaining 7 were open fractures (29.17). Our findings are comparable to other studies made by Ditsios et al. [20], in a study of floating elbow in adults – systemic review and metaanalysis reported that in the study of 258 patients of floating elbow injuries, they had 51.2% (132 patients) of open fractures and 48.8% (126 patients) of closed fractures. Verma et al. [19], in 30 patients, the study had 17 (56.66) closed fractures and 13 (43.33) open fractures. Marius et al. [21], had 3 patients of closed fracture while 1 patient of open fracture. In a study of Jimenez-Diaz et al. [13], 9 patients had closed fracture while 14 patients had open fracture.

According to the classification system given by Ditsios, type I injury found to be more common followed by type IIB followed by type IIA and III. In this series, Ditsios type I, there were 12 (50%) fractures; in type IIA, there were 3 (12.5%) fractures; in type IIB, there were 6 (25%) fractures; and in type III, there were 3 (12.5%) fractures. In study by Ditsios et al. [9], 10 patients had type I fracture, 5 patients had type IIA while 1 Patient had type IIB and 3 patients had type III injury involved intra-articular fractures. In a study of Jimenez-Diaz et al [13] out of 23 patients, 9 patients (39.13 %) were type I injuries, 8 patients (34.78 %) were type IIA injuries, 3 patients (13.04 %) were type IIB injuries, and other 3 patients (13.04 %) were type III injuries.

Finally, the functional outcome of the floating elbow injuries. It depends upon the lots of factors such as open or closed injury, intraarticular involvement, neurovascular injury and other associated injuries. Various literature used their scoring systems for functional evaluation of outcome of the floating elbow injury.

Comparison of results of our study with various studies

**Table 1: Comparison of functional outcome of floating elbow injury in various studies**

Study	Sample size	Type of functional evaluation	Results			
			Excellent	Good	Fair	Poor
Lerner et al. (2000)	7	Khalfayan score	28.57 %	14.28%	57.14%	-
Solomon et al. (2003)	18	Khalfayan score	11.11 %	33.33%	16.66%	38.88 %
Ibrahimi et al. (2012)	12	Lange and Foster classification	-	67%	17%	16%
Ditsios et al. (2013)	19	Khalfayan score	36.84 %	10.52%	42.10%	10.52 %
Jockel et al. (2013)	19	ASES	73.68 %	15.78%	5.26 %	5.26 %

Chul-Hyun Cho et al. (2015)	6	MEPS	33.33 %	33.33%	16.66 %	16.66 %
Marius et al. (2020)	4	MEPS	50%	-	25%	25%
This study	24	Khalfayan score	16.66 %	50%	20.83 %	12.5 %

ASES = American Shoulder and Elbow Surgeons score;  
MEPS = Mayo Elbow Performance Score)

## CONCLUSION

Functional outcome depends on the following factors – neurovascular injury, intraarticular involvement, and nature of the fracture whether open or closed. The timing of fracture fixation depends on various factors; however, first humerus fixation is recommended. Distios type I floating elbow injuries, in whom primary fixation was done mainly with intramedullary nailing had excellent and good result. The best results were obtained when the operative method results in stable fixation of the fracture. Fixation should always be followed by early physiotherapy. The rehabilitation program also plays a very important role in functional outcomes of a floating elbow injury. Hence, the floating elbow is a complex injury; the rate of complications associated with the floating elbow remains high, regardless of the performed management. However, early surgical fixation of both humerus and forearm bones gives good functional outcomes.

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