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# FLOATING ELBOW: AN INTEGRATIVE LITERATURE REVIEW

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**AUTHORS' CONTRIBUTIONS**

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

**Background:** Floating elbow is a rare condition caused by ipsilateral humeral and forearm fractures, resulting in an unstable intermediate articulation. High-velocity or high-energy trauma, such as car accidents or high-angle falls, are the main causes of floating elbow injuries. The multiple injuries, open fractures, and neurovascular injury that occur concurrently are the most common. A clinical and radiological diagnosis has been made. Epiphyseal closure and stiffness are problems associated with fractures of the forearm and elbow.

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**Objectives:** To state the epidemiology of the floating elbow, assess and describe the classification then summarize the management of the injuries of floating elbow.
**Methods:** The PubMed database and EBSCO Information Services were utilized to choose the articles. In our review, all pertinent articles related to both our topic and other articles were used. Other articles that have nothing to do with this subject were not included. The group members looked through a certain format in which the data had been extracted.
**Conclusion:** Floating elbow is a rare and intricate injury pattern that can result in a variety of functional consequences. The expression describes joint fractures of the humerus and forearm bones in the same extremity. It may affect both adults and children. This damage pattern has been documented in a few published publications, but none of them include epidemiological data, therefore its prevalence remains unknown. Hence, this systemic article state all that helps in knowing the disease.

**Keywords:** Floating elbow; humerus; forearm; fracture.

## 1. INTRODUCTION

The floating elbow is a rare and dangerous disorder, particularly when combined with a soft tissue envelope destruction (Open floating elbow) or a neuro-vascular injury. Stanitski and Micheli characterised it first in children in 1980, then Rogers et al. described it in adults [1,2].

The elbow joint is isolated from the rest of the thoracic limb due to a series of fractures involving the humerus and the bones of the ipsilateral forearm. In children and adults, several series have recorded classic floating elbows (association of humeral shaft fracture and diaphyseal fractures of the ipsilateral forearm bones) and non-classic floating elbows (combination of diaphyseal and epiphyseal fractures or epiphyseal fractures of the humerus and epiphyseal bones of the ipsilateral forearm). They are typically caused by high-energy trauma [3,4].

The term "floating elbow" today refers to more than just forearm and diaphyseal humerus fractures. Intra-articular fractures and fractures with concomitant elbow dislocations that can function, such as floating elbow, have been recorded in some case reports and series of cases; these injuries are referred to as "variants." [5,6]. The mechanism of "floating elbow" injury is unknown. Kose et al. proposed that elbow dislocation with forearm fractures occurred in two stages, with the initial elbow dislocation caused by a fall on the outstretched hand being followed by fractures of the forearm bones while the elbow was still in extension, the forearm in hyperpronation, and the wrist in radial deviation [7].

The standard X-ray of the humerus and ipsilateral forearm bones, which shows the upper and lower joints, is still the first choice for diagnosis. In adults, surgical care of floating elbows is used to stabilise the elbow, enable early mobilisation, and limit joint stiffness. However, the prognosis is uncertain when the trauma also causes damage to soft or nerve structures [8]. The "floating-dislocated elbow," which links fractures above and below the elbow (floating elbow) with elbow dislocation, is a less common concomitant injury in adults [9,10].

Because of their severity, surgical fixation is necessary. A better prognosis can result from early detection and timely treatment. These wounds need to be surgically fixed because they are serious. The prognosis may be improved by early detection and rapid treatment. Even with prompt surgical treatment, the outcome is unpredictable due to the numerous complications it is connected with, including as infection, nonunion, and nerve damage [11].

Even now, the accepted guideline of "floating elbow" remains contentious, but damage control theory has been widely employed to deal with various traumas in this injury by phases. The optimal treatment for "floating elbow" is to execute an accurate open reduction, followed by solid internal fixation and painless postoperative functional activity as soon as possible. However, clinically, these disorders were frequently accompanied by multiple system trauma; thus, the "damage control concept" was adopted as a result of dealing with the wounded limbs in the first place. Internal fixation is not a fundamental basis because it only had one or two steps [12].

### 1.1 Study Objective

To evaluate epidemiology, summarize the classification and asses the management of Floating Elbow.

## 2. METHODS AND MATERIALS

### 2.1 Sample and Study Groups

Exploratory research employing a quantitative approach was included in this Integrative Literature Review (ILR). ILR is a strategy used in the health sciences to find health-care approaches and determine innovations, allow the deployment of evidence-based

services, ensure quality, and enhance patient safety. It consists of six phases that must be completed in the following order: The problem of the study was stated, the inclusion and exclusion criteria were listed, the sample was detailed, the included studies were evaluated, the results were interpreted, and the ILR synthesis was presented.

PubMed and EBSCO Information Services would be used as search databases for the papers used in the study due to their reputation as trustworthy sources. PubMed, one of the largest online digital libraries, was founded by the National Center for Biotechnology Information (NCBI), a part of the United States National Library of Medicine. Topics relevant to epidemiology, classification and management of Floating Elbow would be used in the writing of the paper. The titles and abstracts of the published publications would be reviewed.

Inclusion criteria: the articles would be selected based on the relevance to the project which included one of the following topics; Floating elbow, humerus, forearm, fracture.

Exclusion criteria: all other articles which did not have one of these topics as their primary end, or repeated studies, and reviews studies were excluded.

### 2.2 Statistical Analysis

The data was analyzed without the use of any program. The data was extracted using a specified form that includes (article title, author's name, objective, summary, results, and outcomes). To confirm the validity and minimize errors, each member's results were double-revised.

During the article selection process, studies and their results were double-reviewed to ensure that we enroll research related to the purpose of our study and to avoid or reduce inaccuracies in the results.

## 3. RESULTS

Fig. 1 shows the selection and identification of studies. The search of the mentioned databases returned a total of 80 studies that were included for title screening. 61 of them were included for abstract screening, which lead to the exclusion of 24 articles. The remaining 35 publications full-texts were reviewed. The full-text revision led to the exclusion of 31 studies due to difference in inclusion criteria, and 8 were enrolled for final data extraction (Table 1).

Six studies out of 8 were prospective studies (searched hospital databases for Laparoscopy versus Laparotomy in the surgical management of ectopic pregnancy) and the two studies were from doctors' perspectives after face-to-face interview.

The results which reported in the collected studies stated that The Classic floating elbows are uncommon, and their prognosis is uncertain, especially when musculo-cutaneous or neurovascular injury is present. In adults, surgical treatment is required to avoid extended immobility, which may result in elbow stiffness. Then, a multidisciplinary strategy should be considered [8]. Anther case study proved that The complexity of these fractures might result in devastating sequelae if effective therapy is not undertaken. To avoid these consequences, it is critical to check neurovascular and motor function thoroughly and to perform early surgical fixation [13].

Due to the paucity of reported instances, floating elbow dislocation is not thoroughly studied in elbow traumatology. Since there is no established standard of care for this kind of trauma, an emergency physician should focus more on it and select an appropriate stage of treatment. yet the patient still was satisfied with the post-operative outcomes. Within weeks of checkup, the patient reported no pain, and the fracture lines on the radiographs were well-consolidated [14,15].

As some studies had proved that the surgical treatment give a good result most of times but these studies proved otherwise which state that the bad findings in the patient who underwent surgery were found at the final evaluation. No orthopaedic procedure yielded great results; instead, they were mostly mediocre to fair [16,17]. Other study results that Patients with radioulnar synostosis performed worse in functional evaluations than those without it. This variation was statistically noteworthy. While nerve palsy did not seem to have an effect on functional outcomes, we found a statistical link between intra-articular extension and poorer functional evaluation results [18].

A study added a new variant of classification of floating elbow, It hasn't been documented in the literature up until now. Early recovery and a fantastic 2-year functional outcome were made possible by the prompt management of these injuries and stable repair of the fractures [19].

## 4. DISCUSSION

Floating elbow, a combination of ipsilateral humeral and forearm fractures that results in an unstable intermediate articulation, is a rather uncommon lesion

that often occurs in polytrauma patients [17]. This injury is typically caused by high-energy trauma and can be associated with severe soft tissue destruction, open fractures, and neurovascular dysfunction [20]. The force dissipated has a direct correlation with the injury spectrum, which might vary significantly. An elbow dislocation and concomitant intra-articular and shaft fractures can function as a floating elbow. There is no standard classification for them because they are referred to as "variants" [21,10].

De Carli et al. were the first to suggest a classification into 3 kinds based on certain cases recorded before 2006 [21]. Later, in 2017, El Ayoubi et al. described a new form not covered by that classification: the association of proximal humeral fracture with posterolateral elbow dislocation and distal radius fracture, which rendered the entire upper limb unstable [22].

Features of the Floating Elbow:A skeletally separated or floating elbow is the consequence of ipsilateral humerus, radius, and ulna shaft fractures. Any one center's expertise, as well as related fractures, intra-articular involvement, and the inclusion of other traumas such Monteggia fractures, is limited by this unusual mix of fractures [23].

Although healing may be observed over time and an intact nerve that was not visible or functioning during surgery may have recovered, nerve injury is associated with a lower functional outcome. A second possibility is that a nerve that had been repairedmore precisely, the radial nerve—had recovered and had better function [23].

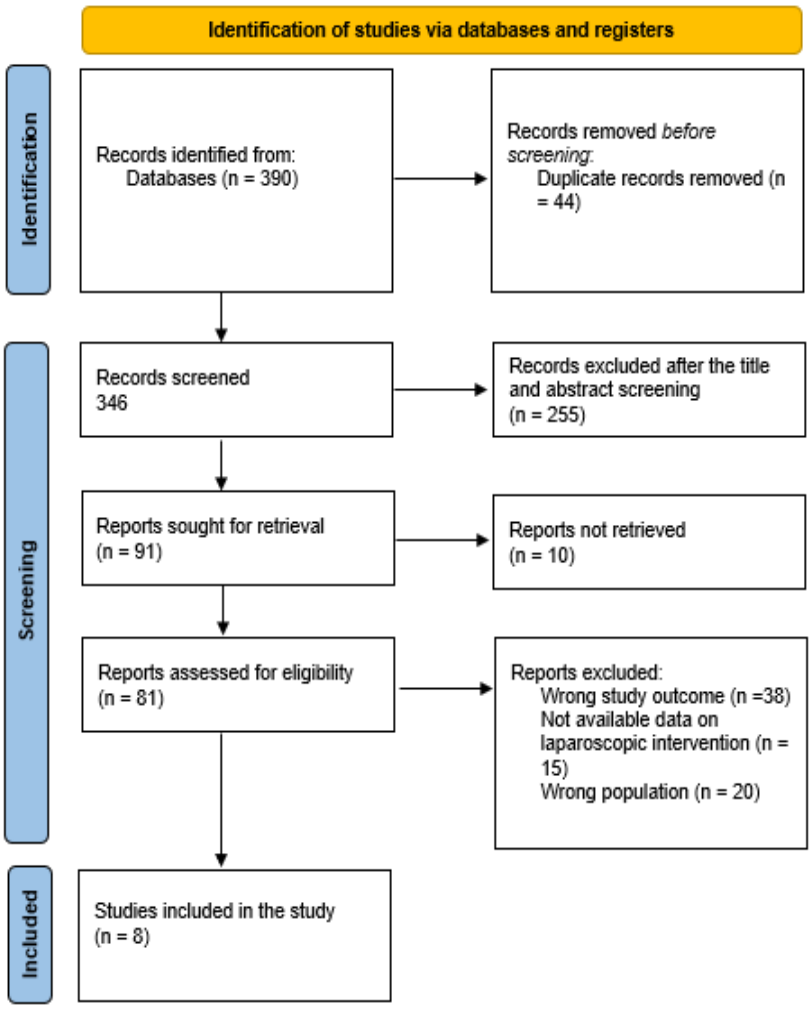


**Fig. 1. The included studies had different study designs**

**Table 1. Author, country, year of publication, methodology and outcome**

| Author, Publishing Year | Region | Methodology | Outcome | Population | Prevalence | Conclusion |
|---|---|---|---|---|---|---|
| [13] | _____ | Unusual example of an eight-year-old girl who also had an open Monteggia fracture and a concurrent ipsilateral supracondylar humerus fracture. Upon physical inspection, a neurovascularly intact limb was discovered. Closed and open reduction, percutaneous pinning utilising Kirschner (K) wires and Titanium Elastic Nails (TENs), wound washing, and debridement of the open lesion were all used in the surgical therapy. Six weeks after the procedure. | The patient got a pin site infection, and she had to have the pins surgically removed. She underwent follow-up testing, and the radiographic and physical examination results were normal. | | With an incidence of 3 to 13% of all supracondylar fractures, a floating elbow is rare. | A rare surgical emergency is a paediatric floating elbow. Although there are no specific standards for the therapy of these fractures, we advise using surgical management rather than conservative management. We also emphasise the value of routine follow-up to address any potential postoperative problems, like the one we experienced. |
| =[5] | Brazzaville Teaching Hospital, Congo | This study was done in retrospect between 2013 and 2018. Surgery was performed on four patients who met the inclusion criteria. According to Gustilo and Anderson's categorization, open | Three floating elbows were closed and one was open at the humeral level due to radial nerve paralysis. Closed fractures were treated with screwed plates, while open fractures were treated with an external fixator. Three patients and one case of | In our investigation, there were 4 patients: 3 men and 1 women. | | Classic floating elbows are uncommon, and the prognosis is still uncertain, particularly if there are musculocutaneous or neurovascular abnormalities present. In order to prevent a protracted immobilisation |

| Author, Publishing Year | Region | Methodology | Outcome | Population | Prevalence | Conclusion |
|---|---|---|---|---|---|---|
| | | fractures were categorised. Based on the effectiveness of bone healing and fracture reduction, anatomy was evaluated. The Mayo Clinic score was used to evaluate the functional outcomes. There was one woman and three males. 31 was the average age (28 and 34). They were all involved in car accidents. | aseptic nonunion of the radius both experienced bone healing. Two patients had very good functional results, one patient had a mediocre result, and one patient had a bad result, according to the Mayo Clinic score. | | | that can cause elbow stiffness, their treatment must be surgical in adults. Then, a multidisciplinary approach must to be taken into account. |
| [14] | _____ | A 13-year-old girl who had fallen from a height of three metres and landed on her right hand while pronating her elbow presented to the emergency room. The patient's right elbow was deformed and hurt a lot. A floating-variant medial dislocation of the elbow with a fractured medial epicondyle and radial shaft were visible on an elbow radiograph. In the emergency room, an | Testing the elbow following reduction and fixation revealed a stable valgus stress test as well as a stable arc of flexion and extension, but considerable laxity with a varus stress test. We decided without approaching the radial shaft fracture because it was thought to be stable and non-displaced. After closure, a brachial antebrachial cast was put on. The patient experienced no pain at the six-week checkup, and the fracture lines were well-consolidated on the | A 13-year-old female | | Due to the rarity of documented instances, the chapter on floating elbow dislocation in elbow traumatology is understudied. We think that by reporting more cases, a more thorough classification will be possible, which could ultimately result in the creation of treatment algorithms for this ailment. |

| Author, Publishing Year | Region | Methodology | Outcome | Population | Prevalence | Conclusion |
|---|---|---|---|---|---|---|
| | | urgent reduction was performed with post-reduction radiography. After being brought into the operation room, the patient underwent an open reduction internal fixation of the medial epicondyle and a medial approach to the elbow. A 2-Kirschner wire was used to attach the epicondylar fragment. | radiographs. After the cast was taken off, the patient began a procedure for auto-reeducation in which both active and passive range of motion were permitted as tolerated. Six weeks after the procedure, Kirshner wires were removed. | | | |
| [15] | China | Due to a fall from a height of 20 m, a 37-year-old female was admitted to the hospital with polytrauma. Right pubic rami fracture, open distal right humerus fracture, closed right olecranon fracture, multiple segment fracture of the radius and ulna, lung contusions, mild traumatic brain injury, large skin contusion in the right lower back and buttocks were all discovered during the initial emergency | 17 was the Injury Severity Score. The four limbs' nerves and arteries were unharmed. The patient was treated using damage control surgical principles and temporarily stabilised with external fixators in the emergency operating room because she was hemodynamically unstable and needed blood products in accordance with the advanced trauma life support protocol. The fracture of the humerus broke through the skin during the debridement of the right open elbow fracture, and a partial bone defect was discovered | Case report of 37-year-old woman | | Depending on the type of injury, a one- or two-stage treatment must be administered; we effectively applied the "damage control principle." |

| Author, Publishing Year | Region | Methodology | Outcome | Population | Prevalence | Conclusion |
|---|---|---|---|---|---|---|
| | | examinations. A bleeding elbow and a deformity of the right upper limb were present, and the pelvic compression test was successful. The bone could be visible outside of the right elbow's weak skin, which had edoema and skin contusions. The patient's fingers and toes were not numbed and could be moved. There were 9 points on the VAS for pain. | and irrigated with 3 L of saline. The wound was also only loosely bandaged. Following surgery, the patient's arm incision healed completely within two weeks, and a seven-month follow-up revealed outstanding satisfaction. | | | |
| [16] | French | 8 individuals with floating elbows who were all involved in traffic accidents were enrolled in a prospective study. Following predetermined indication criteria, two therapy approaches were applied. According to the Mayo Clinic's functional classification, the last examination took place on average after 10 | Real floating elbows made up 37.5% of cases overall on an anatomical-clinical level; the remaining instances were derived diseases. The relationship of a diaphyseal fracture of the humerus with a lesion of either or both forearm bones accounted for 50% of the cases among these derived diseases. Open fractures were found in 37.5% of patients' skin conditions. Two surgically treated patients had unsatisfactory results at the final | 8 patients | | This study demonstrates that the orthopaedic approach is still a viable option for treating floating elbows. Though it's crucial to learn the approach and understand its limitations. |

| Author, Publishing Year | Region | Methodology | Outcome | Population | Prevalence | Conclusion |
|---|---|---|---|---|---|---|
| | | months (with a minimum of 6 and a maximum of 18 months). | examination. No orthopaedic procedure yielded great results; instead, they were mostly mediocre to fair. | | | |
| [17] | France | Retrospective analysis was done on 23 individuals who received treatment at the facility for floating elbow injuries between 2004 and 2013. Depending on the nature of the damage, patients were split into four categories. Demographic information, concomitant injuries, available treatments, and consequences were all examined. Using a traditional goniometer, flexo-extension and prono-supination ranges were tested for clinical evaluation. The Mayo Elbow Performance Score was used to assess functionality. Analysis was done to determine the relationship between | In functional evaluation, patients with radioulnar synostosis performed worse than those without it (56.6 vs. 75); this difference was statistically significant. We discovered a statistical correlation between intra-articular extension and lower functional evaluation outcomes, however nerve palsy does not appear to have an impact on functional outcomes. | 23 patients | Although nerve palsy did not appear to have an impact on functional outcomes, we discovered a significant link between worse results in the functional evaluation ($p = 0.018$.( | Injuries with intra-articular extension and radioulnar synostosis have poor prognosis in floating elbow. |

| Author, Publishing Year | Region | Methodology | Outcome | Population | Prevalence | Conclusion |
|---|---|---|---|---|---|---|
| | | radioulnar synostosis, articular surface disturbance, nerve damage, and clinical and functional outcomes. | | | | |
| [18] | Romania | a rare injury relationship in 2 occurrences. Both patients experienced a fall from a height, a high intensity trauma. Initial X-rays (radiography) in both cases showed floating elbow fractures and the corresponding elbow dislocation (floating-dislocated elbow). One instance involved an open fracture-dislocation of type IIIB Gustilo-Anderson with an intra-articular component (olecranon fracture). Each case was managed independently. After elbow dislocation reduction and surgical reduction of the fracture, the upper limb was immobilised in a | Following surgery, the arm was immobilised in both patients for three weeks with the elbow bent at 90 degrees using a lengthy, well-padded plaster. After that, the patients were urged to start upper limb rehabilitation exercises that included joint range-of-motion and muscle strengthening.<br>In both cases, bone union was visible on radiographs two months after surgery.<br>We observed complete upper limb recovery at the 2-year follow-up in terms of muscle trophism, full elbow flexion/extension range of motion, and full pronation/supination range of motion.<br>The Mayo elbow performance score indicated that both subjects had excellent functional outcomes. | 2 cases | | In add to the 2 new instances we added, there are now less adult cases of these lesion connections overall. We also added a new type of floating-dislocated elbow that has not yet been described in the literature. Early recovery and a fantastic 2-year functional outcome were made possible by the prompt management of these injuries and stable repair of the fractures. |

| Author, Publishing Year | Region | Methodology | Outcome | Population | Prevalence | Conclusion |
|---|---|---|---|---|---|---|
| | | lengthy, comfortable plaster for three weeks with the elbow in 90° of flexion. In both cases, bone union was seen radiographically two months following surgery. | | | | |
| [19] | trauma center | clinical retrospective review From 1995 to 2001, 18 patients with floating elbow injuries. All wounds were surgically treated. Every forearm fracture was treated with internal fixation and open reduction. Intramedullary nails or open reduction and internal fixation were used to treat humerus fractures. Within 48 hours after patients' arrival at the trauma department, definitive fixation was carried out in every case. All patients were available for follow-up for at least a year. A uniform elbow score calculated on a scale of | The average score for the elbow was 68/100. There were two sets of outcomes. Eleven patients (group I) received a score more than 75, with a mean score of 83, and were regarded to have a good or exceptional outcome. Seven patients (group II) had a score less than 75, with a mean score of 45, and were regarded to have an acceptable or unsatisfactory outcome. Two statistically distinguishable clusters could be seen in the distribution of the results. Additionally, compared to group 1, group 2 had a considerably higher incidence of nerve damage. | 18 patients | Compared to group 1, group 2 had a significantly higher incidence of nerve damage. | Patients with good or exceptional results and patients with poor results tend to cluster together when it comes to functional outcomes in floating elbow injuries. At least a 1-year follow-up, patients with concomitant nerve damage have less favourable functional results. |

| Author, Publishing Year | Region | Methodology | Outcome | Population | Prevalence | Conclusion |
|---|---|---|---|---|---|---|
| | | 100 points was used to assess each patient. Age, fracture severity, open fractures, nerve and vascular injuries, the type of humeral fixation, and the presence of concurrent intra-articular elbow injuries were all factors that were connected with these scores. | | | | |

**Table 2. Studies' descriptive characteristics**

| Year | Study | No. | Age | Cause of injury | Sex | Type of functional evaluation |
|---|---|---|---|---|---|---|
| 2022 | Ismaili et al. [13] | 1 | 8 | a 2 m fall from a tree a few hours before the test | F | computed tomography scan as preoperative evaluation |
| 2020 | Marius M et al. [8]. | 4 | ±31 | traffic accidents | 3 M<br>1 F | The Mayo Clinic score was used to evaluate the functional outcomes. |
| 2022 | Moussa et al. [14] | 1 | 13 | fall from a height of 3 metres, bending her elbow and landing on her right hand. | F | NA |
| 2021 | Huang et al. [15] | 1 | 37 | tumbling from a balcony at a height of about 20 metres. | F | 7 mo follow-up |
| 2013 | Lamah et al. [16] | 8 | - | traffic accidents | - | functional classification of the mayo clinic |
| 2016 | Jiménez-Díaz et al. [18] | 23 | - | associated injuries | - | the Mayo Elbow Performance Score. |
| 2022 | Veliceasa B et al. [19] | 2 | 49 & 64 | fall from a height | F | the Mayo elbow performance score |
| 2011 | Galasso, O. et al. [17] | 18 | - | - | - | standardized elbow score based on a 100-point scale |

**Table 3. Patients' descriptive characteristics**

| Study | Year | Location | Age | Sex |
|---|---|---|---|---|
| Ismaili et al. [13] | 2022 | --- | 8 | F |
| Marius M et al. [8]. | 2020 | Brazzaville Teaching Hospital, Congo | ±31 | 3 M<br>1 F |
| Moussa et al. [14] | 2022 | ---- | 13 | F |
| Huang et al. [15] | 2021 | Shanghai, China | 37 | F |
| Lamah et al. [16] | 2013 | France | - | - |
| Jiménez-Díaz et al. [18] | 2016 | France | - | - |
| Veliceasa B et al. [19] | 2022 | Romania | 49 & 64 | F |
| Galasso, O. et al. [17] | 2011 | Level 1 trauma center | - | - |

Over time, treatment approaches have evolved. In the humerus without tight fixation, Rogers et al. reported a 100% nonunion rate in 1984 [24]. Since then, adults with floating elbow injuries should seek treatment with stable internal or external fixation of all fractures [25]. It is best to evaluate the fractures collectively rather than individually to prevent overestimating the severity of the injury. It is generally agreed that patients with a floating elbow injury should undergo surgical stabilisation as soon as it is safe to do so [26]. In the short term, however, observation and conservative treatment may be used if the patient is hemodynamically unstable or if there are other reasons why surgery should not be performed [27]. Concomitant injuries should be taken into account, and the timing and surgical approach should be carefully planned. Such an approach will lower the risk of problems while also resulting in a favourable functional outcome [28].

In their separate series, Pierce and Yokoyama did not identify a specific risk factor for the poor prognosis of these injuries; however, they mention the numerous problems that floating elbows can cause, particularly neurovascular injuries, humeral non-union, and infections [29,13]. The most frequent side effect that our patient experienced was nerve palsy, which typically affected the radial nerve. Furthermore, because patients with intra-articular fractures have shown to have inferior functional outcomes, intra-articular extension has been labeled as a negative prognosis factor. Extra-articular injury patients appear to have a greater range of motion and perform better on functional assessments. These issues have also

been linked to other factors including postponed surgery or hardware protrusion in the interosseous membrane [18].

## 5. CONCLUSION

The combination of ipsilateral humeral and forearm fractures that results in an unstable intermediate articulation is known as floating elbow, and it is a rather uncommon lesion. The classic and its variants of floating elbow injuries are infrequent but complex injuries that may result in long-term functional impairment. For the best functional outcome, they demand a well-considered management strategy and laser-focused rehabilitation. Although there is a paucity of information describing functional results in individuals with floating elbow, surgical therapy has been universally accepted, and there is evidence that surgical stabilisation of the humerus and the forearm is the most successful way to treat these injuries. Floating elbow fractures are a type of high-energy trauma with serious accompanying effects. There is a link between lower subjective outcomes and nerve damage. Patients have been improving for several years, with satisfactory mid-term outcomes.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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