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## Ipsilateral injuries of the elbow joint and the distal radius

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*The elbow joint injury and the ipsilateral fractures of distal radius are rare but are different. Objective. To analyze character of the elbow joint injury and distal part radius fractures in connection with peculiarities of traumatic energy intensity, to consider of treatment options of such trauma cases. Methods. The study is based on the retrospective analyze of the clinical observation of 8 patients with the ipsilateral elbow joint injury and distal part of radius (3 men and 5 women, average age is  $39 \pm 5$ ). Besides of the distal part radius fracture 1 patient had luxation of the forearm, 5 — fracture-dislocations in the elbow joint and in 2 cases — the fractures of distal metaepiphysis of the humerus. In 7 cases of the elbow joint injuries and in 3 cases of the distal part radius fractures the surgical treatment was made. Results. Except 2 cases the injuries happened in result of landing from the height of 1–12 meters. The severity of injuries was ranking and their correlation with the indicator of falling height was analyzed. The treatment peculiarity of the elbow joint injury and the ipsilateral fractures of distal part radius is considered. Conclusions. In the majority of cases ipsilateral injuries of the elbow joint and of the distal part radius are the result of falling from the height, infrequently — the results of falling from easy posture of the body; the severity of injury depends on the falling height (correlation coefficient Spearman's — 0.78), the character of elbow joint injury may depend on the position of the extremity at the time of landing and successive additional collision of elbow region with traumatic agent. When the patient falls from significant height may happen polytrauma, what lead to many stages of treatment. By the ipsilateral injuries substantiation of manipulations or surgical operations priorities is very important. Key words. Ipsilateral Injuries, elbow joint, distal metaepiphysis of the radius, fractures, luxation, fracture-dislocations.*

*Ушкодження ліктьового суглоба та переломи дистального відділу променевої кістки однойменної кінцівки трапляються дуже рідко, а травми досить різноманітні. Мета. Проаналізувати характер іпсилатеральних ушкоджень ліктьового суглоба та дистального метаепіфіза променевої кістки у зв'язку з особливостями енергоємності травмування, розглянути варіанти лікувальної тактики, які використовують за таких ушкоджень. Методи. Дослідження базується на ретроспективному аналізі клінічного матеріалу 8 пацієнтів із іпсилатеральними ушкодженнями ліктьового суглоба та переломами дистального відділу променевої кістки (3 чоловіки, 5 жінок, середній вік ( $39 \pm 5$ ) років). Окрім перелому дистального відділу променевої кістки, в 1 випадку був вивих передпліччя, у 5 — переломовивихи в ліктьовому суглобі, 2 — переломи дистального метаепіфіза плечової кістки. Хірургічне лікування ушкоджень у ділянці ліктьового суглоба проведено у 7 випадках, а в ділянці променево-зап'ясткового суглоба — у 3. Результати. Окрім 2 пацієнтів, травми отримані внаслідок падіння з висоти від 1 до 12 м. Проведено ранжування важкості ушкоджень та аналіз їхнього співвідношення з показниками висоти падіння пацієнтів, тобто з енергоємністю травмування. Розглянуто особливості лікування пацієнтів із односторонніми ушкодженнями в ділянці ліктьового та променево-зап'ясткового суглобів. Висновки. Більшість випадків іпсилатеральних ушкоджень зони ліктьового та променево-зап'ясткового суглобів трапляються в разі падіння з деякої висоти, рідше — з висоти власного зросту. Ступінь тяжкості ушкодження прямо залежить від висоти падіння (коефіцієнт кореляції  $r = 0,78$ ). Характер травми в зоні ліктьового суглоба визначається позицією кінцівки на момент приземлення, а також можливістю послідовного додаткового зіткнення зони ліктьового суглоба з травмувальними агентами. За умов падіння зі значної висоти вага ймовірності виникнення політравм, що обумовлює багатоступінь лікування. Важливо для пацієнтів з іпсилатеральними ушкодженнями є обґрунтування черговості втручання або маніпуляцій. Ключові слова. Іпсилатеральні ушкодження, ліктьовий суглоб, дистальний метаепіфіз променевої кістки, переломи, вивихи, переломовивихи.*

**Key words.** Ipsilateral Injuries, elbow joint, distal metaepiphysis of the radius, fractures, luxation, fracture-dislocations

## Introduction

Combination of elbow injuries with ipsilateral fractures of the distal radial bone is very rare [1, 2]. The variants of injuries are quite diverse: cases of combination of fractures of the radial bone in the proximal and distal parts [3, 4], fractures of the distal part of the radial bone with dislocations in the elbow back [5], with dislocation of the forearm anterior [6], and with fractures in the elbow joint [7]. We can also mention other variants of damage in this area, such as the possibility of simultaneous dislocation in the proximal and distal radial-elbow joint [8], as well as Essex-Lopresti injury [9], which are not mentioned in our study.

*The aim of the study:* to analyze the nature of ipsilateral injuries of the elbow joint and the distal metaepiphysis of the radial bone in connection with the features of energy intensity of injury, to consider options for treatment tactics.

## Material and methods

We observed 8 patients with ipsilateral injuries of the elbow joint and distal radial bone, including 3 men and 5 women, with a mean age of  $39 (5 \pm 5)$  years (19 to 60). In addition to a fracture of the distal radial bone, one patient was diagnosed with posterior forearm dislocation; 5 with forearm dislocations in combination with fractures of the proximal bones of the forearm (2 persons with fracture of the head of the radial bone and coronal process and dislocation of the forearm back, 1 with posterior dislocation of the head and fracture of the proximal metaepiphysis of the ulna, 2 with fracture of the head and forearm posterior dislocation of the forearm); 2 with fractures of the distal metaepiphysis of the humerus. Surgical treatment for fractures of the distal radial bone was performed in 5 cases, conservative in 3. Surgery on the elbow joint was performed in 7 cases and only one patient underwent conservative treatment.

Brief information about patients, height of fall (value 0 is set for cases of falling of the patient from a natural position in the case of standing, walking or running), limb damage on two levels and treatment are given in Table 1. The Spearman correlation coefficient was used to identify a statistically significant relationship between the height of fall of patients and the severity of injuries. Data analysis was performed using Statistica software. The materials of the study were approved by the Committee on Bioethics at the State Institution «Professor M. I. Sytenko Institute of Abnormalities of the Spine and

Joints of the National Academy of Medical Sciences of Ukraine» (Minutes No. 220 of 18.10.2021).

## Results and discussion

In 6 out of 8 cases the injuries were caused by patients falling from a height of 1 to 12 m above the landing surface (it should be noted that these values are not absolutely accurate), in 2 cases from natural height. In other words, the energy intensity of injury to patients' limbs was very different. It was difficult for patients to accurately describe the position of limb segments, including flexion-extension angles in the radiocarpal and elbow joints at the time of limb contact with the landing surface or other objects. Two theories have been proposed that explain the probable mechanisms of radial bone fractures in the distal part and forearm dislocations: «single-impact» and «double-impact» [6]. In the first type, the fall of the patient on the palm of the straightened arm under the contact of the hand with the landing surface is a fracture of the radial bone in its distal part and, if the kinetic energy is not extinguished, it is transmitted mainly through the ulna to the overstretched and valgus elbow joint, which leads to dislocation of the forearm bones. In the second type, the force of the impact when falling on the straightened arm leads to a fracture of the radial bone in the distal part, and damage to the elbow joint is the result of the following separate traumatic impact. Applying the theory of the mechanism of damage to our cases, we can assume that the option of «single-impact» injuries, which include dislocations and fractures of the elbow joint, and «double-impact» is acceptable for fractures of the distal humerus.

Is it possible to connect the nature of the considered injuries with the height of the fall? In two cases (2<sup>nd</sup> and 3<sup>rd</sup>) the height of the fall was greater than in others, namely 12 and 10 m. At the same time, patients were also found to have damage to the pelvic bones, i. e. it can be assumed that the primary contact with the landing surface could occur not with the injured upper limb, but with other parts of the body, and then with the said limb or simultaneously with it, which could slightly reduce the amount of traumatic kinetic energy. Among the analyzed injuries there were two cases (4<sup>th</sup> and 8<sup>th</sup>), when in the area of the elbow joint patients injured not the forearm bones, but the distal metaepiphyses of the humerus. The injury in both episodes occurred due to a fall from a height of 1 and 4 meters. Despite the proximity of these injuries on the basis of classification, according to radiography (Fig. 1), the degree of dislocation of bone fragments differs significantly and it can be assumed

that the soft tissues of the elbow joint in the second case suffered more.

To identify a possible relationship between the nature of the damage and the height of the fall, we ranked the damage, focusing on their complexity and severity from the relative degree of soft tissue damage and bone formation, i.e. the classification affiliation. For injuries of the elbow joint, the following degrees (points) were allocated in ascending order of their severity:

1. Soft tissue injuries (example, 20-A2);
2. Soft tissue injuries of one of the forearm bones (example 20-B2 + 21-B1);
3. Soft tissue and distal humerus injuries (example 13-C2.3);

4. Soft tissue injuries of both forearm bones (example 20-A4 + 21-C2)

For damage in the area of the radiocarpal joint:

1. Metaphyseal fractures of the radial bone without significant displacement (example 23-A2);
2. Metaphyseal fractures of the radial bone with significant displacement (example 23-A3);
3. Epimetaphyseal fractures of the radial bone with displacement in the metaphyseal area and without displacement of the epiphyseal, articular surface (example 23-C 2);
4. Epimetaphyseal fractures of the radial bone with displacement of fragments of the articular surface (example 23-C3).

Table 1

**Information about patients, height of fall, limb damage on two levels and treatment**

Case	Sex	Age	Fall height (m)	Limb	Diagnosis (AO classification)		Treatment (surgical, conservative)	
					elbow joint area	distal forearm	elbow joint area	distal forearm
1	ж	40	1	Left	20-B2 + 21-B1	23-C3	Osteosynthesis of the proximal metaepiphysis of the elbow bone according to Weber	Closed reduction of the radial bone fracture
2	м	45	12	Right	20-A2 + 21-C2	23-C3	In the acute period - closed correction of forearm dislocation, fixation with a plaster bandage, in 1 month – open removal of dislocation of the forearm bones, transarticular fixation with a needle, plaster splint	In the acute period fixation with a plaster cast, in 1 month – distraction extrafocal osteosynthesis of the radial bone
3	м	42	10	Right	20-A4 + 21-C2	23-C3	In the acute period fixation of the elbow joint with an external fixation device, in 2 months — open reduction of the forearm, osteosynthesis of fracture of the head of the radial bone	In the acute period fixation of the radiocarpal joint with external fixation device, in 2 months — open reduction of dislocation of the elbow head in the distal radial-elbow joint
4	ж	60	1	Right	13-C2.3	23-C2	Osteosynthesis of the distal humerus	Osteosynthesis of the distal radial bone
5	ж	54	0	Left	20-A2 + 21-B2	23-C3	Open reduction of the forearm, removal of fragments of the head of the radial bone, transarticular fixation with a needle of the shoulder-elbow joint	Osteosynthesis of the distal radial bone
6	ж	19	0	Right	20-A2 + 21-B2	23-A2	Osteosynthesis of the head of the radial bone	Closed reduction of the radial bone fracture
7	ж	30	1	Left	20-A2	23-A3	Closed reduction of the forearm	Closed reduction of the radial bone fracture
8	м	20	4	Left	13-C3.2	23-C2	External fixation device, in 2 weeks — open reduction, osteosynthesis of the distal humerus	External fixation device, in 2 weeks — open reduction, osteosynthesis of the distal radial bone

Table 2 shows the distribution of cases with the corresponding height of the patient's fall according to the severity of injuries, and Table 3 demonstrates the sum of points of the severity of injuries in the area of the elbow and radiocarpal joint for each case.

As can be seen from Table 3, the most severe injuries (total severity of 8–9 points) were observed in the case of injury after falling from a height of 4–12 m, i. e. due to high-energy injury. Spearman correlation coefficient ( $r$ ) between the severity and height of the patient's fall was 0.78 ( $p < 0.05$ ), which according to the assessment of the tightness of the relationship between random variables indicated a high degree of correlation between these indicators. In all these cases, the injuries were received by males, which, in our examples, can be explained only by some features of the benefits in the occupations of men and women. According to our observations, it is impossible to perform a statistical analysis of the influence of patients' age on the nature of injuries.

The ipsilateral nature of the injury affected the tactics of treatment. The choice of conservative or surgical method for each injury was determined by the same criteria as in the case of isolated injuries, but in the case of ipsilateral injuries, special care should be taken to justify the sequence of manipulations. The authors of studies on this problem also emphasize this [2, 5].

For example, in the presence of dislocation of the forearm and fracture of the radial bone in

the distal part, it is necessary to first eliminate the dislocation of the forearm, and then, in forearm bent at the elbow joint, to perform reposition of the fracture of the radial bone [5]. Manipulations were performed in the same sequence in one of the patients (case 7). Another variant of the sequence of interventions was appropriate to do in other cases, one of which we present below.

*Table 2*  
**Distribution of cases and height of the patient's fall according to the severity of injuries**

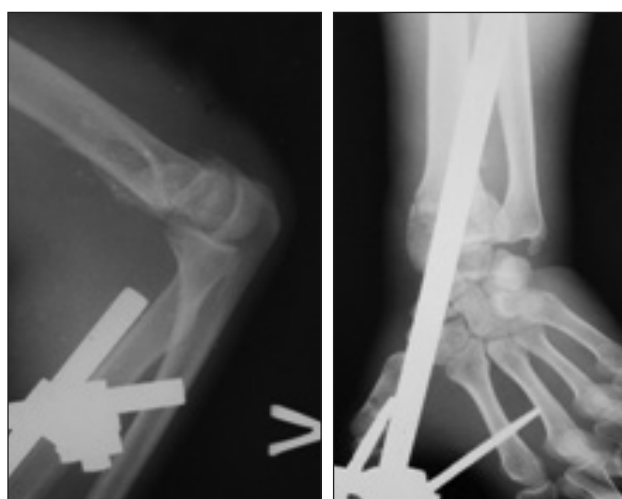
Severity degree	Elbow joint area		Radiocarpal joint area	
	case	height (m)	case	height (m)
1	7	1	6	0
2	1, 6, 5	1, 0, 0	7	1
3	4, 8	1, 4	4, 8	0, 4
4	2, 3	10, 12	1, 2, 3, 5	1, 12, 10, 0

*Table 3*  
**The sum of points for severity of injuries in the elbow and radiocarpal joint area for each case**

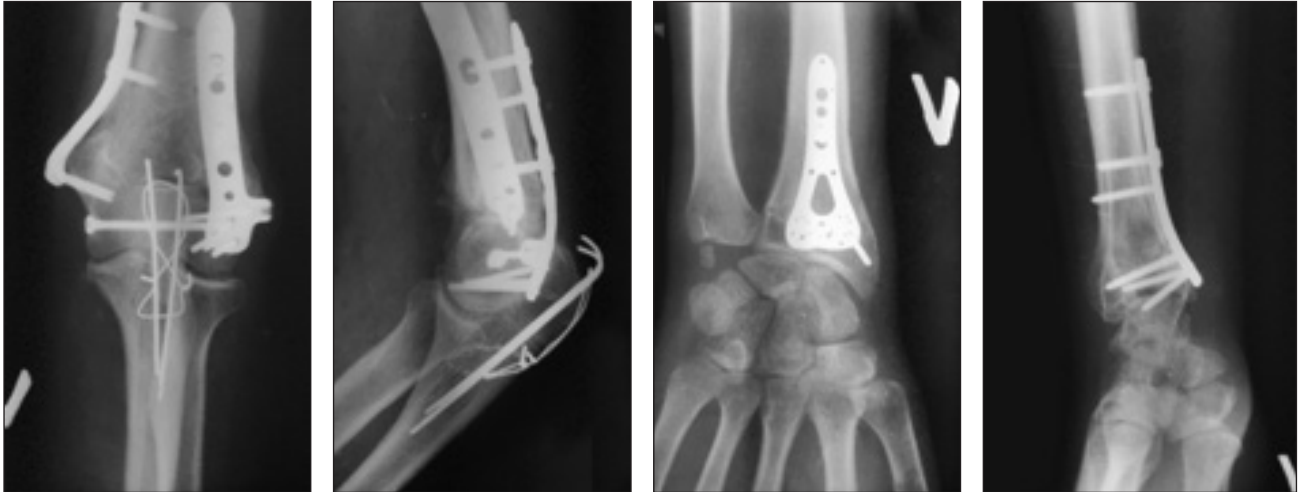
Case	Severity degree	Height (m)
1	5	1
2	9	12
3	9	10
4	6	1
5	6	0
6	3	0
7	3	1
8	8	4



**Fig. 1.** Radiography of the injured limb: a) patient G. (case 4, falling from a height of 1 m); b) patient D. (case 8, falling from a height of 4 m)



**Fig. 2.** Radiography of the elbow and radiocarpal joints after the first surgery on the day of injury



**Fig. 3.** Radiography of the elbow and radiocarpal joints in 6 months after the second intervention

Patients injured as a result of falling from a considerable height are more likely to have multiple trauma (case 2 and 3), and landing can take place (case 2) on an uneven, hard surface, such as construction debris and the like. Even in the absence of concomitant injuries, the soft tissues of the injured limb suffer more when falling from a considerable height. Therefore, the treatment time increases and it can be multi-stage.

An example is clinical observation (case 8). A 20-year-old patient D. was injured as a result of a fall from a height of 4 m. In the medical institution where the patient was taken, after clinical and radiological examination, he was diagnosed with comminuted fracture of the distal metaepiphysis of the left humerus with displacement of fragments, fracture of the distal metaepiphysis of the left radial bone with displacement (Fig. 1, b). Extrafocal osteosynthesis of damaged bone formations (Fig. 2) and anti-inflammatory therapy were performed. Two weeks later, the patient came to the State Institution «Professor M. I. Sytenko Institute of Abnormalities of the Spine and Joints of the National Academy of Medical Sciences of Ukraine». Given the presence of residual displacement of bone fragments, i. e. indications for open fracture correction and osteosynthesis, the extrafocal fixation device was dismantled and, after wound healing at the site of attachment of the rods of the apparatus, first open repositioning, bony osteosynthesis, open reaming and osteosynthesis of the distal humerus were performed. That is, initially the intervention was carried out on the distal part of the radial bone, because there was no need to move the limb on the operating table, so the fracture area of the humerus was not adversely affected. The second stage was the intervention on the humerus with a change in the position of the limb during

the operation, but under conditions of a stabilized fracture zone of the radial bone. When evaluating the results of treatment in 6 months after the operation, it was determined that the function of the limb was restored, the consolidation of fractures was confirmed radiologically (Fig. 3).

Thus, the nature of ipsilateral injuries in the elbow and radiocarpal joints is quite diverse, mainly determined by the intensity of kinetic energy of the body, which develops when falling, the position of the body and limb in contact with the landing surface, and the quality of this surface. The choice of treatment tactics for ipsilateral injuries should be made taking into account the rational sequence of interventions in the areas of injury.

### Conclusions

Most cases of ipsilateral injuries of the elbow and radiocarpal joints occur in the case of a fall from a height, less often from a height of own height. The severity of limb damage is directly proportional to the height of the fall, i. e. the amount of kinetic energy that occurs during the fall of the body (correlation coefficient  $r = 0.78$ ). That is, the nature of the injury in the elbow joint (dislocation of the forearm, fracture, fracture of the distal humerus) is determined by the position of the limb in its joints at the time of landing, as well as the possibility of successive additional collision of the elbow with traumatic agents.

In the case of falling from a considerable height, there is a high probability of multiple injuries, resulting in a multi-stage treatment process in this category of patients. An important point in determining treatment tactics is to justify the sequence of manipulations or interventions.

**Conflict of interest.** The author declare no conflict of interest.

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