Diagnosis and Treatment of Terrible Triad Injury of the Elbow with An Isolated Bone Fragment: A Case Report and Literature Review

Lei Li
The First Affiliated Hospital of the University of Science and Technology of China (Anhui Provincial Hospital)

Meng Li
The First Affiliated Hospital of the University of Science and Technology of China (Anhui Provincial Hospital)

Lei Liu
The First Affiliated Hospital of the University of Science and Technology of China (Anhui Provincial Hospital)

Wei Xu
The First Affiliated Hospital of the University of Science and Technology of China (Anhui Provincial Hospital)

Gang Yao
The First Affiliated Hospital of the University of Science and Technology of China (Anhui Provincial Hospital)

Shiyuan Fang (✉ Fangshiyuan2008@163.com)
The First Affiliated Hospital of the University of Science and Technology of China (Anhui Provincial Hospital)

Case Report

Keywords: Terrible triad injury of the elbow, Radial head fracture, Injury mechanism, Isolated bone fragment, Case report

Posted Date: March 1st, 2023

DOI: https://doi.org/10.21203/rs.3.rs-2607459/v1

License: ☑️ This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License
Abstract

Background

An isolated radial head fracture fragment was rarely seen on the medial side from terrible triad injury. To date, this fracture pattern has not been previously reported and the mechanism of injury remains unknown.

Case Presentation

A 37-year-old male suffered the deformity and swelling of left elbow joint after falling from a high place. He was rushed to the emergency room of the local hospital for reduction and cast immobilization of the dislocated elbow joint. This case described the rarely medial displacement of radial head fracture fragment from terrible triad injury of the elbow, including the radiologic characteristics and possible mechanisms of injury. The combination of medial and lateral incisions was performed and the patient obtained a good recovery.

Conclusions

The variants of the terrible triad injury of the elbow should be constantly recognized. A detailed surgical plan and favorable prognosis attributed to the accurate judgment of the fracture and soft tissue injury. Additionally, an assistant incision is often necessary to remove the medial radial head fracture fragment.

Introduction

The terrible triad injury, a complex elbow dislocation with associated coronoid process and radial head fractures, was defined by the poor clinical outcomes [1]. Complications such as pain, elbow stiffness, function dysfunction, elbow joint instability and heterotopic ossification are frequently observed after surgery [2–4]. The conservative treatments often predict an unsatisfactory prognosis for such high-energy violent injuries, so far there is no gold standard for surgical treatments. Studies have reported that controversy remains focusing on the coronoid process fixation, radial head fracture treatments as well as medial collateral ligament (MCL) repair [5–7]. Therefore, surgeons need to adequately understand the injury mechanism and the sequence of surgical repair in order to restore elbow joint stability and recovery perfect function.

We present a rare variant of terrible triad injury of elbow joint and the injury mechanism may be different from the past. Unfortunately, similar case reports were not found in the literature. Thus, aims of this article are mainly to report the radiological findings and speculate potential injury mechanism of this case. And a review of variations in the terrible triad of the elbow joint is presented in detail. Additionally,
we reported this case with the patient's consent and approved by the first affiliated hospital of USTC medical research ethics committee in accordance with the declaration of Helsinki.

Case Report

A 37-year-old male sustained pain, deformity and immobility in his left elbow after falling from three meters at work. An emergency X-ray examination at the local hospital revealed a posterolateral dislocation of the elbow joint and fractures of radial head and coronoid process. Emergency physicians performed the reduction and plaster fixation for the dislocated elbow joint (Fig. 1A, B). However, the primary doctor ignored an isolated bone fragment on the medial side of the elbow. The patient was admitted to our department 2 days after the injury. We found bruising, significant swelling and extensive tenderness around the left elbow joint. It should be noted that the patient showed no signs of nerve or vascular damage to the left upper limb. Treatments we provided included ice compress, limb elevation to reduce swelling, and oral analgesics for pain relief. Computed tomography (CT) clearly showed the coronal process fracture (Regan-Morrey type I), the radial head fracture (Mason type IV), and a large isolated bone fragment in the subcutaneous muscle group on the medial side of the elbow (Figure. 1C). Magnetic resonance imaging (MRI) revealed periarticular soft tissue edema, articular effusion, and injury of the lateral collateral ligaments (LCL) complex. Severe bone contusions were observed in coronal process and radial head, but the elbow joint were in normal anatomical position (Fig. 1D).

The patient underwent surgery on the third day after admission (Fig. 2A, B). The Kocher approach was utilized during the operation. The incision was made at 5cm proximal to the epicondylar crest of the external humerus and distal to the lateral forearm and behind the radial head. The radial head was then located between the anconeus muscle and the extensor carpi ulnaris muscle. Anterolateral fracture of the radial head with defect and anterior joint capsule tear with coronoid process fracture were observed in operation. The origin of LCL complex from distal humeral was avulsed, which formed the exposed bone surface. During the operation it was found that the isolated bone fragment on medial side could not be removed through the existing incision. The isolated bone fragment was then preliminarily located by X-ray fluoroscopy, and a medial incision was added under the premise of protecting the ulnar nerve. The fracture fragment was successfully found in flexor muscles of the forearm as MRI showed. The isolated bone block was identified as the defect part of radial head, which was fixed with an headless screw (3.0mm diameter, Zimmer) after anatomic reduction. A non-developing PEEK countersunk screw (4.5mm diameter, DePuy Synthes) was used to repair the LCL complex at the isometric point in the distal part of the humerus according to standard surgical procedures. It should be noted that no disposal was done for the coronoid process fracture in this case. Finally, the elbow was stable without dislocation between 20° and 130° under general anesthesia and postoperative image revealed a stable concentric reduction (Fig. 3A). Three days after surgery, the patient was discharged and returned home with a upper limb cast. Three weeks later, the cast was removed and elbow functional exercise was performed. At the last follow-up, the elbow joint was painless and the range of motion was between 0° and 140°with heterotopic ossification. But the physical examination confirmed perfect stability of the elbow joint under flexion,
extension and rotation, with no significant difference in range of motion from that of the right (Fig. 3B, C). The patient was very satisfied with the clinical outcome.

**Discussion**

This is a kind of rare variant of terrible triad of elbow joint in clinical practice. The isolated bone fragment was displaced to the medial elbow after the radial head fracture at the moment of injury. It is essential for surgeons to speculate on the uncertain injury mechanism and then design the operation scheme in complex fracture-dislocations of the elbow joint [8]. Thus, we hypothesized the possible mechanism of the injury based on the chief complaint of this patient, the elbow valgus deformity at the time of injury and the history of reduction at the local hospital. The patient fell with his forearm pronation on the ground, and his elbow joint was in an extended or overextended position. At the same time, the elbow joint suffered the strong valgus force in which the humeral head impinged on the anterolateral portion of the radial head, resulting in a splitting fracture of the radial head accompanied with bone fragments. The proximal ulna and radius was then continued with external rotation and valgus on the sagittal axis, leading to the fracture fragment of radial head being pushed medial or slightly anterior elbow by the capitulum humeri, and the state of posterior dislocation or subluxation was seen in the elbow joint. Therefore, the displacement pathway of this bone fragment located infero-posterior to the capitulum humeri through the anterior trochlear notch to the medial side of the elbow joint. After the injury, due to obvious elbow malformation, the reduction usually was operated by themselves, or by the nearby hospital emergency in a short period of painless pulling. Thus, the dislocation of the elbow was no longer present when the patient was transferred to our hospital, while the radial head fracture was retained medial to the elbow joint. However, a special situation may also exist, that is the valgus violence causes the sudden opening of the space inside the elbow joint, which not only contribute to the rupture of the capsule and MCL of the elbow joint, but also the displaced bone fragment may be retracted and entrapped in ulnohumeral joint owing to the negative pressure effect (Fig. 4).

The explicit surgical planning was developed by the comprehensive assessment of the injury mechanism and the fractures displacement. Given that the dislocated elbow has been reduced, so it is difficult to find and remove the isolated bone fragment through the Kocher approach. Therefore, medial incision was append, which is different from the incision used for the MCL repair [9]. The coronoid process fracture, meanwhile, was not considered for fixation based on current philosophy in our case [10, 11], and the patient achieved a stable elbow joint after reduction and fixation of the radial head fracture and LCL repair.

As a typical injury of complex elbow fracture-dislocation, the prognosis of terror triad injury has been gradually improved in the literature at present [12, 13]. The sequential anatomic repair and early mobilization prevent the onset of postoperative complications. However, some rare variants are also seen in clinic, which require carefully physical examination and imaging data to analysis of all lesions. A variant of the terrible triad of the elbow consisting of fracture of the capitellum involving the full length of the trochlea replaced the radial head fracture, was reported to obtain good recovery after capitellum
fracture fixation. And the injury has been confirmed that it was not associated with the avulsion of the LCL complex [14]. Moreover, the terrible triad with a capitellar shear fracture was also observed in clinic, which involved LCL complex injury and performed repair [15]. A special case combining medial and lateral elbow instability with the terrible triad injury without radial head fracture was successfully treated via fractures fixation, LCL repair and MCL reconstruction [16]. In fact, soft tissue injury in the terrible triad is not just associated with the LCL and MCL tear, and avulsion of the triceps and flexor-pronator mass was also involved in it, which formed completely circumferential injury to the elbow. So, the careful repair of soft tissue injury is the necessary prerequisite for acquiring a stable elbow joint [17]. Furthermore, recent case reports frequently refer to the terrible triad of the elbow combined with Essex-Lopresti lesion, which the management of such injuries can be technically demanding and is also known as full-length forearm injury [18–20]. Treatments of radial head fracture, interosseous membrane (IOM) and distal radioulnar joint (DRUJ) remain controversial. We note that in the two case reports of such injuries, all fractures of forearm were treated with internal fixation at the first surgery, but revision surgery was performed after the reduction lost of the radial head fracture and the DRUJ mismatch, thus good function can be obtained finally after the radial head replacement and distal ulna resection or ulnar osteotomy [21, 22] (Table 1). Although ectopic ossication was present at the last follow-up, but it is indeed a common complication after surgery of the terrible triad of the elbow. We hypothesized that this may be related to the medially assisted incision, since superimposed soft tissue injury is a high risk factor for heterotopic ossification. Fortunately, the patient ended up with good recovery of elbow function.
Table 1: The variants of terrible triad of the elbow joint and treatments reported in the literature

<table>
<thead>
<tr>
<th>Authors</th>
<th>Sex/Age (years)</th>
<th>Variant/Associated injuries</th>
<th>Treatments</th>
<th>Elbow Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>MM Desai14</td>
<td>F/25</td>
<td>Posterolateral dislocation&lt;br&gt;Capitellum fracture&lt;br&gt;Coronoid fracture</td>
<td>Capitellum fracture fixation</td>
<td>Better</td>
</tr>
<tr>
<td>P M Courtney15</td>
<td>F/62</td>
<td>Terrible triad injury Capitellar shear fracture</td>
<td>Radial head replacement&lt;br&gt;Anterior capsule suture&lt;br&gt;Capitellum fixation&lt;br&gt;LCL repair</td>
<td>Normal</td>
</tr>
<tr>
<td>T Almalki16</td>
<td>M/38</td>
<td>Posterolateral dislocation&lt;br&gt;Coronoid fracture&lt;br&gt;Avulsion fracture of medial and lateral epicondyles of the distal humerus</td>
<td>Coronoid process fixation&lt;br&gt;LCL repair&lt;br&gt;MCL reconstruction</td>
<td>Normal</td>
</tr>
<tr>
<td>V K Gajendran17</td>
<td>F/29</td>
<td>Terrible triad injury&lt;br&gt;Triceps and flexor-pronator mass avulsion</td>
<td>Radial head replacement&lt;br&gt;Anterior capsule suture&lt;br&gt;LCL repair&lt;br&gt;Triceps repair&lt;br&gt;Flexorpronator mass repair</td>
<td>Normal</td>
</tr>
<tr>
<td>R Seijas18</td>
<td>F/45 M/17</td>
<td>Terrible triad injury&lt;br&gt;Essex-Lopresti lesion</td>
<td>Radial head resection&lt;br&gt;Darrach’s osteotomy&lt;br&gt;Elbow arthroplasty (1 case)</td>
<td>Better</td>
</tr>
<tr>
<td>Z Ramzi19</td>
<td>M/56</td>
<td>Terrible triad injury&lt;br&gt;Essex-Lopresti injury</td>
<td>LCL complex repair&lt;br&gt;DRUJ fixation</td>
<td>Normal</td>
</tr>
<tr>
<td>Authors</td>
<td>Sex/Age (years)</td>
<td>Variant/Associated injuries</td>
<td>Treatments</td>
<td>Elbow Function</td>
</tr>
<tr>
<td>----------</td>
<td>----------------</td>
<td>-----------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>P Knapp</td>
<td>M/60</td>
<td>Terrible triad injury&lt;br&gt;Essex-Lopresti injury&lt;br&gt;Devastating injury</td>
<td>First surgery:&lt;br&gt;  - Transradial amputation&lt;br&gt;Second surgery:&lt;br&gt;  - Radial head replacement&lt;br&gt;  - LCL repair&lt;br&gt;  - MCL repair&lt;br&gt;  - Ulnar nerve decompression&lt;br&gt;  - Ulna and radius pin</td>
<td>Better</td>
</tr>
<tr>
<td>J Wang</td>
<td>M/21</td>
<td>Terrible triad injury&lt;br&gt;Essex-Lopresti injury&lt;br&gt;Carpal bone fracture- dislocation</td>
<td>First surgery:&lt;br&gt;  - Coronoid process fixation&lt;br&gt;  - Radial head Fixation&lt;br&gt;  - LCL repair&lt;br&gt;  - DRUJ fixation&lt;br&gt;  - Carpal bone fixation&lt;br&gt;Revision surgery:&lt;br&gt;  - Radial head replacement&lt;br&gt;  - Distal ulna resection</td>
<td>Better</td>
</tr>
<tr>
<td>Authors</td>
<td>Sex/Age (years)</td>
<td>Variant/Associated injuries</td>
<td>Treatments</td>
<td>Elbow Function</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------</td>
<td>-----------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>I Shinohara</td>
<td>M/38</td>
<td>Terrible triad injury</td>
<td>First surgery:</td>
<td>Satisfactory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Essex-Lopresti injury</td>
<td>External fixator</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Carpal bone fracture- dislocation</td>
<td>Second surgery:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open fracture</td>
<td>Radial head fixation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LCL repair</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MCL repair</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DRUJ fixation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Carpal bone fixation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Third surgery:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Radial head replacement</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ulnar shortening osteotomy</td>
<td></td>
</tr>
</tbody>
</table>

**Conclusion**

We report a rare case of terrible triad injury of the elbow with an medial isolated bone fragment and that the potential injury mechanism was speculated. We hold the opinion that that the treatment algorithm followed was appropriate for our case, especially the assisted medial incision, which acted as a vital role for the removal and reduction of the isolated fracture fragment from the radial head and stabilized the lateral structure of the elbow joint. Attempts to locate the medial bone fragment through the Kocher incision are also futile. As this rare injury pattern provided valuable information regarding of the diagnosis and optimal surgical management for terrible triad of the elbow joint.

**Abbreviations**

MCL: medial collateral ligament; LCL: medial collateral ligament; CT: computed tomographic; MRI: Magnetic Resonance Imaging; IOM: interosseous membrane; DRUJ: distal radioulnar joint

**Declarations**

**Acknowledgements**
The authors thank all the other staff of the traumatic orthopedics department of Anhui emergency center of the First Affiliated Hospital of the University of Science and Technology of China (Anhui Provincial Hospital) for their support.

**Author contributions**

LL, ML and LL wrote the manuscript. WX, GY and SF formulated the surgical treatment plan and revised the manuscript. LL, ML and GY performed the surgery and clinical follow-up. All authors reviewed and approved the final version of the manuscript.

**Funding**

This study was supported by the Fundamental Research Funds for the Central Universities (Grant Number: WK9110000178, WK9110000152 and WK9110000190), Joint Fund for Medical Artificial Intelligence (Grant Number: MAI2022Q014) and Natural Science Foundation of Anhui Province (Grant Number: 2108085QH317)

**Availability of data and materials**

The data supporting the findings is available in the section of case presentation within the article.

**Ethics approval and consent to participate**

Ethical approval was obtained from the First Affiliated Hospital of the University of Science and Technology of China Medical Research Ethics Committee (2022-N(H)-023). Written informed consent was obtained from the patient about all presentations of this case report.

**Consent for publication**

All authors approved publication of the manuscript. Written informed consent was also obtained from the patient for publication of this case report and related image data.

**Competing interests**

All authors have no conflict of interest.

**References**


Figures

Figure 1

(A) Anterolateral and lateral radiographs of the left elbow at the time of the injury showed posterolateral dislocation and an isolated medial fracture fragment. (B) Anterolateral and lateral radiographs of the left elbow after reduction and the isolated fracture fragment was circled in red. (C) CT scans of the left elbow showed fractures of the radial head and coronoid process, as well as the isolated bone fragment on the medial side of the ulna. (D) MRI scan revealed the LCL complex injury and the isolated bone fragment located in the medial muscle group.
Figure 2

(A) The Kocher incision was used to represent tearing of the LCL complex and anterior capsule of the elbow, and partial defect of the radial head. A soft tissue pathway was explored leading to the inner side of the elbow joint. Thus, an auxiliary medial incision was made to remove the isolated bone fragment. (B) The isolated bone fragment was eventually identified as the defect part of the radial head and was fixed after anatomic reduction (green arrow). LCL complex repair was also performed in surgery.
Figure 3

(A) Anterolateral and lateral radiographs of the elbow after surgery showed reduction of the radial head fracture with well-matched joint. (B) Anterolateral and lateral radiographs of the elbow six months after surgery observed heterotopic ossification in front of the joint. (C) The stable left elbow joint achieved good recovery regarding the function of flexion, extension and rotation.
Figure 4

The potential injury mechanism for the terrible triad injury of the elbow with a medial isolated bone fragment.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryMaterial.pdf