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## Variants of terrible triad of the elbow: A brief literature review

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### Abstract

Elbow fractures with dislocation are a challenge to treat and are associated with poor clinical outcomes as outlined in the literature. The terrible triad of the elbow is a combination of radial head fracture, coronoid process fracture, injury to collateral ligaments, and posterior dislocation of the elbow. The involvement of osseous and chondral supports around the elbow are considered as the variants in the terrible triad of elbow. We are reporting a brief review on such terrible triad variance of the elbow including cases who underwent management at our institute and a glimpse on other globally reported cases of similar variance. As it is necessary for the treating clinicians to get well-versed with such injuries, which can be easily missed during evaluation. The data available on these entities are limited and there is a further need to educate the clinicians regarding the same and its implications on the patients.

**Keywords:** terrible, chondral supports, collateral ligaments

### Introduction

Elbow fractures with dislocation are notoriously difficult to treat and associated with poor clinical outcomes as described in the literature. In 1996, Hotchkiss described the “Terrible Triad of Elbow” as the combination of elbow dislocation associated with radial head fracture and coronoid process fracture and collateral ligaments with posterior dislocation of the elbow [1]. Hence, it is infamously known as the “Terrible Triad of the elbow” because of its complexity and poor outcome.

The classification laid by Mason for isolated radial head fractures categorized it into three types, which includes, non-displaced fracture (type I), displaced partial articular fracture with or without comminution (type II), and type III fractures are mostly comminuted radial head fracture involving the whole head [2].

Similarly, for the coronoid fractures, classification by Regan and Morrey still holds good which was based on the height of the coronoid fragment until *O’Driscoll et al.* used a CT scan to classify it anatomically. Type I Fracture in Regan and Morrey classification involved an “avulsion” of the tip of the coronoid process, type II involved a single or comminuted fracture representing < 50% of the coronoid process, and type III involved a single or comminuted fracture of > 50% of the coronoid [3]. They further classified on basis of absence or presence of dislocation as types into A and B respectively.

*O’Driscoll et al.* classification of coronoid fracture was based on the location of the fracture about local anatomy. Coronoid tip fractures are divided into fragments that are <2 mm or >2 mm [4].

The associated mechanism of injury for such type of elbow injury has been described as a fall on the outstretched hand with the arm extended in supination with simultaneous valgus stress, axial load, and a posterolateral rotational force generation from the energy of the trauma, that results in failure of the lateral collateral ligament complex (LCL) [5, 6] and lastly, it involves medial collateral ligament (MCL) [7].

Because of these injuries, the elbow becomes unstable. Due to the complexity of this injury conservative treatment is least preferred and should be avoided as it has more long-term complications such as elbow stiffness, pain, joint instability, and secondary arthrosis. Hence, always managed with surgical intervention [8].

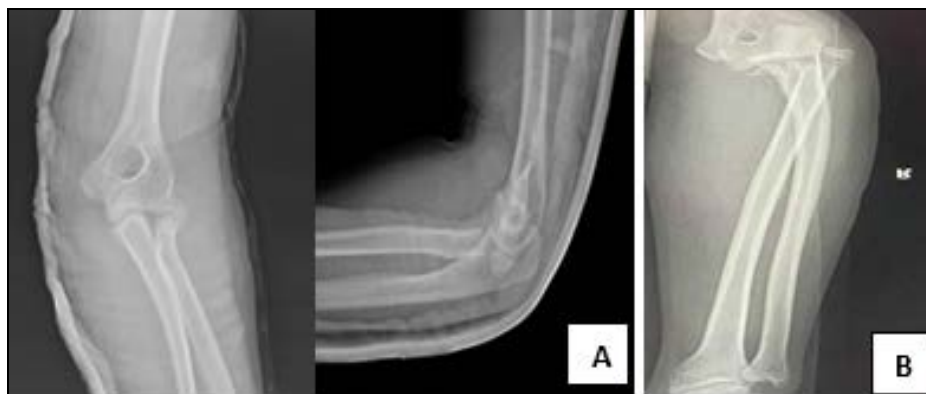
The surge in motorbike accidents are giving rise to different injury patterns i.e., variants of terrible triad injury. With the advent of 3D CT scan and MRI modalities detecting these variants have become easier. The terrible triad variant includes a combination of osseous and/or chondral injuries to the elbow in addition to other osteoarticular injury [9]. Variants reported were mostly capitellum fractures, radial neck fracture, coronoid Chandra injury, and medial condyle fracture [9]. In this proximity, we are reporting a few cases with terrible triad variant and its management at a tertiary center and a brief review to shed some light on this entity.

**Patients & Methods**

The present study was undertaken with patients who

underwent management for the terrible triad at our tertiary center during 2020-2021. Patients were seen in the emergency department, after giving first aid, and an above elbow POP slab was applied due to their instability. Out of the 6 cases of classical terrible triad injury of the elbow, two cases were with variants. Both injuries were complex and unstable. The diagnosis was confirmed by radiographs, 3D - CT scans, and MRI.

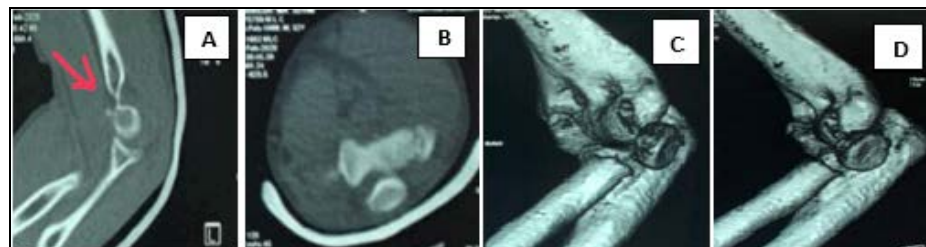
Figure 1 shows the AP and Lateral radiographs of both cases with a variant. Instead of a head fracture, the first case had a radial neck fracture. The second case had a fracture coronoid extending distally to the ulna. He also had a contralateral humerus shaft fracture and comminuted olecranon fracture.



**Fig 1:** The radiograph images of elbow AP/LAT views, showing terrible triad with variants (A) Radial neck B) Coronoid fracture with extension into the proximal ulna

Figure 2 shows the CT scan with the 3D reconstruction of the first case, clearly showing the displaced radial head with a

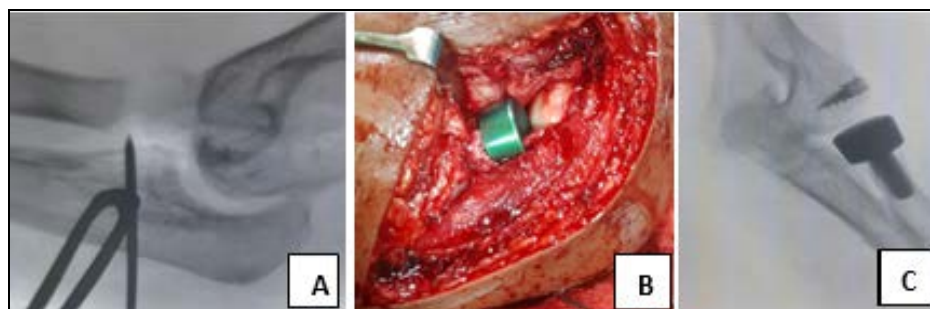
neck fracture. Red arrows showing the coronoid (type 1 avulsion fracture with a fleck sign)



**Fig 2:** CT Scan images of the Sagittal and Axial cuts and 3D reconstruction of the elbow

Both variant cases were stabilized and taken up for surgery. Kocher's-Approach was used to enter the lateral column. The ruptured lateral collateral ligament was identified. The fractured radial head was seen superficially and devitalized from the blood supply. Hence it was decided to excise it. Following coronoid fragment reduction, the guidewire was inserted from the dorsal surface of the ulna subcutaneously

and exited from the coronoid process under direct vision. The fractured fragment was repaired using by placing Lasso sutures passing through the anterior capsule of the elbow and sutured to the base of the coronoid of the ulna subcutaneously using pull-in and pull-out technique with an eyed Kirschner wire (Fig. 3 A).



**Fig 3:** (a) Coronoid fracture being repaired lasso suture technique (b) Radial head spacer in place. (c) Intraoperative C-arm image

The excised radial head fragment was evaluated and measured following which, a prosthesis was inserted under the C-arm assistance and the placement was confirmed. The articulation of the implant at the level of the proximal aspect of the proximal radio ulnar joint, and around 2 mm distal to the tip of the coronoid process. (Fig 3B & C)

Following fracture fixation, the lateral collateral ligament was repaired and reattached using a non-absorbable suture with suture anchors. Inserted in the center of the Capitellar

curvature on the lateral epicondyle – for a successful, isometric repair. Stability was achieved. Post-surgery, an above elbow slab was applied with the elbow in 90 flexion and mid-prone position with limb elevation. Similarly, the second case was also managed with a radial head prosthesis, pull-out sutures for capsule strengthened with endobutton and ethibond sutures. The coronoid fracture was stabilized with a 3.5 mm cancellous screw.

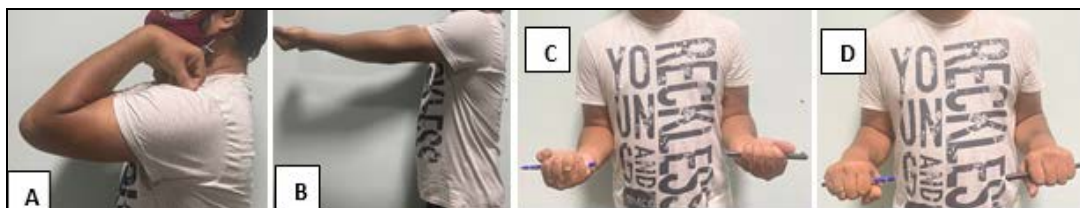


**Fig 4:** Postoperative AP/Lat radiograph (A & B) of 12 months follow-up. C shows the lateral view of the second case post-op 6 months. D) Contralateral humerus shaft fracture and olecranon fracture of 2<sup>nd</sup> case immediate post-op.

Postoperatively, the above elbow was retained with the elbow in 90-degree flexion for 2 weeks and followed by removal of the slab. A hinged elbow brace was applied, and rehabilitation was started. The hinged elbow brace was removed by 8

weeks. Cases were followed up to 12 months.

Figure 5 shows the elbow range of movements at 12 months after surgery.



**Fig 5:** Elbow range of motion at 12months following surgery

Institutional clearance and informed consent were obtained as per the standard operating protocol. The author reviewed two cases with terrible triad variants and was included in this brief review study.

The first case had a fractured neck of radius along with a posterior dislocation and coronoid fracture, with intact MCL. The second case had gross injury of the right elbow with fracture of coronoid, extending distally to ulna and injury to MCL. He also had contralateral injury of shaft of humerus as well as olecranon.

“Terrible triad variants according to Medina G [9] was a combined bony or a cartilage injury to the elbow, and at least two of the three classical components of Terrible triad (coronoid fracture, radius head fracture, posterior ulno-humeral dislocation) should be present in addition to other unique elbow osteoarticular injury” [9].

## Results

Literature search on variants of terrible triad showed about 4 articles mentioning the same [9].

Medina G *et al.* had done a systematic review on the classic components of terrible triad injury to the elbow and their variants. They had divided the cases into two groups, the first group with terrible triad and concomitant ipsilateral upper limb injury and the second group with terrible triad variants. They concluded that it is vital, not to miss these less common complex injuries of the elbow. A detailed secondary survey with imaging modalities (CT scan and MRI scan) is needed to

identify these injuries.

Desai *et al.* in his article mentioned a case involving a polytrauma patient who had a terrible triad variant consisting of a posterior elbow dislocation, coronoid process, and capitellum Fractures [1].

MRI was needed by Rooke *et al.* [9] to diagnose an adolescent with terrible triad variant injury of the elbow, initially, a diagnosis of epiphyseal injury of the wrist was made. Later further evaluation revealed MCL laxity with ulno-humeral dislocation [9].

Similarly, Luis M. Salazar *et al.* [10] in their case report mentions about associated ipsilateral Essex-Lopresti injury with terrible triad, which was fixed with IJS system, radial head was fixed with smaller screws. Patient had a good outcome following the surgery [10].

One case out of 15 cases as reported by Bhavsar *et al* [9] had a terrible triad variant injury (i.e., medial condyle fracture with LCL injury along with classical triad) further details like the mechanism of injury were not specified.

Essex- Lopresti injury along with terrible triad of elbow was also mentioned by Kumar *et al.* [9] in his case report of a 30-year-old male patient who had RTA. Only coronoid fracture, radial head fracture with capitellum fracture and ipsilateral distal end radius fracture was present. Not associated with dislocation of ulno-humeral joint. Fractures were fixed with mini plates and screws.

## Discussion

Elbow joint is a hinge joint. It is formed by the articulation of 3 bones: Radius, Ulna, and Humerus. Usually, terrible triad of the elbow consists of posterior dislocation of the elbow, radial head fracture, and coronoid process fracture in which the bony, as well as capsule-ligamentous structures, are disrupted, giving rise to instability. Variants in terrible triad arise due to changes in the force across the elbow joint at the time of the injury [9]. The medial column includes medial collateral ligament, coronoid process, and medial condyle. Lateral column is formed by radial head, capitellum, and lateral collateral ligament. Medial and lateral columns provide maximum stability to elbow [1]. Radial head provides 30° of the valgus stability and acts as a primary stabilizer of the lateral column [9].

Medina G [9] reported that the variants were capitellum fractures, radial neck fracture, coronoid chondral injury, and medial condyle fracture [9]. The percentage of radial neck fracture was 3 % in 27 cases. Our cases showed an equal percentage of involvement of radial neck fracture. Associated concomitant injury in decreasing trend was an olecranon fracture (27.3%), followed by Essex-Lopresti injury, triceps tendon avulsion, and carpal fracture-dislocation (12.1%) [9]. The cases presented to our institute had radial neck fracture apart from the classical terrible triad components and fracture coronoid extending from the medial rim distally to ulna.

There is a need for detailed evaluation of elbow injuries especially occurring due to road traffic accident in young working population. These injuries can be missed and can affect the functional outcome of the individual. The reported cases with terrible triad variants are very uncommon.

Kumar *et al.* [9] had showed a case with only coronoid fracture with capitellum and no dislocation, termed it as bony variant of terrible triad. He suggested a varus force at the elbow along with axial load produces such a complex injury [9].

Elbow injuries in children resulting in chondral shear fractures, need further evaluation with MRI scans, as reported by Rooke *et al.* [11]. Their case had an elbow dislocation, a radial neck fracture, and a displaced coronoid chondral fragment which prevented primary closed reduction, later was removed and the coronoid fragment was sutured along with capsule to coronoid bed. The Postoperative was uneventful but resulted in partial radio ulnar synostosis.

Although, in practice, many clinicians consider the lateral approach satisfactory for managing most cases [12, 13]. Hence, in our case, we have used Kocher's lateral approach, which gave us a good and direct view of the radial head fracture and LCL management.

Ideal fixation of terrible triad as described by McKee *et al.* [11], is to start from inside to outwards, in the order of coronoid fixation followed by radial head fixation/replacement and finally lateral collateral ligament repair. If fixation is done in a sequential manner, better results can be expected. Fig 5 shows good range of motion of the elbow following sequential repair at 12 months.

Fragment excision of radial head is indicated in scenarios when head involvement is less than 25%, bone fragments are too small or osteoporotic to fix, other structures are intact, and when the fragments do not articulate with the proximal radio ulnar joint. In such scenarios, excision can be done considering that the stability of the elbow is achieved by secure repair of the coronoid and collateral ligament [14, 15]. In young patients, it is always better to conserve or reconstruct the fractured radial head.

In our case scenarios, the radial head was non – salvageable,

hence due to instability of the joint, they were replaced with radial head prosthesis.

Other options include mini-screws or mini plates, placed in the region that does not articulate with the proximal radioulnar joint also called the “safe zone” [16]. Care should be taken while dissecting in proximity to the radial head, posterior interosseous nerve needs to be protected. Hence, the forearm is pronated which pushes the nerve away from the surgical plane of dissection [17].

Radial head arthroplasty is done in injuries with radial head comminution, fractures of the radial neck, and when the elbow is unstable. Once the prosthesis is placed the placement is checked and confirmed that it is articulating at the level of the proximal aspect of the proximal radioulnar joint, which is approximately 2 mm distal to the tip of the coronoid process [17].

In the case of the terrible triad, the LCL is usually avulsed from the common extensor origin of the lateral epicondyle. The management of the LCL avulsion can be managed with refixation onto the lateral epicondyle using either suture anchors or trans-osseous sutures. And it is critically important to provide an isometric repair by placing the sutures at the center of rotation of the elbow, placed at the center of the capitellar curvature on the lateral epicondyle [18].

Mathew *et al* preferred the trans-osseous technique and is a preferred method, as it uses running locking sutures with the elbow at 90°. They also explained that position of the forearm changes for LCL repair in relation to the MCL involvement. If the MCL is intact, the LCL is repaired with the forearm in pronation. And if MCL is disrupted, then LCL is repaired in supination to avoid gapping open the medial side of the elbow by overtightening the lateral repair [17]. Following the complete repair in the order of coronoid process, radial head-neck junction, and LCL, the elbow must be examined under the guidance of the portable fluoroscopy for any instability. The elbow on the table must be flexed and extended with the forearm in supination, neutral position, and pronation. We used 5mm titanium suture anchors to reinforce the lateral collateral ligament and common extensor origin.

When the elbow is showing instability after the surgical repair external fixator (static or hinged) must be applied. This helps in maintaining the concentric reduction of the affected elbow [19].

In the literature, static fixators can be used for up to 3 weeks of post-surgical repair. However, the use of a dynamic fixator is superior to the static brace as they provide stability of the elbow when there are suboptimal soft-tissue and bony repair [17]. Above elbow POP slabs were used in both our cases, to provide additional stability.

## Conclusion

Thereby, we would like to summarize, based on our study that terrible triad injury of the elbow is the most complex pattern of all dislocations. Terrible triad variants are very uncommon, chances of missing these rare entities are high during the initial survey. Clinicians need to be vigilant while examining complex elbow dislocations. Judicious use of imaging modalities is a priority. Normal radiographs can show dislocations and obvious bony injuries. For recognizing ligament injuries of the elbow MRI scan is the most sought-after modality. 3D CT scan unearths variant injuries associated with terrible triad of the elbow. Knowing the mechanism of injury is the key to understanding the fracture pattern and it helps in predicting possible variance and/or concomitant injuries associated with the initial presentation.

The data available on these entities are limited and there is a further need to educate the clinicians regarding the same and its implications on the individual.

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