Case Series

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The anconeus-triceps lateral flap approach in terrible triad of the elbow: good outcome in a series of ten cases

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Introduction: Standard surgical management for the terrible triad of the elbow (TTE) has been established since 2004, yet postoperative complications are common and consensus on optimal management is absent. Different surgical algorithms for treating TTE and their efficacy have been reported worldwide, yet evidence from Vietnam remains limited.

Methods: Ten cases diagnosed with TTE admitted to the Hospital of Traumatology and Orthopedics, a tertiary orthopedic center in Ho Chi Minh City, were presented to demonstrate the effectiveness and rate of postoperative complications following our stepwise surgical procedures using the anconeus-triceps lateral flap approach. The intraoperative "drop sign", quantitative assessment of pain and level of upper arm disability (via VAS and QuickDASH score) was mentioned to assess the algorithm's benefit. All patients' information was retrieved from medical records from August 2022 to January 2024.

Results: All 10 cases required repair of the lateral ligament complex and underwent surgery within 2 days of hospitalization. Immediate postoperative imaging revealed no drop sign, and none of the patients experienced elbow dislocation nor the need for repeated surgery, and a full range of elbow motion was demonstrated at 3–6 months follow-up.

Conclusion: TTE is a challenging injury that almost always obligates surgical correction. The anconeus-triceps lateral flap approach, with its advantages of better visualization and preservation of certain essential stabilizing muscles of the elbow, was demonstrated to yield a high success rate and low postoperative complication rate.

Keywords: anconeus-triceps lateral flap approach, case series, posterior approach, terrible triad of the elbow

Introduction

Terrible triad of the elbow (TTE) is a complex injury involving fracture of the radial head and the coronoid process of the ulnar, which typically leads to posterolateral dislocation of the elbow joint[1]. Damage to both structures at once readily engenders joint's instability and is associated with poor prognosis[2]. Although few patients could be eligible for conservative management, the majority of patients require surgical intervention to regain stability of the elbow joint and early rehabilitation via fracture fixation or replacement as well as collateral ligament repair if necessary. The current treatment algorithm has been reported to yield satisfactory functional outcome, yet postoperative complications including chronic instability, ulnar neuropathy, joint stiffness, and arthritis remain common[3,4]. Prospective evidence has shown several factors negatively affecting the patients' outcome, such as low compliance, obesity, extensive soft elbow tissue damage caused by high-energy trauma, and delayed treatment as well as the surgeons' expertise[5]. One of the radiographic markers serving as a

HIGHLIGHTS

- Terrible triad of the elbow (TTE) is a complex injury involving fracture of the radial head and the coronoid process of the ulnar, which typically leads to posterolateral dislocation of the elbow joint.
- Surgery is almost always required to treat TTE, yet no consensus on surgical approach has been established.
- The anconeus-triceps lateral flap approach allows convenient access to both the lateral and medial aspects of the elbow, providing better visualization and postoperative elbow stability.
- A drop sign is a signal for compromised static restraint from ligamentous damage rather than muscle hypotonia.

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prognostic factor and the need for ligament reconstruction is "drop sign". The sign refers to the joint space between the humerus and ulna being widened by greater than or equal to 4 mm on lateral X-ray of the elbow, which suggests a complete or incomplete rupture of the lateral and/or medial collateral ligament, which indicates a higher risk for postoperative instability[6,7].

In this case series, we presented 10 patients with TTE admitted and managed with the surgical algorithm at The Hospital of Traumatology and Orthopedics, a tertiary orthopedic center in Ho Chi Minh City in order to assess the number of cases described with the 'drop sign' and to demonstrate the effectiveness and rate of postoperative complications following our stepwise surgical procedures using the anconeus-triceps lateral flap approach. The results provide additional evidence to the current literature to help with the refinement of surgical treatment for this complex orthopedic issue.

Method

This is a descriptive study with data retrieval of already conducted surgery. Ethical approval is not required for this report in accordance with the local guidelines. Written informed consent for publication of this case and any accompanying images was obtained from the patient before writing the manuscript. The PROCESS checklist has been completed by the authors for this case series in compliance with the PROCESS guidelines[8] (attached as supplementary material, Supplemental Digital Content 1, http://links.lww.com/MS9/A515).

10 patients diagnosed with TTE, admitted during August 2022 to January 2024 and operated by the same surgeon at the Hospital of Traumatology and Orthopedics using the anconeus-triceps lateral flap approach were retrospectively studied. Radial head fractures were classified by Mason–Johnson classification, and coronoid process fractures were classified by Regan–Morrey classification. All procedures were scheduled within 2 days of admission (mostly within 1 week of injury). The surgery is performed with the patient in a lateral position, under both brachial plexus block and general anesthesia, lasting for 1–1.5 h. Elbow stability was confirmed right after fixation using intraoperative C-arm imaging. Postoperative follow-ups were scheduled at 3 and 6 months to evaluate functional recuperation as well as post-surgical complications.

Superficial exposure

To expose the superficial layer, a long skin incision was made in the posterior elbow, along the lateral of the ulna, directed toward the lateral condyle, and the entire skin flap was completely dissected from the deeper layer (Fig. 1). The anconeus and the intermuscular septum attached to the coronoid fossa were identified and incised longitudinally from the midpoint of the olecranon to the anconeus attachment. The medial of the anconeus was also identified and carefully dissected, separating the anconeus flap and the medial end of triceps.

Deep exposure

After exposing the layers of the forearm and the periosteum through the anconeus, the triceps was longitudinally split, and the insertion of the anconeus to the lateral olecranon was detached. Deeper to this layer, the annular ligament, lateral collateral ligament, and the entire elbow joint complex are identified. The tissue is progressively dissected outward until the lateral collateral ligament was visible and detached (Fig. 1). The radial head can be palpated at this location. The ligaments and joint capsule were exposed directly from the supinator crest (Fig. 2). The extension muscles insertion site was then identified, and the elbow joint was located.

Fracture management

Coronoid process fragments are reduced using Kirchner wires or, in case the fracture is sufficiently small, the fragment was sutured onto the anterior part of the elbow joint capsule through the posterior of the ulna. The radial head was replaced by prosthesis or bone graft or internally fixed by Kirchner wires, plates or screws (Fig. 3).

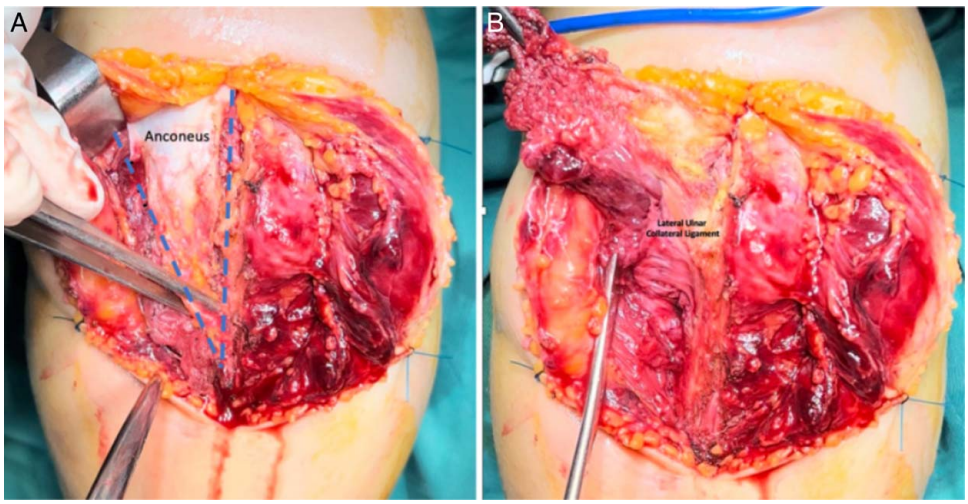

Figure 1. (A) The anconeus-tricep lateral flap. (B) Completely expose the entire lateral ulnar collateral ligament.

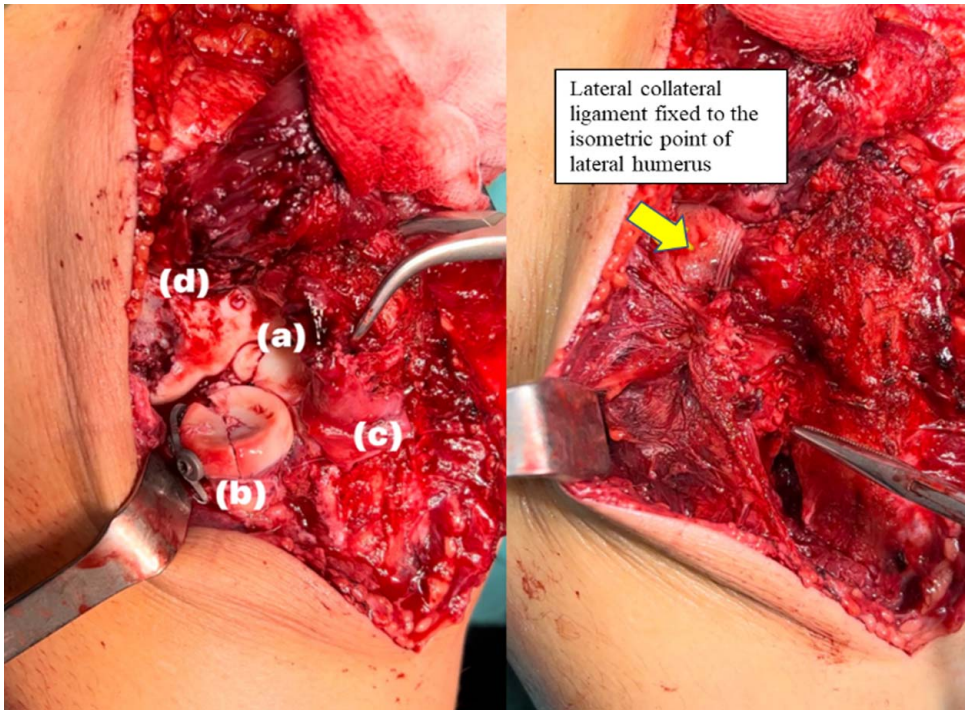

Figure 2. (A) Coronoid process fracture, (B) radial head fracture, (C) lateral collateral ligament, (D) detachment of the lateral collateral ligament.

Ligament repair

The annular ligament and the lateral collateral ligament were fixed by drilling through the ulna. The lateral collateral ligament is repaired by suturing the tissue strip with ultra-strong braided sutures (Maxon or Hifi) through the humerus, into the isometric center on the lateral of the capitulum (Fig. 2). Both the capsule ligament suture and the lateral collateral ligament anchor screw are secured when the elbow is flexed to 30°. The elbow joint is finally fixed by flexing the elbow to 90° and supine the forearm.

Postoperative care

Discharge was permitted after an average of 3 days. The patients were immobilized with an elbow splint for 6 weeks. Physical therapy commenced after that with initial exercise involving active supination of the forearm to enhance joint stability. Passive extension beyond the range of motion was not recommended as it could compromise the tension of the external structures, but a limit of 30° of extension should be achieved. The patients were reassessed each 2 weeks for clinical and imaging examinations for a duration of 3–6 months.

Results

The average age of the patients was 47 with the youngest being 21 years old and the oldest being 76 years old. 6 out of 10 patients were female (60%). The majority of causes were fall from height with outstretched hands, followed by traffic accidents, and sport

Figure 3. Preoperative and postoperative X-ray, showing no drop sign. (A, B) Patient 1. (C–F) Patient 2. (G–J) Patient 3.

injury. All patients present with pain, swollen and compromised mobility of the injured elbow. Conservative management was mainly sprinting with a duration of 2–7 days before the surgery was scheduled.

All patients experience laceration of the lateral ligament complex and require lateral ligament and capsular repair. Of the 10 patients, only 3 patients suffered from isolated radial head fracture and posterior dislocation of the elbow joint, whereas 7 patients had both radial head and coronoid process fractured and underwent fixation of both structures. There was one patient diagnosed with radial head fracture with anteromedial displacement. Preservation of the radial head was conducted using the bone grafting technique (Table 1). None of the patients required repair of the medial collateral ligament or an external fixation.

Among the 10 cases, none showed a drop sign as assessed by intraoperative C-arm right after the surgical correction, and the sign remained absent during postoperative follow-up (Fig. 3). None of the patients experienced re-dislocation, the need for revision surgery, or symptoms of elbow instability during follow-up. At 3 months, the patients achieved a full range of motion exercises (Fig. 4). Daily activities including riding motorbike, changing clothes, doing chores, combing hair were carried out normally. A decreasing trend of pain and level of upper arm disability was observed throughout postoperative visits, at 3 and 6 months (Table 2).

Discussion

TTE is a severe injury of the elbow joint associated with poor prognosis. Here, we reported a series of 10 cases diagnosed with TTE and intervened surgically using the anconeus-triceps lateral flap approach to evaluate the efficacy of our algorithm.

The selection of a surgical approach depends primarily on the types of fracture, types of instability, the extent of soft tissue damage, and the surgeon's experience. The posterior approach has been a common option in several case series[3,5,9] because it readily exposes the medial and lateral aspect of the elbow without the need for additional incisions as well as lowers the risk of damaging the cutaneous nerve. However, the skin flap created during the posterior approach poses a risk for hematoma formation. A different option is to both dissect the medial and lateral aspects of the elbow as the surgeons want to access a large coronoid process fragment or when the medial collateral ligament repair is required because of persistent posterolateral instability despite the lateral side address[3,10–12].

A modified posterior approach was introduced in 2015 called the anconeus-triceps lateral flap[13], which facilitates easier access to the radial head and coronoid process, also to the anterior aspect as needed without the requirement for an additional skin incision. The approach is less likely to affect the ulnar nerve and the posterior antebrachial cutaneous nerve as it typically lies outside of the incision site in the forearm. The lateral collateral ligament complex can be readily visualized because the site of injury is usually at the attachment point on the lateral epicondyle of the distal humerus, thus facilitating a precise repair. Secondly, the coronoid process can be accessed for fixation either using Kirschner wires or suturing the coronoid fragment to the anterior capsule. Furthermore, although published evidence has revealed no significant discrepancy in clinical outcomes in the group whose medial ligaments were repaired[14], had the medial collateral ligament required to be repaired due to instability despite all steps taken, the medial side can be accessed without the need for an extra skin incision. Thirdly, the fracture of the radial head can also be evaluated from the posterior view when the elbow is in supination.

Although different methods can be utilized to correct the fracture, preservation of the radial head is advised, and if not possible arthroplasty for implantation of a prosthesis is recommended. Such indications arise when there is extensive comminuted fracture or poor bone quality[1]. In this case series, the radial head was reduced and fixed using K wire or plates and screw.

Table 1

Patient characteristics and corresponding treatment.

Number	Sex	Age	Diagnosis	Treatment	Drop sign
1	Female	56	TTE right Fall from height	ORIF RH + Coronoid + capsule, lateral ligament repair	None
2	Female	53	TTE left Fall from height	ORIF RH + Coronoid + capsule, lateral ligament repair	None
3	Male	26	TTE right Traffic accident	ORIF RH + Coronoid + capsule, lateral ligament repair	None
4	Male	69	TTE right Fall from height	ORIF RH + Coronoid + capsule, lateral ligament repair	None
5	Female	21	TTE left Sport injury	ORIF RH + capsule, lateral ligament repair	None
6	Male	47	TTE right Traffic accident	ORIF RH + capsule, lateral ligament repair	None
7	Female	75	TTE left Fall	ORIF RH + Coronoid + capsule, lateral ligament repair	None
8	Female	54	TTE left Fall from height	ORIF RH + capsule, lateral ligament repair	None
9	Male	76	TTE right Fall	ORIF RH + Coronoid + capsule, lateral ligament repair	None
10	Female	54	TTE left Traffic accident	ORIF RH + Coronoid + capsule, lateral ligament repair	None

ORIF, open reduction and internal fixation; RH, radial head; TTE, terrible triad of the elbow.

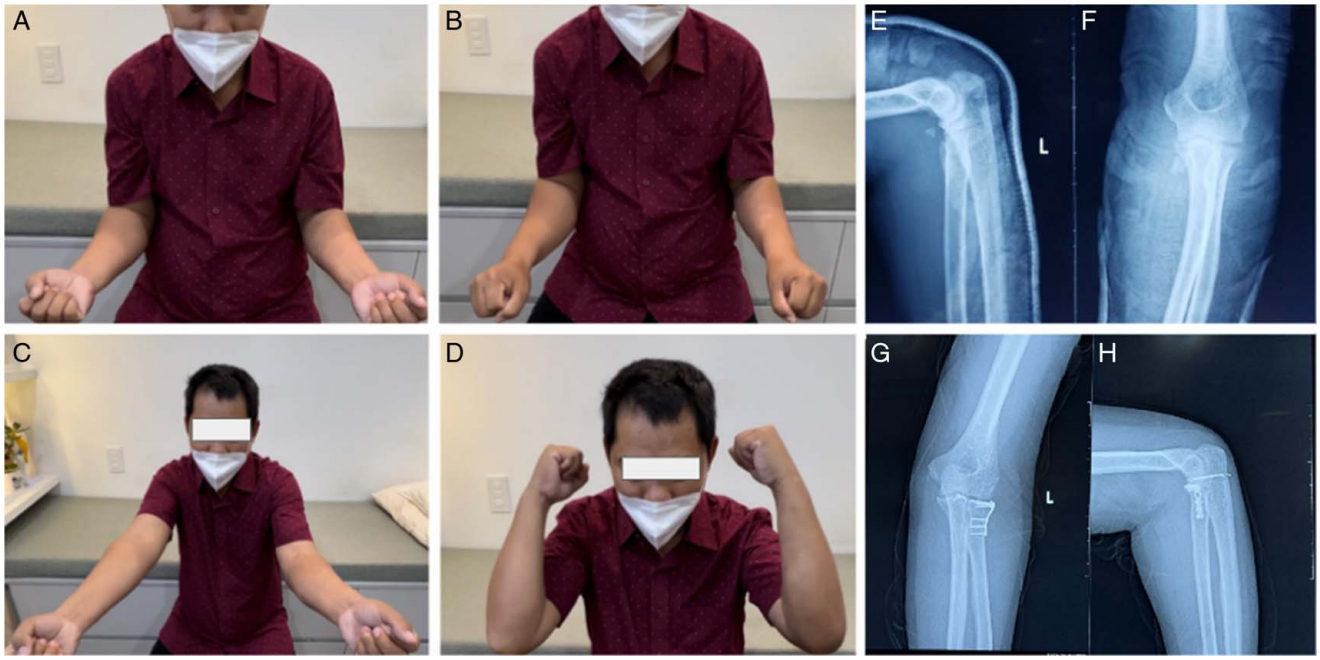

Figure 4. Range of motion of the patient at 3-month follow-up. (A) Supination; (B) pronation; (C) extension; (D) flexion. (E–H) The patient's radiograph before and after surgery.

One patient was transplanted the displaced radial head with a bone graft, thus retaining an important secondary stabilizer of the elbow joints.

According to Coonrad, the presence of a drop sign becomes concerning if it persists after surgery because it may portend the risk of long-term instability[7]. However, a retrospective study of 107 patients with TTE has revealed the rate of drop sign postoperatively was quite low (2%) and did not lead to frank elbow instability, yet required correction by physiotherapy within the first few weeks after surgery[15]. The study also reported that the most common surgical algorithm utilized was comprised of suture fixation of the coronoid, suture anchor fixation of the lateral collateral ligament, arthroplasty of the radial head, and no fixation of the medial collateral ligament, which was similar to our approach except for the management of the radial head fracture.

In a series of 23 consecutive TTE cases undergoing surgery with posterior approach without medial repairment, a drop sign was absent in all patients during intraoperative imaging after the surgery had been performed[16]. This demonstration was consistent with our observation. The authors also suggested that the occurrence of this phenomenon was due to an impaired static restraint from ligamentous damage rather than muscle hypotonia, which is also consistent with the fact that regional anesthesia had no effect on the joint's subluxation in our 10 cases. Moreover, the posterior flap approach preserved the extensor muscle group attached to the lateral of the humerus, which is responsible for maintaining elbow stability, thus contributing to the stabilization of the joint postoperatively and obliterating the presence of drop signs. Lateral approaches such as Kaplan or Kocher may affect this muscle group for the convenience of treating injuries in terrible triad cases. Furthermore, all of 10

Table 2

Postoperative hospital staying and quantitative evaluation of pain and upper arm disability during follow-up

Number	VAS 3 months	VAS 6 months	VAS final	QDASH 3 months	QDASH 6 months	QDASH final	Days in hospital
1	3.5	2.8	1.5	23.0	15.0	9.0	3
2	3.0	2.3	1.0	22.0	14.0	8.0	5
3	3.8	2.9	1.3	23.5	15.2	8.8	3
4	2.9	2.4	1.1	22.3	14.3	8.3	4
5	3.4	2.6	1.4	23.2	14.8	8.6	3
6	3.1	2.7	1.2	22.8	14.6	8.4	3
7	3.6	2.5	1.6	23.3	15.1	9.1	3
8	3.0	2.2	1.0	21.9	13.9	7.9	2
9	3.7	2.8	1.3	23.4	15.0	8.7	3
10	2.8	2.4	1.1	22.1	14.1	8.1	2
Mean	3.2	2.5	1.2	22.5	14.5	8.5	3,2

QDASH, quick disability of the arm, shoulder, and hand; VAS, visual analog scale.

patients underwent repair of the joint capsule, which could be another contributor to the joint's stability postoperatively. The anterior band of the lateral collateral ligament is crucial for maintaining elbow stability during varus stress and external rotation[17].

This is, to our knowledge, the first report in managing TTE in Vietnam. Besides the report on postoperative outcome such as the absence of drop signs indicating proper joint stability or the absent requirement of reoperation, the patients' functional status was also assessed. However, this observation was limited to a series of 10 cases at a tertiary orthopedic center. Therefore, more studies with larger populations from different hospitals should be conducted to yield generalization about the effectiveness of the presented algorithm in the setting of Vietnam national healthcare capacity.

Conclusion

This report presented a series of 10 cases diagnosed with the terrible triad of the elbow and managed surgically within 1 week at the Hospital for Traumatology and Orthopaedics in Ho Chi Minh City. Assessment of postoperative joint stability and functional outcomes following the stepwise surgical procedures using the anconeus-triceps lateral flap approach revealed good results. Together with the advantage of surgical visualization, this initial observation demonstrated the benefit of the algorithm at our hospital. Further research is recommended to test out the application of such algorithms for other national and domestic healthcare facilities.

Ethical approval

Ethical approval is not required for this study in accordance with local guidelines.

Consent

Written informed consent was obtained from the patient before writing the manuscript for publication and any accompanying images.

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This research received no specific grant from any funding agency in the public, commercial, or not for profit sectors.

Author contribution

L.G.A.T. proposed the idea, together with K.T. leading the study. K.T., N.T.D., N.V.T., P.T.N. mainly wrote the manuscript. N.V.T. and T.T.T.T. contributed significantly to manuscript editing. L.G.A.T., N.V.T., P.T.N. were the main surgeons who performed the procedures, collected the data. V.T.T. supervised the study and commented on the final manuscript.

Conflicts of interest disclosure

The authors have no competing interests to disclose.

Research registration unique identifying number (UIN)

Not applicable.

Guarantor

Dr Le Gia Anh Thy.

Data availability statement

The data in this study are available from the corresponding author, V.T.T., upon reasonable request.

Provenance and peer review

Not applicable.

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