OPEN Research Article

Revision Olecranon Fixation: Is Tension Band Wiring the Solution? A Case Series and Review of the Literature

Marcus C. Appleton, MD
Sohan K. Jakkaraju, MD
Paul C. Appleton, MD
Anil K. Dutta, MD

ABSTRACT

Background: The optimal revision construct for failed olecranon fracture fixation is controversial. Here, we aim to review existing revision techniques and describe tension band wiring as a surgical option for these challenging scenarios and to evaluate its clinical and radiographic outcomes.

Methods: This retrospective case series was performed at an urban, university-based, level-1 trauma center. Patients aged 18 to 65 years who underwent revision fixation of their olecranon fracture using tension band wiring were included. The study data were collected through a retrospective chart review and review of the existing radiographic studies. Primary outcome measure was mechanical failure. Secondary outcome measures included nonunion, malunion, medical, and surgical complications. Functional outcome was determined by range of motion and restoration of extensor mechanism strength.

Results: A total of five patients were included in this study. Causes for revision were acute implant failure (n = 2), aseptic nonunion (n = 1), and infected nonunion (n = 2). All patients eventually achieved bony union after revision. Two patients required an additional surgery because of Kirschner wire migration (n = 1) and symptomatic implant (n = 1). Average flexion was 126° (range 110 to 135) and average extension was 18° (range 5 to 30). All patients experienced restoration of extensor mechanism with full strength and returned to their previous working status. No other mechanical failures, surgical complications, or medical complications occurred.

Conclusions: Early results of revision open reduction and internal fixation for failed olecranon fracture fixation using tension band wiring demonstrated favorable outcomes and low complication rates. This technique may be used for revision of failed olecranon fixation.

From the Long School of Medicine, UT Health San Antonio, San Antonio, TX (Dr. M. C. Appleton, Dr. Jakkaraju, and Dr. P. C. Appleton), and the Department of Orthopaedics, UT Health San Antonio, San Antonio, TX (Dr. Dutta).

Corresponding to Dr. M. C. Appleton: marcappleton23@gmail.com

None of the following authors or any immediate family member has received anything of value from or has stock or stock options held in a commercial company or institution related directly or indirectly to the subject of this article: Dr. M. C. Appleton, Dr. Jakkaraju, Dr. P. C. Appleton, and Dr. Dutta.

JAAOS Glob Res Rev 2025;9: e25.00049

DOI: 10.5435/JAAOSGlobal-D-25-00049

Olecranon fractures constitute nearly 10% of all upper extremity fractures.[1,2] Because of the intra-articular nature of olecranon fractures, open reduction and internal fixation is often necessary. Primary reduction techniques frequently described include tension-band wiring (TBW), locking plate fixation, intramedullary nail fixation, intramedullary screw fixation, and triceps advancement with fragment excision.[3] Decision making for the primary treatment approach is influenced by fracture type, comminution extent, and elbow stability. Although TBW has shown favorable outcomes for simple and nondisplaced fractures, its role in revision surgeries remains inadequately explored.

Currently, there is no consensus on optimal revision techniques after failed olecranon fracture fixation, as factors like fracture comminution, diaphyseal extension, elbow instability, soft-tissue deficiency, construct design limitations, and implant prominence contribute to the complexity.[1-3] Revision surgeries also pose challenges because of interval healing, scarring, and limited treatment options, particularly after failed plate fixation.[1]

Given the paucity of the literature, and as an extension of this review, a case series is included to evaluate the clinical and radiographic outcomes of tension band wiring after failed primary olecranon fixation.

Intermedullary Fixation (Nail and Screw)

Use of olecranon nails is becoming more popular for primary treatment of both simple and complex olecranon fractures.[4] Although long-term studies are limited, existing biomechanical studies reveal robust fixation through compression across the fracture site. Nails have a minimal extracortical profile, which may decrease the likelihood of implant irritation.[4,5] However, it should be noted that although long-term studies demonstrate favorable outcomes with little-to-no implant irritation, elective implant removal remains high (half of patients).[5] Data regarding the use of olecranon nails for revision of failed olecranon fixation are extremely limited.

Intramedullary noncannulated long screws are also used to achieve rigid internal fixation with minimal exposure and reduced risk of implant-related complications. This technique allows for endosteal purchase at the isthmus of the ulna, increasing pull-out strength and providing anatomic reduction while enabling early range of motion.[6] Advantages of this approach include quicker surgery, less blood loss, and a minimal extracortical profile.[6] Data regarding intramedullary screw fixation in the revision setting are minimal.

Locking Plate Fixation

Locking plate fixation (LFP) with anatomically contoured plates has gained popularity for primary fixation of complex olecranon fractures. It is thought that dynamic fracture site compression provided by LFP is useful in comminuted fractures where rotational stability is required and in fractures involving the coronoid process.[7] LFP has also been advocated as a superior method of fixation compared with others due to having fewer complications and revision surgery rates. However, more recent studies have noted similar outcomes when comparing LFP to other fixation methods.[8,9] Tobenna Oputa et al, in a 140 patient study, noted no notable difference in complication rate, infection rate, or rate of implant-related symptoms when comparing LPF with TBW in both simple and comminuted fracture groups.[8]

Tension Band Wiring

Tension band wiring (TBW) is the standard approach for simple transverse fractures, allowing early motion and demonstrating comparable outcomes to plate fixation for simple displaced fractures.[8-11] Interestingly, considerations such as age, comorbidities, and sex may affect the revision surgery rate more markedly than the implant type.[9]

TBW also allows for early postoperative rehabilitation to avoid stiffness, minimal implant prominence, and less soft-tissue handling/dissection.[12] In the context of revision fixation, initial fixation before implant failure may contribute to interval healing at the articular surface and allow for successful TBW fixation despite initial fracture comminution. The unique ability of the tension band construct to translate tensile forces of the posterior aspect into compression forces at the joint may also expedite healing in these situations.

Cost is an important factor in decision making that is often overlooked.[13] The average total cost of TBW surgery was found to be 2.6 times cheaper than plate fixation in the treatment of displaced olecranon fractures.[14] When the cost of TBW with implant removal was compared with the cost of LPF without removal, the cost was still markedly less (181% cost difference).[14] For these reasons, we propose TBW is a preferred option in revision cases with a highly comminuted proximal

segment, osteoporotic bone, or cases where limited bone stock preclude an attempt at plate fixation.

Allograft Reconstruction

Koso et al reports a technique of using a tendo-osseous allograft reconstruction (OTOA) as a revision option for failed olecranon fixation.[15] Three of the nine patients they reported on had olecranon fractures that were fixed with an OTOA. The technique, as reported by the authors, has very narrow indications and selected patients for whom standard treatment methods were unlikely to be successful, such as one with limited preoperative elbow flexion with triceps repair or reconstruction, one with failed triceps reconstruction, and another with loss of more than half of the articular surface of the greater sigmoid notch of the proximal ulna. Two of the three patients with olecranon fractures treated with this approach suffered serious complications such as deep infection, and gross instability with recurrent ulnohumeral dislocation. With these considerations, this technique remains an approach for those without additional options to restore function to the upper limb.[15]

Sotelo et al reports a technique of using an Achilles allograft for reconstruction of the triceps, which can be used in this situation as well. They report on seven patients, three of which received the tendo-Achillis allograft, and four of which received a rotational flap using the anconeus. Patients were indicated for the allograft if their anconeus muscle had been devitalized. Of the patients who received an allograft, no failures were reported, and all of the patients had good outcomes with return to daily activities without additional limitations.[16]

Olecranon Excision With Triceps Advancement

In cases with severely comminuted fractures, especially in elderly or osteoporotic patients, partial olecranon excision with triceps advancement serves as an alternative approach to LFP, TBW, or olecranon nails.[17] Nonsurgical management is also feasible for isolated displaced fractures in elderly patients with multiple comorbidities.[18] Although comparative data on triceps advancement versus other primary treatments are limited, biomechanical studies reveal decreased extensor strength regardless of positioning.[19,20]

Regarding fixation of the triceps brachii tendon in cases where triceps lengthening is necessary, V-Y and turndown techniques are available options. The V-Y plasty may lead to greater levels of postoperative pain, decreased elbow extension strength, and extension lag.[21] However, it is a simpler procedure when compared with the turndown technique and provides adequate length of the triceps aponeurosis along with good exposure required for reduction of the elbow joint.[21] The turndown (Van Gorder) technique involves using an allograft from the Achilles tendon or fascia lata following a transverse sectioning of the triceps.[22] This approach necessitates an additional surgical preparation, which may affect both the healing process and mechanical results at the elbow. Furthermore, this method requires much longer procedure time and elevates the risk of complications because of the extrasurgical site.[22]

Olecranon Nail With Allograft

As a combination of using both an olecranon nail and allograft reconstruction, this technique has shown some success in recent years at our institution. There is currently an ongoing study looking at outcomes in three patients who developed nonunion of the ulna and underwent repair using an olecranon nail with allograft. Preliminary data show very positive results with all patients reporting no complications 1 year postoperatively and great outcome scores; however, data are sparse, and this technique requires more exploration before it can be recommended. Current indications, advantages, and disadvantages are still being discussed; however, initial data are promising and warrant inclusion in the list of possible techniques. A summary of the advantages and disadvantages of the various revision approaches discussed is shown in Table 1.

Case Series: Olecranon Fractures Treated With Tension Band Wiring Revision

Methods

This retrospective case series was conducted at a level-1 trauma center. Patients aged 18 to 65 years who underwent revision fixation of olecranon fractures using tension band wiring were included from 2016 to 2018. Patients with pathologic fractures from neoplastic disease were excluded. Approval from the institutional review board was obtained.

Patients were considered as incomplete follow-up if clinical and radiographic outcome data were not

Table 1. Summary of Approaches for Revision of Failed Olecranon Fixation

Surgical Construct	Key Considerations and Indications	Advantages	Disadvantages	Additional Information
Nail/screw	Simple and complex fractures Robust fixation	Minimal extracortical profile	Elective implant removal rates remain high Limited data for revision settings	
Locking plate fixation	Unstable patterns Severe comminution Fractures involving the coronoid process	Achieves dynamic fracture site compression	Higher cost Higher risk of infection and revision	Implant -related symptoms may not differ markedly from TBW
Tension band wiring (TBW)	Simple transverse fractures	Allows early motion Lower cost Lower risk of infection and revision	Similar clinical outcomes to plate fixation in simple transverse fractures Similar range of motion at 6 months	TBW provides tensile forces preventing fracture fragment escape
Bony triceps advancement	Severely comminuted fractures, especially in osteoporotic or elderly patients In cases of failed plate fixation with residual proximal bone loss	Alternative approach when open reduction is unlikely to be successful May be an option without the need to restore primary proximal bone stock	Decreased extensor strength May lead to greater postoperative biomechanical restrictions in revision surgery	Comparative data on triceps advancement versus other methods lacking Consideration of interval healing and soft-tissue scarring in revision settings
Allograft reconstruction	Uses tendo-osseous allograft Useful for concomitant triceps or articular damage	Satisfactory outcomes in selected high-risk cases	High complication rates, infection, or instability Narrow indications	
Nonsurgical management	Isolated displaced fractures in elderly comorbid patients	Viable option in specific cases where surgery entails an excessive level of risk	—	—

available for a minimum of 12 weeks after surgery. Technical data on the fixation construct and the mechanical failures were collected from the postoperative radiographs and determined by two board-certified orthopaedic surgeons.

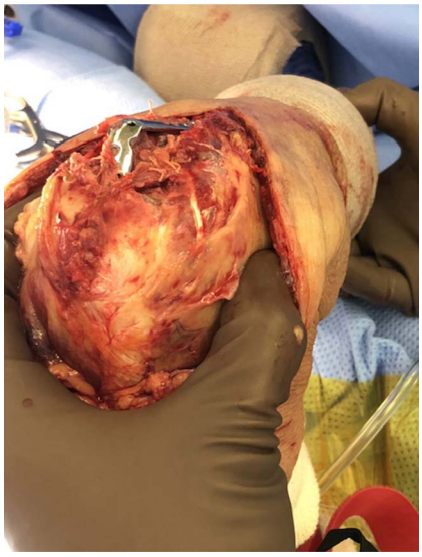
Surgical Technique

All patients underwent revision fixation of the olecranon using tension band wiring. Patients were positioned in a sloppy lateral position on a standard OR table. The posterior incision from the index procedure was used. The ulnar nerve was carefully dissected and protected. The previous implant was exposed as demonstrated in Figure 1. The fracture was reduced with forceps, and a tension band wiring construct was performed as per established techniques.[9,10] Specifically, for the insertion of our 1.0-mm wire, a 2.0-mm drill was employed to create a hole in the ulna approximately 40-mm distal to the fracture line and 5 mm from the posterior cortex. Using the same hole, a loop was fashioned with the wire approximately one third along its length. Two parallel 1.6-mm Kirschner wires were then inserted through the proximal end of the olecranon to the anterior cortex, maintaining proximity to the articular surface. Employing the 1.0-mm wire, a figure-of-eight configuration was crafted beneath the triceps tendon around the protruding ends of the Kirschner wires. The wire was united and tightened, and once appropriately tensioned, the Kirschner wire and 1.0-mm wire were cut and tamped down to prevent soft-tissue irritation, as illustrated in Figure 2. Stages of patient management are depicted in Figures 3–6.

Outcome Measures

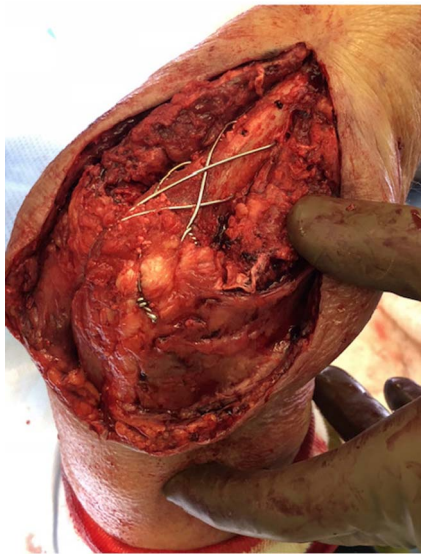
The primary outcome measure focused on mechanical implant failure, specifically defined as the mechanical

Figure 1



Intraoperative views demonstrating proximal ulna prior to complete plate removal.

Figure 2



Intraoperative views demonstrating proximal ulna after tension band wire placement.

breakdown of the tension band wiring (TBW) construct. Secondary outcome measures included nonunion (necessity for a subsequent surgical procedure to enhance healing), malunion (radiographic varus or valgus malalignment exceeding 5°, procurvatum or recurvatum malalignment exceeding 10° radiographically, or clinical rotational deformity exceeding 10°), postoperative surgical complications, perioperative medical complications, and postoperative functional status (assessed through parameters such as range of motion, use of assistive devices, and return to work).

Case Presentations

Case 1

A 67-year-old nonsmoking woman with a closed olecranon fracture initially underwent plate fixation. Fourteen days postoperatively, acute implant failure led to a TBW revision surgery, complicated by pin migration. The patient achieved union with a final motion arc of 30 to 110° and maintained 5/5 triceps strength.

Case 2

A 22-year-old nonsmoking woman presented with an open olecranon fracture, initially treated with plate fixation. Fourteen days later, acute implant failure necessitated a TBW revision surgery, accompanied by symptomatic implant complications. Despite challenges, the patient achieved union and demonstrated a motion arc ranging from 30 to 125°, maintaining 5/5 triceps strength.

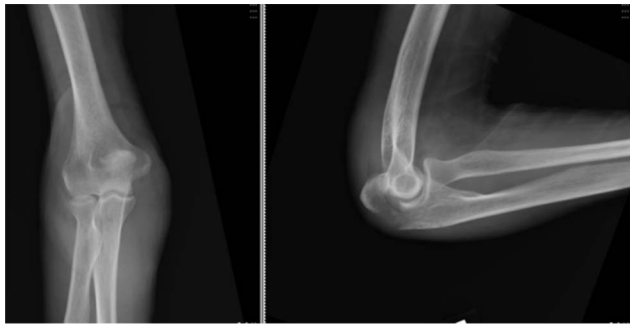
Case 3

A 54-year-old nonsmoking woman with a closed olecranon fracture developed an infected nonunion after initial plate fixation. After 38 days, a TBW revision was performed, ultimately resulting in union. The patient exhibited a motion arc of 5 to 135° and maintained 5/5 triceps strength.

Case 4

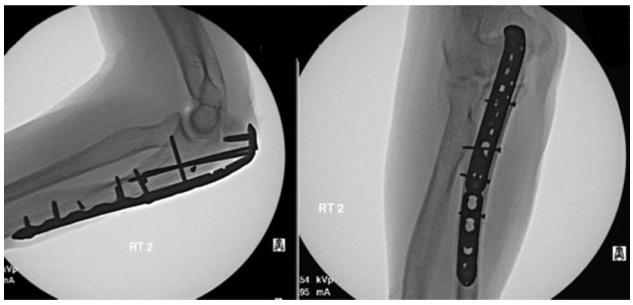
In a 73-year-old non-smoking woman with a closed olecranon fracture, an aseptic nonunion occurred following initial plate fixation. After 27 days, a TBW

Figure 3



AP and lateral elbow radiographs demonstrating proximal olecranon fragment migration prior to plate fixation.

Figure 4



AP and lateral elbow radiographs demonstrating proximal olecranon fragment migration post-plate fixation showing reduction of the proximal fragment.

revision was conducted, leading to union with a motion arc of 10 to 130° and maintaining 5/5 triceps strength.

Case 5

A 75-year-old woman with a 19-pack-year history of tobacco use presented with an open olecranon fracture. Eighty-six days after initial plate fixation, a TBW revision was performed due to an infected nonunion. The patient achieved union with a motion arc ranging from 15 to 130°, maintaining 5/5 triceps strength.

Results

Five patients treated from 2016 to 2018 at a university-based, urban, level-1 trauma center were included. Two of our five patients were referrals from an external facility, leading to a lack of detailed information on their initial fracture patterns or fixation constructs. All underwent removal of the previous plate fixation (n = 5) followed by revision surgery with tension band wiring. Causes for revision included acute implant failure (n = 2), aseptic nonunion (n = 1), and infected nonunion (n = 2). The average time for initial construct failure was 35.8 days (range 14 to 86 days). The average surgical time for TBW revisions was 119.2 minutes (range 102 to 133 minutes), with a mean estimated blood loss of 50.0 mL (range 50 mL).

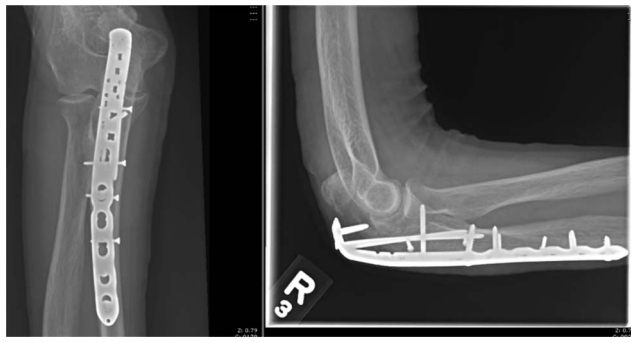
All patients eventually achieved radiographic and clinical union after revision. One patient required additional surgery because of Kirschner wire migration, achieving union at the last follow-up. Another patient underwent implant removal because of symptomatic implant. Average follow-up was 392.8 days (range 160 to 392 days), with restoration of extensor mechanism and full strength in all patients. No mechanical failures, surgical complications, or medical complications occurred. A comprehensive review of all patients can be seen in Table 2.

Discussion

Olecranon fractures present challenges for orthopaedic surgeons, with varied injury patterns and no established optimal treatment option in the revision setting.[1-4] Biomechanical stability and clinical outcomes for failed olecranon fixation treatments remain controversial.[5] This study evaluated five cases of olecranon fixation failures through revision using tension band wiring (TBW), resulting in successful radiographic and clinical union in all instances. The application of this technique demonstrated efficacy across diverse challenges, including acute implant failure, aseptic nonunion, and infected nonunion. Notably, patients exhibited favorable functional outcomes with an average arc of motion ranging from 18 to 126°, and they successfully resumed their previous working status within a mean follow-up time of 392.8 days (range 160 to 392 days).

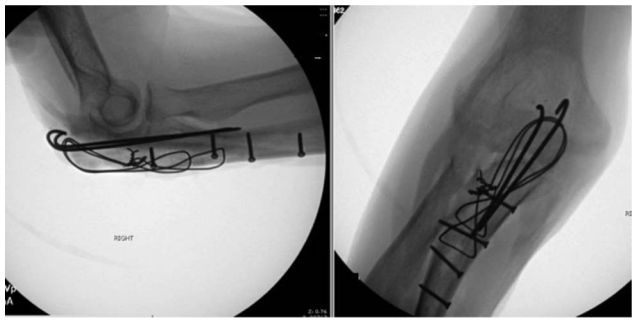
Although TBW is ideal for fracture patterns with well-preserved articular cartilage and good bone quality, our study showed that this technique may also be a viable, or even preferred, option in the treatment of failed olecranon fixation. The initial fixation before implant failure may contribute to interval healing at the articular surface to allow TBW despite initial fracture comminution. The ability of the tension band construct to translate the tensile forces of the posterior aspect into compression forces at the joint may also expedite healing in these situations. TBW allows for early postoperative rehabilitation to avoid stiffness, minimal implant prominence, and less soft-tissue handling/dissection.[10,11] Regardless of techniques, treatment should consider age, fracture pattern, bone quality, and soft-tissue injury to avoid implant failure, nonunions, and complications.[8,9] Risks of failures and nonunion

Figure 5



AP and lateral elbow radiographs demonstrating proximal olecranon fragment migration followed by migration of the proximal fragment.

Figure 6



AP and lateral elbow radiographs demonstrating final fracture union after tension band wire placement.

include surgical technique, quality of fixation and reduction, and distraction at the fracture site.[1-3] Also, complications associated with revisions of olecranon fractures include loss of motion, complex regional pain syndrome, ulnar neuropathy, mechanical failure, nonunions, and loss of extensor strength.[1-3] In this reported case series, no nonunions or implant failures were reported; however, one case of pin migration and symptomatic implant was also reported.

Cost is an important factor in decision making that is often overlooked.[13,23,24] Orthopaedic surgeons tend to markedly underestimate the cost of orthopaedic implants, with the error in cost estimation being higher with more expensive implants.[14] The average total cost of TBW surgery was found to be 2.6 times cheaper than plate fixation in treatment of displaced Mayo 2a olecranon fractures.[14] When the cost of TBW with implant removal was compared with the cost of plating without removal, the cost was still markedly less (181% cost difference).[14] With these considerations, TBW might be a preferred option for primary or revision olecranon fixation when considering cost and postoperative outcomes.

Although our clinical and radiographic outcomes are favorable, the literature regarding other revision techniques has been few. However, several studies evaluated chronic olecranon nonunions and their treatment outcomes. Papagelopoulos and Morrey[25] evaluated 24 patients with nonunion of olecranon fractures treated with different techniques—excision (1), plate fixation (16), and joint replacement (3). They found favorable outcomes with only nine patients reporting moderate pain, an average arc of motion of 98°, and union being achieved in 15 of the 16 patients treated with osteosynthesis. Also, Danziger and Healy[26] treated five chronic olecranon nonunions, four with tension band wiring, and one with plating and reported that all five achieved radiographic union with nearly full range of motion. From our review of the literature, our five patient sample represents the largest study of TBW used for revision of failed olecranon plate fixation.

Limitations inherent in this case series include its retrospective design and the restricted number of patients. Furthermore, the absence of a comparison group treated with an alternative technique restricts our ability to draw direct comparisons, necessitating reliance on historical data from the literature. Although our study comprised only five patients, the extended average follow-up duration of 392.8 days adds value to our findings. Notably, similar-sized studies in the past have yielded statistically significant results within comparable study populations.[2,7,8,10,17,27]

The existing literature on biomechanical and clinical outcomes associated with tension band wiring in the context of failed olecranon fixation is sparse. Despite these limitations, our study demonstrated successful bony union and

Table 2. Patient Demographics and Outcomes

Patient No.	Sex	Age (yr)	Tobacco Use	Fracture	Mode of Failure	Days Until TBW	Surgical Complications	Union	Arc of Motion (Degrees)	Triceps Strength
1	F	67	No	Closed	Acute failure	14	Pin migration	Yes	30-110	5/5
2	F	22	No	Open	Acute failure	14	Symptomatic implant	Yes	30-125	5/5
3	F	54	No	Closed	Infected nonunion	38	___	Yes	5-135	5/5
4	F	73	No	Closed	Aseptic nonunion	27	___	Yes	10-130	5/5
5	F	75	Previous 19 pack-year history	Open	Infected nonunion	86	___	Yes	15-130	5/5

favorable functional outcomes in all cases, accompanied by acceptable complication rates. The cost-effectiveness of our surgical technique positions it as a viable option in technically challenging scenarios. However, given the scarcity of literature addressing the management of these revisions, additional studies are warranted to elucidate the long-term clinical outcomes of tension band fixation following failed olecranon plate fixation.

Conclusion

In summary, this case series presents successful outcomes in the revision fixation of failed olecranon fractures using tension band wiring (TBW) as a technique. The study includes five cases demonstrating favorable results, including successful union and improved functionality. TBW stands out as a cost-effective and versatile option, proving particularly effective in challenging scenarios like acute failures and nonunions. Despite these promising findings, the limited availability of comparative data highlights the need for further research to establish the long-term efficacy of TBW in managing failed olecranon fixation, both in primary and revision settings. Although this study offers valuable insights into the potential of TBW, it emphasizes the necessity for more comprehensive investigations to solidify its role in these intricate revision cases.

References

1. Snoddy MC, Lang MF, An TJ, et al: Olecranon fractures: Factors influencing re-operation. *Int Orthopaedics* 2014;38:1711-1716.

2. Tarallo L, Mugnai R, Adani R, Capra F, Zambianchi F, Catani F: Simple and comminuted displaced olecranon fractures: A clinical comparison between tension band wiring and plate fixation techniques. *Arch Orthopaedic Trauma Surg* 2014;134:1107-1114.

3. Hak DJ, Golladay GJ: Olecranon fractures: Treatment options. *J Am Acad Orthopaedic Surgeons* 2000;8:266-275.

4. Nowak TE, Burkhart KJ, Andres T, et al: Locking-plate osteosynthesis versus intramedullary nailing for fixation of olecranon fractures: A biomechanical study. *Int Orthop* 2013;37:899e903.

5. Höchtl-Lee L, Spalteholz M, Raven TF, Moghaddam A, Friedl W: Long-term results of olecranon fractures treated using the XS NAIL system. *Chin J Traumatol* 2022;25:336-344.

6. Labrum JT, Foster BD, Weikert DR: Augmented intramedullary screw tension band construct for olecranon fracture reduction and fixation: A review of literature and surgical technique. *JSES Int* 2020a;4:470-477.

7. Duckworth AD, Clement ND, White TO, Court-Brown CM, McQueen MM: Plate versus tension-band wire fixation for olecranon fractures: A prospective randomized trial. *J Bone Joint Surg* 2017;99:1261-1273.

8. Oputa TJ, Plastow R, Kennedy J, et al: There is no difference in the complication or re-operation rates between tension band wiring and locking plate fixation for olecranon fractures. the findings of a multicentre study. *Arch Orthopaedic Trauma Surg* 2021;142:3341-3345.

9. Claessen FM, Braun Y, Peters RM, Dyer G, Doornberg JN, Ring D: Factors associated with reoperation after fixation of displaced olecranon fractures. *Clin Orthop Relat Res* 2016;474:193-200.

10. Villanueva P, Osorio F, Commessatti M, Sanchez-Sotelo J: Tension-band wiring for olecranon fractures: Analysis of risk factors for failure. *J Shoulder Elbow Surg* 2006;15:351-356.

11. Carter TH, Molyneux SG, Reid JT, et al: Tension-band wire fixation of olecranon fractures. *JBJS Essent Surg Tech* 2018;8:e22.

12. Takada N, Kato K, Fukuta M, Wada I, Otsuka T: Minimally invasive tension band wiring technique for olecranon fractures. *Tech Hand Upper Extremity Surg* 2013;17:199-201.

13. Lybrand KE, Althausen PL: The role of value-based implants in orthopedic trauma. *Orthop Clin North America* 2018;49:437-443.

14. Steadman JN, Stephens AR, Zhang C, Presson AP, Kazmers NH: Cost assessment of plating versus tension band wiring constructs for treating Mayo type 2A olecranon fractures. *J Hand Surg* 2022;47:311-319.

15. Koso R, Gabig AM, Brady CI, Dutta AK: Olecranon tendo-osseous allograft reconstruction for complex extensor mechanism and bone loss at the elbow. *J Hand Surg Am* 2023;49:e1-e1141.

16. Sanchez-Sotelo J, Morrey BF: Surgical techniques for reconstruction of chronic insufficiency of the triceps: Rotation flap using anconeus and tendo achillis allograft. *J Bone Joint Surg Br* 2002;84:1116-1120.

17. Edwards SG, Martin BD, Fu RH, et al: Comparison of olecranon plate fixation in osteoporotic bone: Do current technologies and designs make a difference? *J Orthopaedic Trauma* 2011;25:306-311.

18. Powell AJ, Farhan-Alanie OM, Bryceland JK, Nunn T: Treatment of olecranon fractures in adults. *Musculoskelet Surg* 2017;101:1-9.

19. DiDonna ML, Fernandez JJ, Lim T-H, Hastings H, Cohen MS: Partial olecranon excision: The relationship between triceps insertion site and extension strength of the elbow. *J Hand Surg* 2003;28:117-122.

20. Ferreira LM, Bell TH, Johnson JA, King GJW: Effect of triceps repair techniques following olecranon excision on elbow stability and extension strength: An in vitro biomechanical study. *J Orthopaedic Trauma* 2011;25:420-424.

21. Khanna V, Gupta A, Kumar S: Outcome of long standing ulno-humeral dislocation managed by open reduction and stabilization with V-Y plasty; our experience. *Bull Emerg Trauma* 2017;5:259-265.

22. Tirtosuharto H, Karna MB, Asmara AAGY, Meregawa PF: Open reduction, triceps lengthening, and collateral ligaments reconstruction in neglected elbow dislocation: A case report. *Int J Res Med Sci* 2020;8:4488-4492.

23. Kooner S, Hewison C, Sridharan S, et al: Waste and recycling among orthopedic subspecialties. *Can J Surg* 2020;63:E278-E283.

24. Ayoub M, Paul Bassett W, Seuffert P, Matijakovich D, O'Hara DA, Butler MS: Perception versus reality in the cost of orthopedic trauma implants. *J Surg Education* 2018;75:1333-1341.

25. Papagelopoulos PJ, Morrey BF: Treatment of nonunion of olecranon fractures. *J Bone Joint Surg Br* 1994;76:627-635.

26. Danziger MB, Healy WL: Operative treatment of olecranon nonunion. *J Orthopaedic Trauma* 1992;6:290-293.

27. Bailey CS, MacDermid J, Patterson SD, King GJ: Outcome of plate fixation of olecranon fractures. *J Orthopaedic Trauma* 2001;15:542-548.