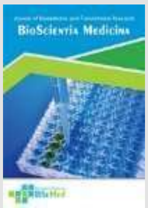
eISSN (Online): 2598-0580



Bioscientia Medicina: Journal of Biomedicine & Translational Research

Journal Homepage: www.bioscmed.com

Novel Application of a Modified Small T-Plate as an Internal Joint Stabilizer for Chronic Elbow Instability: Technique and Two-Year Results

Wiria Aryanta[1,2], Satria Putra Wicaksana[3*]

[1]Department of Orthopaedic Surgery, Dr. Mohammad Hoesin General Hospital, Palembang, Indonesia

[2]Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia

[3]Orthopaedic Residency Program, Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia

ARTICLE INFO

Keywords:
Chronic dislocation
Elbow instability
Internal joint stabilizer
Modified T-plate
Neglected injury

***Corresponding author:**
Satria Putra Wicaksana

E-mail address:
satriaputrawicaksana3@gmail.com

All authors have reviewed and approved the final version of the manuscript.

https://doi.org/10.37275/bsm.v9i6.1310

A B S T R A C T

Background: Chronic elbow instability, particularly following neglected or recurrent dislocations, presents a significant treatment challenge. Restoring stability while preserving functional motion is difficult, especially when standard internal joint stabilizers (IJS) are unavailable. We explored the use of a readily available small T-plate, modified intraoperatively, as a temporary internal hinge stabilizer. **Case presentation:** A 33-year-old male presented with chronic left elbow instability and functional impairment persisting for 14 years after an initial injury. Previous treatments, including traditional bone setting and K-wire fixation, had failed, resulting in recurrent dislocations. Surgical exploration revealed significant fibrosis and compromised ligamentous structures. Open reduction was performed, followed by stabilization using a modified small T-plate contoured to act as an internal hinge, maintaining the ulnohumeral joint space. The implant was removed after 4 weeks. At the 24-month follow-up, the patient exhibited excellent functional outcomes, with a stable elbow, substantial improvement in range of motion (Flexion-extension: 4.2°-129.2°; Pronation-supination: 80°), and an excellent Broberg-Morrey score, enabling pain-free daily activities. **Conclusion:** This case demonstrated that a modified small T-plate can serve as an effective, low-cost internal hinge joint stabilizer for managing complex chronic elbow instability, particularly in resource-limited settings. It facilitated early controlled motion, promoted stable fibrous tissue healing, and resulted in excellent long-term functional outcomes. This technique presents a viable alternative when standard IJS devices are not accessible.

1. Introduction

The elbow joint is a complex and crucial articulation, essential for the functionality of the upper extremity. As the second most commonly dislocated major joint in adults, its stability is paramount for daily activities and overall upper limb function. While acute elbow dislocations are frequently managed effectively through closed reduction, followed by a period of immobilization and subsequent early motion exercises, a subset of these injuries can progress to a state of chronic instability. Chronic elbow instability presents a considerable challenge for orthopedic surgeons. This condition is often the result of neglected initial injuries, inadequate primary treatment interventions, or complex fracture-dislocations that lead to substantial disruption of the osseous and ligamentous structures that stabilize the joint. In chronic cases, the native ligamentous components of the elbow, most notably the medial and lateral collateral ligament complexes, frequently exhibit attenuation, scarring, or functional incompetence. The presence of contracture in the surrounding soft tissues and the formation of intra-articular fibrous adhesions further complicate the efforts to achieve and maintain reduction and stabilization of the joint.[1-3]

Open reduction procedures are often necessary to address these impediments that affect both the intra-articular and periarticular structures. However, a significant challenge lies in achieving and subsequently maintaining a stable, concentric reduction of the joint following surgical release and any ligamentous repair or reconstruction that may be undertaken. The dilemma is further compounded by the fact that simple immobilization of the elbow joint after reduction carries a substantial risk of stiffness development, primarily due to the propensity of the joint to develop fibrosis in a position of fixation. Conversely, initiating early, unprotected motion may predispose the joint to recurrent instability. To navigate this complex clinical scenario, various stabilization strategies have been developed, which can be broadly classified into external and internal fixation methods. External fixators, which can be static or hinged, provide stability by spanning the joint from the exterior. Static external fixators, while simpler in their application, immobilize the joint and are associated with a high incidence of post-treatment stiffness, as well as complications such as pin-tract infections. Hinged external fixators offer the advantage of allowing controlled motion, which can potentially mitigate the risk of stiffness. However, they are still susceptible to pin-related complications and can be cumbersome and inconvenient for patients to manage. Furthermore, it is important to note that both static and hinged external fixators, particularly the more sophisticated hinged systems, can be expensive and may not be readily accessible in all healthcare settings, especially in resource-limited environments and developing countries.[4-6]

Internal joint stabilizers (IJS) have emerged as an alternative approach, offering the theoretical benefits of providing dynamic stability while simultaneously minimizing the risks associated with the use of external pins. Commercially available IJS devices typically function as an internal hinge, allowing for motion around a defined axis while effectively preventing joint subluxation or dislocation. Studies have reported promising outcomes with the use of IJS in the management of complex elbow instability. These studies suggest that IJS can potentially lead to improved motion and a reduction in complications when compared to external fixation techniques, although some research indicates that outcomes may be comparable, with internal devices potentially having higher rates of reoperation. However, similar to advanced external fixators, dedicated IJS implants represent a specialized technology, which translates to higher costs and limited availability in many regions of the world, including Indonesia. This limitation underscores the need to explore alternative, more accessible methods for achieving internal stabilization of the elbow joint. The fundamental concept behind internal stabilization, regardless of the method employed, is to provide temporary stability to the joint. This temporary stabilization allows for the formation of mature fibrous tissue around the joint, which, in turn, can confer long-term stability once the stabilizing implant is removed. In light of the limitations associated with commercially available IJS devices, we hypothesized that a standard orthopedic implant, such as a small T-plate, could be modified intraoperatively to function as a temporary internal hinge stabilizer. Small T-plates are widely available, relatively inexpensive, and orthopedic surgeons are familiar with their handling characteristics, making them a potentially viable alternative. The rationale is that by carefully contouring the plate and strategically placing screws, it could be used to bridge the ulnohumeral joint, effectively maintaining reduction while simultaneously allowing controlled hinge motion and preserving a small joint gap to prevent the formation of adhesions.[7-10] This case report details the novel application of a modified small T-plate as an internal hinge joint stabilizer in a patient who presented with a challenging case of chronic, recurrent elbow instability that had been subjected to multiple failed treatment attempts. We aim to describe the surgical technique employed, the post-operative management protocol, and present the clinical and functional outcomes observed after a 24-month follow-up period.

2. Case Presentation

This case report concerns a 33-year-old male patient who presented to our orthopedic department with a complex history of chronic left elbow instability. The constellation of symptoms and clinical findings revealed a long-standing and significantly debilitating condition, ultimately leading to surgical intervention. A thorough evaluation, encompassing demographic details, a detailed anamnesis, comprehensive physical examination, laboratory investigations, and imaging studies, was conducted to fully characterize the patient's pre-operative status. The patient was a 33-year-old male. This demographic information is essential for contextualizing the case, as age and gender can influence the etiology, presentation, and management of orthopedic conditions. In this instance, the patient's relatively young age underscores the potential impact of the chronic elbow instability on his long-term functional capacity and quality of life. The patient's medical history was significant for a primary complaint of persistent instability of the left elbow, which he described subjectively as a sensation of "giving way." This subjective report of instability is a cardinal symptom in elbow pathologies involving ligamentous insufficiency or joint incongruity. The patient also reported chronic pain associated with the affected elbow, a common sequela of chronic instability and repetitive injury. Crucially, the patient indicated a significant limitation of function that interfered with his daily activities and work. This functional impairment highlights the substantial impact of the condition on the patient's overall well-being and emphasizes the clinical necessity for effective intervention. Quantifying the functional limitations (e.g., using standardized functional scales) would have further strengthened this aspect of the report. The patient's history of injury dates back 14 years prior to presentation. The initial injury was attributed to a fall from a height, during which he landed with his body weight directly suppressing the left elbow. This mechanism of injury is important, as it suggests a high-energy trauma capable of causing significant damage to the complex osseoligamentous structures of the elbow. Such a traumatic event can lead to a spectrum of injuries, including dislocations, fractures, and ligamentous ruptures, either in isolation or in combination. Understanding the initial injury mechanism aids in comprehending the subsequent pathological processes that led to chronic instability. The patient's history of previous treatments is particularly noteworthy. Over the 14-year period following the initial injury, he had undergone multiple (>6) manipulations performed by traditional bone setters. These repeated manipulations, rather than resolving the underlying pathology, resulted in recurrent dislocations. This pattern of recurrent instability following manipulation strongly suggests that the initial injury was inadequately treated, leading to chronic ligamentous laxity or other structural damage that predisposed the joint to repeated dislocations. Traditional bone setting practices, while culturally relevant in some settings, may lack the precision and controlled reduction techniques of modern orthopedic management, potentially resulting in further soft tissue damage or malalignment. More recently, in February 2022, the patient underwent an open reduction and K-wire fixation procedure. This surgical intervention represents a more conventional orthopedic approach to addressing an elbow dislocation. Open reduction aims to anatomically realign the dislocated joint under direct visualization, while K-wire fixation provides temporary stabilization to allow for ligamentous healing. However, in this patient's case, the K-wires were removed after one month, which was followed by redislocation of the elbow joint. This relatively short duration of K-wire fixation may have been insufficient to allow for adequate ligamentous healing and subsequent joint stability. Alternatively, underlying ligamentous damage may have been too severe to be addressed by this method alone. The post-operative redislocation underscores the complexity of this case and the challenges in achieving stable reduction in chronic elbow instability. The reference to "Figure 2" likely indicates radiographic images demonstrating this redislocation, which would be crucial for a comprehensive understanding of the case. The patient's past medical history was notable for the absence of any other major comorbidities relevant to the elective surgical procedure planned for his elbow. This information is important for assessing the patient's overall surgical risk and potential for post-operative complications. The absence of significant comorbidities generally suggests a lower risk profile for anesthesia and surgery. The patient reported no known drug allergies. This is a critical component of the medical history, as it directly influences the choice of medications that can be safely administered during and after the surgical procedure. The patient's social history revealed that he was a non-smoker. Smoking is a well-established risk factor for delayed bone and soft tissue healing, as well as increased risk of post-operative complications such as infections. The patient's non-smoking status is a favorable prognostic factor for his surgical outcome and recovery. The pre-operative physical examination provided crucial objective findings that complemented the patient's subjective complaints and further characterized the nature and extent of his elbow pathology. The patient's general appearance was described as alert, oriented, and cooperative. He was in no acute distress, and his vital signs were stable. This overall assessment suggests that the patient was medically stable and capable of participating in the evaluation and management process. Stable vital signs are essential before proceeding with any elective surgical intervention. The left elbow inspection revealed an obvious deformity suggestive of posterior dislocation. This is a critical finding, as it provides visual confirmation of the joint incongruity. Posterior dislocation is the most common type of elbow dislocation, and the observation of a visible deformity is a strong indicator of this condition. The presence of healed surgical scars posteriorly indicates the patient's previous surgical intervention (open reduction and K-wire fixation). Mild diffuse swelling was noted around the elbow joint, which is a common finding in chronic elbow conditions, often indicative of ongoing inflammation or effusion. Notably, there were no signs of acute inflammation, such as marked erythema, warmth, or significant tenderness, which might suggest an acute infection or inflammatory process. Palpation of the left elbow revealed tenderness around the elbow joint line and the posterior aspect of the joint. This localized tenderness is consistent with ligamentous injury, capsular inflammation, or underlying bony pathology. Gross instability was elicited on stress testing, specifically with anterior-posterior and varus-valgus stress. This is a key finding, as it objectively demonstrates the clinical instability reported by the patient. Anterior-posterior stress testing assesses the stability of the ulnohumeral joint in the sagittal plane, while varus-valgus stress testing evaluates the integrity of the medial and lateral collateral ligament complexes, respectively. The elicitation of gross instability with these maneuvers confirms significant ligamentous insufficiency and abnormal joint mechanics. The range of motion (ROM) of the left elbow was severely limited. Active flexion-extension was restricted to a range of 0° to 38.2°. This represents a dramatic limitation in the normal arc of elbow motion, which typically ranges from 0° (full extension) to approximately 140-150° (full flexion). This severe restriction significantly impacts the patient's ability to perform activities of daily living that require elbow flexion and extension. Active pronation-supination was also significantly limited, estimated to be less than 50% of the normal arc. Normal pronation-supination allows for rotation of the forearm, enabling activities such as turning a doorknob or using a screwdriver. A limitation of this magnitude severely compromises the functional capacity of the upper extremity. The precise degree of limitation should ideally have been quantified and documented. The neurological examination of the left upper extremity revealed that sensation was intact in the distributions of the median, ulnar, and radial nerves distally. These three nerves provide sensory innervation to the forearm and hand. The finding of intact sensation is crucial, as it suggests that there was no significant nerve injury associated with the chronic instability or previous treatments. Motor function was difficult to fully assess due to the patient's pain and instability, but grossly intact finger and wrist motion was noted. While gross motor function of the hand and wrist was preserved, the inability to fully assess motor function due to pain and instability suggests that the underlying condition was significantly limiting the patient's ability to cooperate with a detailed motor examination. Further specific testing (e.g., manual muscle testing) after addressing the instability would have been beneficial. The vascular examination of the left upper extremity revealed palpable radial and ulnar pulses distally, with a capillary refill time of less than 2 seconds in the digits. Palpable distal pulses indicate adequate arterial perfusion to the forearm and hand. A capillary refill time of less than 2 seconds is within the normal range, further supporting adequate peripheral circulation. These findings are important for ruling out vascular compromise, which can occur in the setting of trauma or dislocation. Pre-operative laboratory investigations were conducted to assess the patient's overall health status and to screen for any underlying systemic conditions that might affect surgical planning or post-operative recovery. The complete blood count (CBC) was within normal limits. Specifically, hemoglobin, hematocrit, white blood cell count, and platelet count were all within the expected ranges. A normal CBC rules out anemia, infection, and other hematologic disorders. The basic metabolic panel was also within normal limits, with electrolytes and renal function tests falling within the normal ranges. Normal electrolyte levels are essential for proper cellular function, and normal renal function is crucial for drug metabolism and excretion. The coagulation profile, including prothrombin time (PT) and partial thromboplastin time (PTT), was within normal limits. Normal coagulation parameters are essential for preventing excessive bleeding during and after surgery. Inflammatory markers, including erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP), were within normal limits. Normal ESR and CRP levels suggest the absence of an acute inflammatory process. However, it's important to note that in chronic conditions, these markers may not always be elevated, even if there is ongoing low-grade inflammation. Radiographic imaging played a crucial role in confirming the clinical diagnosis and delineating the structural abnormalities of the elbow joint. Radiographs, specifically anteroposterior (AP) and lateral views (Lat), confirmed the presence of a chronic posterior dislocation of the ulnohumeral joint. This is a critical finding, as it objectively documents the persistent joint incongruity. The radiocapitellar joint congruency was also disrupted, indicating that the dislocation involved not only the articulation between the ulna and humerus but also the articulation between the radius and humerus. The disruption of both the ulnohumeral and radiocapitellar joints contributes to the overall instability and functional impairment. The radiographs showed no evidence of any acute fracture, which is important for surgical planning. The articular surfaces were described as "relatively smooth." This suggests that while there was dislocation and incongruity, there was no evidence of significant acute or severe chronic arthritic changes. However, the term "relatively smooth" is somewhat subjective, and a more detailed description of the articular cartilage status would have been beneficial. The reference to "Figure 1" likely indicates a specific radiograph image, which would provide a visual representation of these findings. Based on the comprehensive pre-operative evaluation, the patient received a clinical diagnosis of chronic, recurrent, post-traumatic posterior instability of the left elbow, following multiple failed conservative and surgical treatments. This diagnosis accurately reflects the complex and long-standing nature of the patient's condition, emphasizing the chronicity, recurrence, and post-traumatic etiology of the instability. It also acknowledges the previous treatment failures, which highlight the challenges in managing this particular case (Table 1)

This section delineates the comprehensive treatment strategy employed for the patient with chronic elbow instability, encompassing the pre-operative planning, the index surgical procedure, the immediate post-operative management, the implant removal procedure, the subsequent rehabilitation phases, and the follow-up assessments. This detailed account provides a thorough understanding of the interventions and the patient's progression throughout the treatment course. The treatment approach was initiated with meticulous pre-operative planning. The decision to proceed with open reduction and internal stabilization was driven by the patient's chronic, recurrent elbow instability, which had proven refractory to prior treatment modalities. Given the unavailability of standard internal joint stabilizer (IJS) devices, a strategic decision was made to utilize a modified small T-plate as an alternative internal hinge joint stabilizer. This planning phase is critical as it sets the stage for the entire surgical intervention, taking into account the limitations and available resources. The choice to use a modified T-plate reflects a creative solution to a complex problem, particularly relevant in resource-constrained settings where specialized implants may not be accessible. The index surgical procedure, performed in May 2022, was carried out under general anesthesia. General anesthesia ensured complete patient comfort and muscle relaxation, facilitating the complex surgical maneuvers required to address the elbow instability. Patient positioning and preparation were crucial for optimal surgical access and sterility. The patient was positioned in either a supine or lateral decubitus position, depending on the surgeon's preference and the specific requirements of the procedure. Standard sterile preparation and draping of the left upper extremity were meticulously performed to minimize the risk of surgical site infection. A tourniquet was applied to the upper arm. The use of a tourniquet aids in achieving a relatively bloodless surgical field, improving visualization and precision during the procedure. However, the duration of tourniquet use is carefully monitored to prevent complications. The surgical approach involved a posterior midline incision. Importantly, the previous surgical scar was incorporated into this incision to minimize additional skin trauma and optimize wound healing. Careful subcutaneous dissection was performed to protect the underlying soft tissues and neurovascular structures. The meticulous approach to the soft tissues is essential to minimize iatrogenic injury and optimize functional outcomes. Nerve management was a critical aspect of the surgical procedure. The ulnar nerve was identified proximally, carefully dissected, and protected throughout the procedure. A vessel loop was utilized to gently retract and safeguard the nerve. The ulnar nerve is particularly vulnerable in elbow surgery, and meticulous dissection and protection are paramount to prevent post-operative neuropathy. Joint exposure and debridement were performed to address the pathological changes within the elbow joint. A deep dissection was carried out through the triceps fascia, utilizing either a triceps-sparing or splitting approach, depending on the specific surgical considerations. The posterior elbow joint was exposed, revealing significant fibrosis and scar tissue tethering the joint. Extensive debridement of fibrous tissue and release of soft tissue contractures were performed. This step is crucial in chronic instability cases, as the accumulated scar tissue and contractures impede joint motion and contribute to instability. Thorough debridement is necessary to restore joint congruity and facilitate mobilization. Assessment of structures was conducted intraoperatively to evaluate the extent of ligamentous damage. Significant attenuation and fibrosis of the lateral collateral ligament (LCL) complex were identified. The medial collateral ligament (MCL) integrity was also likely compromised, although this was presumed rather than definitively confirmed. The articular surfaces were assessed after reduction to evaluate their condition and guide further management. Accurate assessment of the ligamentous structures is essential to determine the appropriate stabilization strategy. Joint reduction was achieved through meticulous surgical manipulation. Concentric reduction of both the ulnohumeral and radiocapitellar joints was achieved following the release of soft tissue contractures. Achieving and maintaining a concentric reduction is the primary goal of the surgery, as it restores the normal biomechanics of the elbow joint. Implant selection and modification were key elements of this novel surgical technique. A standard small T-plate, specifically a 3.5mm stainless steel T-plate, was selected. Intraoperative contouring of the plate was performed using plate benders to create an offset hinge shape. This intraoperative modification allowed the standard T-plate to function as a dynamic stabilizer, a crucial aspect of this technique. Implant placement was performed with precision to achieve the desired stabilization. The shaft of the "T" was fixed to the lateral aspect of the distal humerus, proximal to the joint line, using cortical screws (3.5mm cortical screws). The transverse ("head") portion of the T-plate was bent and positioned to articulate loosely over the proximal ulna, specifically in the lateral aspect/crista supinatoris area. This positioning acted as a stabilizing buttress/guide without rigid ulnar fixation. Importantly, a small joint gap was intentionally maintained. This strategic placement aimed to provide stability while allowing controlled motion, preventing excessive compression and promoting fibrous tissue healing. Stability and motion check were conducted intraoperatively to ensure the adequacy of the stabilization. Intraoperative assessment confirmed stable hinge motion in flexion and extension, without any subluxation or dislocation. The range of motion was checked and found to be between 0 and 120 degrees. This intraoperative assessment is crucial for verifying the effectiveness of the implant placement and ensuring that the desired range of motion is achievable. Wound closure was meticulously performed to minimize the risk of complications. The surgical site was thoroughly irrigated to remove any debris and reduce the risk of infection. A closed suction drain was placed to prevent hematoma formation. Layered closure of the fascia, subcutaneous tissue, and skin was performed using non-absorbable sutures. Layered closure promotes wound healing and minimizes the risk of wound dehiscence. Dressing and immobilization were applied to protect the surgical site and provide initial support. A sterile dressing was applied, followed by placement in a bulky soft dressing and a posterior plaster or fiberglass splint. The elbow was placed in approximately 90 degrees of flexion. This immobilization strategy aimed to provide initial stability while allowing for early controlled motion. Post-operative imaging, specifically AP and lateral radiographs, was obtained to confirm satisfactory joint reduction and appropriate placement of the modified T-plate construct. The reference to "Figure 3" likely indicates these post-operative radiographs, which serve as a baseline for subsequent follow-up assessments. The patient was admitted to the ward following the surgical procedure. The hospital stay involved close monitoring and management of post-operative care. The patient was discharged on post-operative day 3, indicating a relatively uncomplicated immediate post-operative course. Analgesia and medications were administered to manage post-operative pain and prevent infection. Intravenous and oral analgesics were provided for pain control. Prophylactic antibiotics were administered to reduce the risk of surgical site infection. Drain management involved the removal of the closed suction drain when the output decreased, which occurred on post-operative day 2. Early removal of the drain minimizes the risk of infection and promotes patient comfort. Initial mobilization was initiated with caution to promote early recovery while protecting the healing tissues. The posterior splint was maintained initially. Early, gentle active and passive range-of-motion (ROM) exercises were initiated shortly after surgery, within the first few days, under the supervision of physical therapy. These exercises focused on flexion and extension within a stable arc, as tolerated by the patient. Early controlled motion is crucial for preventing stiffness and promoting optimal functional recovery. Implant removal was planned and executed as a separate procedure. The timing of the implant removal was set at 4 weeks after the index surgery. This timeframe was likely chosen to allow for sufficient fibrous tissue formation to provide stability after implant removal. The procedure involved a second surgical intervention performed under appropriate anesthesia, either regional block or general anesthesia. The previous incision was utilized to minimize additional tissue trauma. The T-plate and screws were removed. Wound closure was performed meticulously to ensure proper healing. Rehabilitation following implant removal was divided into distinct phases, each with specific goals and exercises. Phase 1, spanning weeks 4-8 post-index surgery, focused on a gradual increase in active and passive ROM, including flexion/extension and pronation/supination. Continued protection from excessive loads was emphasized during this phase. Scar management was initiated to prevent adhesions and promote optimal tissue flexibility. Phase 2, encompassing weeks 8-12 post-index surgery, involved progressive strengthening exercises targeting the elbow flexors, extensors, forearm rotators, and grip. Continued ROM exercises aimed at achieving maximal functional range. This phase aimed to build strength and endurance, further enhancing functional recovery. Phase 3, extending from months 3-6 post-index surgery, involved advanced strengthening and endurance training. Gradual return to more demanding activities, including work simulation if applicable, was encouraged. Emphasis was placed on .the functional use of the elbow in everyday activities. The patient was followed up regularly to monitor his progress and ensure optimal functional recovery. At 6 weeks post-implant removal, approximately 10 weeks post-index surgery, the patient demonstrated good progress in functional recovery. Imaging studies, specifically radiographs, showed maintained concentric reduction of the elbow joint, indicating stability. During the period of 3-6 months post-index surgery, the patient attended regular outpatient visits, initially monthly and then bi-monthly. These visits involved monitoring ROM, stability, strength, and function. Continued physical therapy was provided as needed to optimize rehabilitation. At 12 months post-index surgery, a clinical assessment revealed a stable joint with improving function and minimal pain. Range of motion was assessed to track progress. The final follow-up, conducted at 24 months post-index surgery, demonstrated excellent long-term outcomes. Clinically, the patient reported no pain during daily activities, and the elbow joint was stable on examination. Functionally, the patient had regained excellent use of the left upper extremity. The range of motion was quantified, with flexion-extension ranging from 4.2° to 129.2°, representing a 125° arc, and pronation-supination totaling 80°. The functional score, as measured by the Broberg-Morrey Score, was excellent. Imaging studies, specifically radiographs, confirmed maintained concentric joint reduction and the absence of significant degenerative changes. The Broberg-Morrey score is a well-established tool that assesses pain and function after elbow injuries, with higher scores indicating better outcomes (Table 2).

3. Discussion

This case report presents an illustrative example of the complexities inherent in managing chronic elbow instability. The patient, a 33-year-old male, had endured 14 years of recurrent instability, a debilitating condition that had persisted despite multiple prior treatment attempts. These previous treatments included manipulations performed by traditional bone setters and a prior surgical intervention involving open reduction and K-wire fixation. The failure of these previous interventions underscores the challenging nature of this patient's condition and highlights the need for alternative treatment strategies in cases of chronic, recurrent elbow instability. The successful outcome achieved in this case, utilizing a novel modification of a standard small T-plate as a temporary internal hinge stabilizer, provides a basis for discussing the technique, the rationale behind its application, and its potential role in the treatment algorithm for such challenging cases.[11-13]

Table 1. Summary of patient's pre-operative clinical findings.

Feature	Details
Demographics	
Age	33 years
Gender	Male
Anamnesis (History)	
Chief complaint	Persistent instability of the left elbow ("giving way"), chronic pain, significant limitation of function interfering with daily activities and work.
History of Injury	Initial injury 14 years prior due to a fall from height, landing with body weight suppressing the left elbow.
Previous treatments	- Multiple (>6) manipulations by traditional bone setters over 14 years, resulting in recurrent dislocations. - Open reduction and K-wire fixation (February 2022). K-wires removed after 1 month, followed by redislocation (Figure 2).
Past medical history	no other major comorbidities relevant to elective surgery.
Allergies	No known drug allergies.
Social history	Non-smoker.
Physical examination (Pre-operative)	
General appearance	Alert, oriented, cooperative male in no acute distress. Vital signs stable.
Left elbow inspection	Obvious deformity suggestive of posterior dislocation. Presence of healed surgical scars posteriorly. Mild diffuse swelling. No signs of acute inflammation.
Palpation	Tenderness around the elbow joint line and posterior aspect. Gross instability elicited on stress testing (anterior-posterior and varus-valgus stress).
Range of motion	- Active Flexion-Extension: Severely limited to 0° - 38.2°. - Active Pronation-Supination: Significantly limited (estimated <50% of normal arc).
Neurological exam	- Sensation: Intact in the distributions of the median, ulnar, and radial nerves distally. - Motor: Difficult to fully assess due to pain and instability, but grossly intact finger/wrist motion.
Vascular exam	Palpable radial and ulnar pulses distally. Capillary refill < 2 seconds in digits.
Laboratory findings (Pre-operative)	
Complete blood count	Within normal limits (Hemoglobin, Hematocrit, White Blood Cell count, Platelet count).
Basic metabolic panel	Within normal limits (Electrolytes, Renal function).
Coagulation profile	Prothrombin Time (PT), Partial Thromboplastin Time (PTT) within normal limits.
Inflammatory markers	Erythrocyte Sedimentation Rate (ESR), C-Reactive Protein (CRP) within normal limits.
Imaging findings (Pre-operative)	
Radiographs (AP/Lat) (Figure 1)	- Confirmed chronic posterior dislocation of the ulnohumeral joint. - Radiocapitellar joint congruency disrupted. - No evidence of acute fracture. - Articular surfaces described as "relatively smooth".
Clinical diagnosis	Chronic, recurrent, post-traumatic posterior instability of the left elbow, following multiple failed conservative and surgical treatments.

Table 2. Summary of treatment procedure and follow-up.

Phase	Step / Aspect	Details
Pre-operative	Planning	Decision for open reduction and internal stabilization due to chronic, recurrent instability refractory to prior treatments. Plan to use a modified small T-plate as an internal hinge joint stabilizer due to the unavailability of standard IJS devices.
Surgical Procedure (Index Surgery - May 2022)		
	Anesthesia	General anesthesia.
	Positioning & Prep	Patient positioned (supine or lateral decubitus). Standard sterile preparation and draping of the left upper extremity. Tourniquet applied to the upper arm.
	Surgical Approach	Posterior midline incision, incorporating the previous surgical scar. Careful subcutaneous dissection.
	Nerve Management	Ulnar nerve identified proximally, carefully dissected, and protected throughout the procedure (with a vessel loop).
	Joint Exposure & Debridement	Deep dissection through the triceps fascia (triceps-sparing or splitting approach). Exposure of the posterior elbow joint. Encountered significant fibrosis and scar tissue tethering the joint. Extensive debridement of fibrous tissue and release of soft tissue contractures performed.
	Assessment of Structures	Intraoperative finding of significant attenuation and fibrosis of the Lateral Collateral Ligament (LCL) complex. Medial Collateral Ligament (MCL) integrity also likely compromised (presumed). Articular surfaces assessed after reduction.
	Joint Reduction	Concentric reduction of the ulnohumeral and radiocapitellar joints achieved after soft tissue release.
	Implant Selection & Modification	Standard small T-plate selected (3.5mm Stainless Steel T-plate). Intraoperative contouring using plate benders to create an offset hinge shape.
	Implant Placement	Shaft of the 'T' fixed to the lateral aspect of the distal humerus (proximal to joint line) with cortical screws (3.5mm cortical screws). Transverse ('head') portion bent and positioned to articulate loosely over the proximal ulna (lateral aspect/crista supinatoris area), acting as a stabilizing buttress/guide without rigid ulnar fixation. Intentionally maintained small joint gap.
	Stability & Motion Check	Intraoperative assessment confirmed stable hinge motion (flexion-extension) without subluxation or dislocation. Range checked (0-120 degrees).
	Wound Closure	Thorough irrigation of the surgical site. Placement of a closed suction drain. Layered closure of fascia, subcutaneous tissue, and skin (with non-absorbable sutures).
	Dressing & Immobilization	Application of sterile dressing. Placement in a bulky soft dressing and a posterior plaster or fiberglass splint with the elbow in 90 degrees of flexion.
	Post-operative Imaging	AP and Lateral radiographs confirmed satisfactory joint reduction and appropriate placement of the modified T-plate construct (Figure 3).
Immediate Post-operative Period		
	Hospital Stay	Admitted to ward. Discharged on post-operative day 3.
	Analgesia & Medications	Intravenous and oral analgesics for pain control. Prophylactic antibiotics administered.
	Drain Management	Drain removed when output decreased (Post-operative day 2).
	Initial Mobilization	Posterior splint maintained initially. Early, gentle active and passive range-of-motion (ROM) exercises initiated shortly after surgery (within first few days, supervised by physical therapy), focusing on flexion/extension within a stable arc, as tolerated.
Implant Removal		
	Timing	4 weeks after the index surgery.
	Procedure	Second surgical procedure performed under appropriate anesthesia (regional block or general). Previous incision utilized. T-plate and screws removed. Wound closure.
Rehabilitation (Post-Implant Removal)		
	Phase 1 (Weeks 4-8)	Focus on gradual increase in active and passive ROM (flexion/extension and pronation/supination). Continued protection from excessive loads. Scar management initiated.
	Phase 2 (Weeks 8-12)	Progressive strengthening exercises for elbow flexors, extensors, forearm rotators, and grip. Continued ROM exercises aiming for maximal functional range.
	Phase 3 (Months 3-6)	Advanced strengthening, endurance training. Gradual return to more demanding activities, including work simulation if applicable. Emphasis on functional use.
Follow-up (Figure 4)		
	6 Weeks Post-Implant Removal (~10 weeks post-index surgery)	Clinical: Good progress in functional recovery. Imaging: Radiographs showed maintained concentric reduction of the elbow joint.
	3-6 Months Post-Index Surgery	Regular outpatient visits (monthly then bi-monthly). Monitoring ROM, stability, strength, and function. Continued physical therapy as needed.
	12 Months Post-Index Surgery	Clinical assessment: Stable joint, improving function, minimal pain. ROM assessed.
	24 Months Post-Index Surgery (Final Follow-up)	**Clinical:** Pain: None during daily activities. Stability: Elbow joint stable on examination. Function: Excellent functional use of left upper extremity regained. **Range of Motion:** Flexion-Extension: 4.2° to 129.2° (125° arc). Pronation-Supination: 80° total arc. **Functional Score:** Broberg-Morrey Score: Excellent. **Imaging:** Radiographs confirmed maintained concentric joint reduction and absence of significant degenerative changes.

Figure 1. A radiograph in early pre operative shown a posterior dislocation without any fractures and smooth articular surface.

Figure 2. (A, B) after open reduction and transfixing K-wire, (C, D) recurrent dislocation in 2 months follow up after removal implant 1 month before.

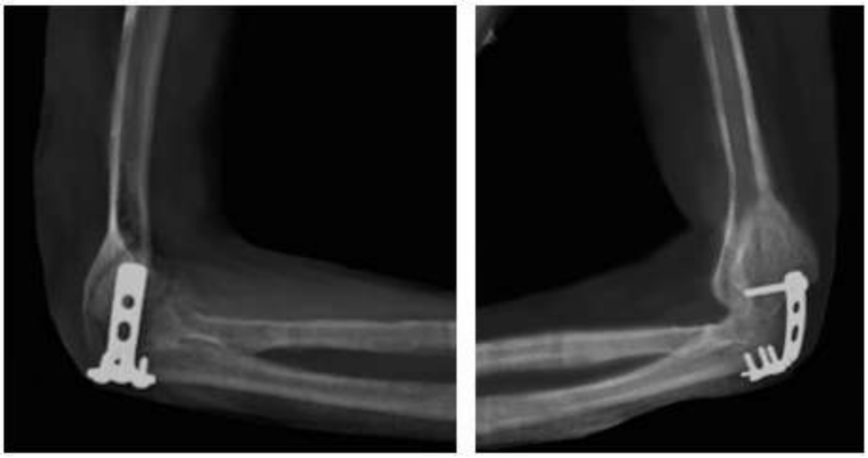


Figure 3. X-ray post operation.

Figure 4. (A, B) X-ray 6 weeks post removal internal joint hinge stabilization with modified small T-plate, (C, D) functional outcomes in early 2 months.

The primary objective in the treatment of chronic elbow instability is to achieve a stable and congruent joint. This stability is essential for allowing early motion, which is crucial in preventing the development of stiffness, a common and debilitating complication following elbow injuries and surgical interventions. Standard treatment options for addressing elbow instability often involve ligament reconstruction procedures. These reconstructions are frequently augmented with temporary stabilization methods, which can be broadly categorized as either external or internal fixation devices. External fixators, while effective in maintaining joint reduction during the healing process, are associated with a number of recognized drawbacks and potential complications. These complications include pin tract infections, which can be a source of significant morbidity and may require further interventions to manage. There is also the risk of nerve injury during the placement of external fixator pins, which can lead to sensory or motor deficits. Patients often experience discomfort associated with the presence of an external fixator, which can limit their mobility and impact their quality of life during the treatment period. Furthermore, the use of external fixators, particularly static fixators that rigidly immobilize the joint, carries the potential for residual stiffness. This stiffness can persist even after the fixator is removed and may require prolonged and intensive rehabilitation efforts to overcome. Reported reoperation rates for complications related to external fixation or for the management of post-treatment stiffness are significant in some series, highlighting the challenges associated with this treatment modality. Studies have reported reoperation rates as high as 29.6% in series utilizing static external fixation for chronic instability, and fixator-related complications have been shown to correlate with outcomes in a substantial proportion (26%) of patients treated with hinged external fixation. Internal joint stabilizers (IJS) were developed as an alternative to external fixation, with the aim of overcoming some of the limitations associated with external devices. IJS devices offer the theoretical advantage of providing dynamic stability, allowing for controlled motion at the elbow joint without the need for transcutaneous pins. This dynamic stability is intended to promote healing and reduce the risk of stiffness while still preventing excessive or unwanted joint movement. Several studies have demonstrated favorable outcomes with the use of commercially available IJS systems in the management of complex elbow instability scenarios. For example, a multicenter trial reported a mean flexion arc of 119° at 6 months following IJS removal, indicating a good degree of functional recovery. However, despite their potential advantages, these specialized IJS devices also have limitations. A significant limitation is their limited availability, particularly in many healthcare environments globally. This limited availability can restrict their use, especially in resource-constrained settings where access to advanced medical technologies may be limited. Furthermore, these devices often come with significant costs, which can further limit their accessibility and affordability. Cost comparisons between IJS and external fixation, for instance, have highlighted these differences, although some studies have found no significant difference in outcomes between the two treatment modalities.[14-17]

The technique described in this case report, involving the modification of a standard small T-plate, directly addresses the critical issues of accessibility and cost that often limit the use of specialized IJS devices. Small T-plates are ubiquitous in orthopedic practice, meaning they are widely available in most hospitals and surgical settings. They are also relatively inexpensive compared to specialized IJS devices, making them a more affordable option, particularly in resource-limited environments. Furthermore, orthopedic surgeons are generally familiar with the handling characteristics of small T-plates, as they are commonly used in various fracture fixation procedures. The modification of the T-plate is crucial to its function as an internal hinge stabilizer. The key aspects of this modification involve contouring the plate to create an offset hinge mechanism. This contouring allows the plate to provide stability against posterior translation of the ulna while simultaneously allowing for controlled flexion and extension movements at the elbow joint. Another important aspect of the technique is preserving a small joint space during implant placement. This intentional joint space preservation is crucial for preventing excessive compression of the joint surfaces, which could lead to stiffness or the development of adhesions. This temporary dynamic stabilization provided by the modified T-plate allows for the principle of "ligamentotaxis" or, more accurately, "fibrotaxis" to occur. Ligamentotaxis refers to the gradual reduction of a dislocated joint through the tension applied by surrounding soft tissues, while fibrotaxis describes the process by which fibrous tissue forms and aligns itself along lines of stress. By maintaining joint congruity and allowing for controlled motion during the critical healing period of several weeks, the traumatized and healing soft tissues surrounding the elbow joint, including the joint capsule and any remaining remnants of the native ligaments, can form organized fibrous tissue. This organized fibrous tissue can then assume a stabilizing role in the elbow joint after the implant is removed. The 4-week duration of implant placement before removal in this case appears to be consistent with the timeframe needed for initial soft tissue healing and the development of fibrous stabilization. However, it is important to acknowledge that the optimal duration of temporary stabilization may vary depending on individual patient factors and the specific characteristics of the injury.[18-20]

4. Conclusion

This case report demonstrates the successful application of a modified small T-plate as a temporary internal hinge stabilizer in a patient with chronic, recurrent elbow instability. This technique offers a viable and cost-effective alternative to specialized IJS devices, particularly in settings where these advanced implants are not readily available or are cost-prohibitive. The intraoperative modification of the T-plate allowed for the provision of dynamic stability, facilitating early controlled motion and promoting the development of stable fibrous tissue. The positive outcome in this case, with excellent functional results and a stable elbow at the 24-month follow-up, suggests that this technique can be a valuable tool in the management of complex elbow instability. The utilization of a widely available and familiar orthopedic implant, modified to address a complex joint problem, highlights the potential for innovation and resourcefulness in surgical practice. While this case report presents a single successful outcome, it provides a foundation for further investigation into the broader applicability and long-term efficacy of this technique. Further studies, including comparative trials and larger case series, would be beneficial to validate these findings and to define the optimal indications and parameters for the use of modified T-plates as internal joint stabilizers in elbow surgery.

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