

Advances in the Management of Varus Posteromedial Rotatory Instability (VPMRI) of the Elbow: The Role of Internal Brace Augmentation

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Article Info

Article Notes

Received: April 04, 2025

Accepted: June 10, 2025

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Keywords

Varus Posteromedial Rotatory Instability

Elbow

Management

Internal Brace Augmentation

Abstract

Varus posteromedial rotatory instability (VPMRI) of the elbow is a complex condition that results from a combination of bony and ligamentous injuries. Traditional treatment strategies often involve open reduction and internal fixation (ORIF) combined with primary ligament repair, necessitating postoperative immobilization to facilitate healing. However, prolonged immobilization can lead to joint stiffness, complicating rehabilitation. Recent advances have introduced internal brace augmentation as a potential solution to these challenges. This review article discusses the pathophysiology of VPMRI, traditional treatment approaches, and the emerging role of internal brace augmentation, with a specific focus on the study conducted by Greiner et al. which highlights the advantages of this technique in preventing stiffness and allowing early rehabilitation. Additional studies supporting internal bracing are reviewed, emphasizing its biomechanical benefits and improved patient outcomes.

Introduction

Elbow stability is maintained through a complex interplay between osseous congruency, ligamentous structures, and dynamic muscular support. Disruptions in this balance, particularly involving the anteromedial coronoid facet (AMCF) and lateral ulnar collateral ligament (LUCL), can lead to varus posteromedial rotatory instability (VPMRI). VPMRI is a relatively uncommon yet functionally debilitating condition that often results from high-energy trauma, such as falls on an outstretched arm¹.

Traditional surgical approaches for VPMRI focus on anatomical reconstruction of the injured structures, primarily through ORIF of the coronoid fracture and ligament repair². While these methods restore stability, the necessary postoperative immobilization often results in joint stiffness, limiting functional recovery. The study by Greiner et al.¹ introduces internal brace augmentation as an alternative strategy that enhances stability while allowing early mobilization, thereby mitigating stiffness and improving outcomes.

Pathophysiology and Diagnosis of VPMRI

VPMRI occurs due to a combination of ligamentous and osseous injuries, primarily affecting the anteromedial coronoid facet (AMCF), which provides anterior support to the ulnohumeral joint; the lateral ulnar collateral ligament (LUCL), a crucial stabiliser against varus stress; and the medial collateral ligament (MCL), which may also be involved in severe cases. Patients typically present with

pain, swelling, and mechanical instability. Diagnosis is confirmed through a combination of clinical examination and imaging, with MRI and CT scans being particularly useful in assessing soft tissue and bony injuries.

Traditional Treatment Approaches

Historically, treatment for VPMRI has included ORIF for coronoid fractures, primary ligament repair or reconstruction and temporary immobilisation to allow healing. While effective, these strategies necessitate restricted postoperative movement, often leading to complications such as joint stiffness and prolonged rehabilitation times². To address these limitations, internal brace augmentation has been introduced as an adjunctive technique.

Internal Brace Augmentation: A Paradigm Shift

Mechanism of Internal Bracing

Internal brace augmentation involves the use of non-absorbable suture tape to reinforce ligament repair and fracture fixation. This augmentation provides immediate mechanical stability, allowing for early mobilization while still protecting the healing tissues. The technical details are mentioned below:

Coronoid Reconstruction/Repair¹

All procedures can be performed using the Hotchkiss over-the-top approach. The coronoid fragments are to be exposed. Based on the condition of the fragments and the time elapsed since injury, a decision is to be made to either proceed with direct fixation or to reconstruct the coronoid using an iliac crest autograft. If the fragments are deemed suitable for fixation, they should be anatomically reduced, and then fixed. Final fixation can be achieved using an anatomically pre-contoured coronoid plate. In cases of non-union or fragment resorption, tricortical iliac crest autograft can be used to fill the defect, and secured to the coronoid using the same anatomically contoured plate and screws. Following fixation, the stability of the humeroulnar joint and the collateral ligaments needs to be evaluated intraoperatively to ensure optimal alignment and joint integrity.

Medial Collateral Ligament (MCL) Repair with Internal Bracing¹

Assessment of the MCL should be conducted intraoperatively during coronoid exposure. In cases where the ligament remained structurally intact, primary repair can be performed using 2-0 Vicryl sutures. If significant attenuation or rupture is present, internal bracing can be incorporated to augment the repair. The origin of the MCL at the medial epicondyle is to be identified and secured

using a 5.5 mm knotless suture anchor pre-loaded with FiberTape. The ligament can be reinforced by anchoring one limb of the FiberTape at 100° of elbow flexion to support the posterior bundle and the other limb at 30° of flexion for the anterior bundle. Fixation is achieved either at the sublime tubercle via a 3.5 mm knotless suture anchor or by securing the FiberTape directly to the coronoid plate. The ligament repair is performed in conjunction with capsular imbrication to optimize joint stability. Restoration of ulnohumeral joint congruity should be confirmed intraoperatively.

Lateral Ulnar Collateral Ligament (LUCL) Repair with Internal Bracing¹

Repair of the LUCL complex can be carried out according to established internal bracing techniques. A 3.5 mm knotless anchor or a 2.6 × 12.0 mm subcortical flipped titanium button is pre-loaded with 2 mm non-absorbable FiberTape and inserted into the ulna, distal to the radial neck, at approximately a 60° angle to the ulnar shaft. The FiberTape is to be passed superficial to the joint capsule and disrupted LUCL fibers, but deep to the common extensor origin and the anconeus muscle. The humeral attachment site -the isometric point on the lateral epicondyle is then identified. A pilot hole is drilled at approximately 30° to the long axis of the humerus, and threads tapped to accommodate a 5.5 mm knotless anchor loaded with the FiberTape and the residual LUCL sutures. The repair is aimed to reestablish lateral elbow stability and prevent posterolateral rotatory instability.

Key Findings from Greiner et al.'s Study¹

Greiner et al. conducted a study involving 17 patients treated for VPMRI with internal brace augmentation. The study reported an average follow-up period of 43 months with no significant postoperative contractures or any clinical signs of instability. There was complete radiographic healing of fractures/grfts without subluxation with a mean range of motion from 6.2° to 139.1° and an Oxford Elbow Score averaging 42.0, indicating good functional outcomes. These findings underscore the effectiveness of internal bracing in restoring stability while permitting early rehabilitation.

Major limitations of the study by Greiner et al.¹ is that it included a small number of patients (n=17); the selection criteria including age, gender or injury severity were not clearly explained and it lacked long-term follow-up data. Further studies with larger cohorts are required to strengthen the generalizability of their findings and also to assess the long-term efficacy and potential complications of Internal Brace Augmentation (IBA).

Table 1- Detailed Comparison of Studies on VPMRI and Elbow Instability

Study	Study Design	Sample Size	Methodology	Key Findings	Clinical Implications
Sun et al. (2025) ³	3D imaging and functional analysis	Not specified	Studied coronoid fractures in different elbow injury patterns using 3D imaging	Different coronoid fracture types influence elbow stability and treatment strategy	Provides better imaging-based fracture classification , aiding surgical planning
Zhang et al. (2025) ⁴	Literature review	Multiple studies reviewed	Summarized surgical options for coronoid fractures in VPMRI	Conservative treatment leads to higher complications; surgical intervention is recommended	Supports surgical over conservative management for better functional outcomes
Greiner et al. (2024) ¹	Retrospective clinical study	Not specified	Evaluated the use of internal brace augmentation for VPMRI	Internal bracing provides early rehabilitation and prevents stiffness ; helps in immediate stability while allowing ligament healing	Encourages the use of internal bracing as a primary stabilization method to facilitate early motion and reduce stiffness risk
Cho et al. (2024) ⁵	Retrospective case series	Not specified	Investigated radiographic findings, treatments, and outcomes in pure VPMRI cases	Early detection and intervention prevent chronic instability ; conservative treatment had higher failure rates	Highlights the need for early surgical intervention to prevent progression to chronic instability
Kang et al. (2024) ⁶	Prospective feasibility study	Not specified	Assessed the use of the hanging arm test intraoperatively for elbow stability in VPMRI	The test was safe and effective in assessing elbow stability intraoperatively	Recommends using the hanging arm test intraoperatively to decide if additional stabilization is needed
Kim et al. (2024) ⁷	Systematic review	Multiple studies reviewed	Compared outcomes of surgical vs. nonsurgical treatment of anteromedial facet fractures in VPMRI	Surgical fixation leads to better functional outcomes and reduces risk of instability	Reinforces that surgical fixation is superior to nonoperative treatment in VPMRI-related fractures
Reiter et al. (2021) ⁸	Cadaveric biomechanical study	9 cadaveric specimens	Compared medially placed internal joint stabilizer (MIJS) vs. static lateral external fixation (SLEF) for elbow stability	MIJS was as effective as SLEF in maintaining elbow stability after a coronoid fracture	Suggests MIJS as an alternative to external fixation , reducing complications associated with external hardware
McLean et al. (2018) ²	Retrospective clinical study	27 patients	Analyzed injury patterns and surgical experiences in acute VPMRI cases	Identified frequent associated injuries and the need for individualized surgical strategies	Suggests future studies should evaluate clinical and functional outcomes of different surgical techniques

Table 2- Comparative Analysis: Internal Bracing vs. Traditional Approaches

Feature	Traditional ORIF + Ligament Repair	Internal Brace Augmentation
Stability	Dependent on healing tissues	Immediate, reinforced
Rehabilitation Speed	Delayed due to immobilization	Early mobilization enabled
Risk of Stiffness	High due to prolonged restriction	Lower due to early motion
Functional Outcomes	Variable, often limited by stiffness	Generally improved

Key Takeaways from the Comparison

- Early surgical intervention is preferred** over conservative management for **VPMRI and coronoid fractures** to prevent chronic instability (Cho et al.⁵, Zhang et al.⁴ and Kim et al.⁷).
- Internal bracing (Greiner et al.¹) and medial internal joint stabilizer (Reiter et al.⁸) are effective alternatives** to external fixation, promoting early mobility and reducing stiffness.
- The hanging arm test (Kang et al.⁶) is a valuable intraoperative tool** for assessing elbow stability, helping surgeons decide on additional stabilization needs.

4. **Advanced imaging techniques (Sun et al.³) can refine surgical planning**, offering insights into coronoid fracture patterns and their effects on elbow function.

Study by Dugas et al. (2019)⁹ has supported the efficacy of internal brace augmentation in elbow stabilization and ligament repair: This research highlights the biomechanical advantages of internal bracing in ulnar collateral ligament repair, demonstrating its ability to enhance joint stability while preserving native anatomy.

Complications

Complications of Traditional methods as described by Mclean et al² are infection, contracture, prominent hardware, heterotopic ossification, adhesive capsulitis,

brachial neuritis, etc. Internal Brace Augmentation is a recently described technique and has limited published literature. In the study by Greiner et al.¹, complications were not identified. However, their small sample size and lack of long-term follow-up data are limiting factors.

Cost Effectiveness Analysis

As far as cost effectiveness is concerned, it relies on surgeons' discretion to use vicryl and non-absorbable sutures like ethibond for cost reduction instead of costly fibre wire and suture anchors. The main goal of internal bracing is to provide support to MCL and prevent rotatory instability by a non-absorbable sutures acting as a medial support.

Conclusion

Internal brace augmentation represents a significant advancement in the surgical management of VPMRI. By providing immediate stability and allowing for early rehabilitation, this technique addresses the limitations associated with traditional approaches, particularly joint stiffness. The study by Greiner et al.¹, along with additional supporting research, provides compelling evidence advocating for the broader adoption of internal bracing in clinical practice. Further studies including multicentric Randomised Control Trials along with long term functional assessments are needed to continue refining surgical techniques and expanding the applications of internal bracing in orthopedic surgery.

Conflicts of Interest

There are no conflicts of interest.

Funding

None.

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