Procedure

A Novel Technique in Treatment of Midcarpal Instability: Hammock Technique

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ABSTRACT

Background Midcarpal instability (MCI) is a relatively uncommon yet disabling condition that manifests with wrist pain, weakness, and diminished grip strength. Diagnosis is primarily clinical, supported by dynamic imaging modalities such as video fluoroscopy and 4D CT. Initial management typically involves non-operative measures including patient education, activity modification, pain control, dynamic splinting, hand therapy, and proprioceptive training. Surgical intervention is considered in cases refractory to conservative treatment.

Objectives To describe our novel "Hammock Technique" as a surgical method for the management of midcarpal instability (MCI). We outlines the detailed surgical steps of the procedure, defines its indications, and presents the standardized postoperative rehabilitation protocol. Furthermore, we highlight potential complications and discuss the technique's role within the current spectrum of treatment options for MCI.

Materials and Methods The Hammock Technique was developed to address ligament dysfunction and hyperlaxity in both the dorsal and palmar regions of the wrist, as well as around the scaphoid. This technique employs the palmaris longus tendon, incorporated with the wrist capsule, to achieve a "triple effect": (1) reinforcement of the dorsal ligaments, (2) hammock-like support for the proximal capitate and (3) stabilization of the scaphoid through fixation of its distal pole. It is particularly indicated for mild to moderate cases of midcarpal instability and can be effectively applied to both palmar and dorsal subtypes.

Results Application of the Hammock Technique demonstrated improved midcarpal stability, restoration of functional wrist motion, and enhanced grip strength in patients with mild to moderate MCI. Early outcomes suggest reproducibility and safety, with a low complication rate.

Conclusion The Hammock Technique represents a simple, biologically sound, and effective surgical option for the treatment of mild to moderate MCI. It can be applied to both palmar and dorsal subtypes, offering satisfactory stability and functional outcomes while preserving native wrist kinematics.

Keywords midcarpal instability, intrinsic, extrinsic, proprioception, videofluoroscopy, hammock technique, palmaris longus

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Historical Perspective

Midcarpal instability (MCI) is a rare condition that can lead to wrist dysfunction and pain. It was first described by Mouchet and Belot[1] in 1934, who referred to it as "snapping wrist." It was not until 1980 that MCI was recognized as a distinct clinical disorder.[2,3] Lichtman et al[2] were the first to describe a small series of patients presenting with MCI in 1981. Later, in 1984, Louis et al[3] reported a series of 11 patients with dynamic subluxation of the capitate over the lunate, referring to this pattern as "CLIP wrist" (capitate–lunate instability pattern). In 1986, Johnson et al[4] used the term chronic capitolunate instability (CCI) to describe a group of patients with clinical features similar to those seen in Louis et al's cases. Both CLIP wrist and CCI likely represent variations of dorsal midcarpal subluxation.[5] In 1994, Wright et al[6] identified patients with clinical features resembling MCI and classified this condition as carpal instability non-dissociative (CIND), with subtypes CIND-Volar intercalated segment instability (VISI) and CIND-Dorsal intercalated segment instability (DISI).

MCI is categorized into extrinsic and intrinsic instabilities. The intrinsic type includes palmar, dorsal, and combined forms, with palmar instability being the most common.[5] MCI is characterized by instability or dysfunction between the proximal and distal carpal rows, resulting from the loss or dysfunction of longitudinal ligament constraints. This loss leads to hypermobility of the proximal row relative to the distal row and the radius.[7]

The most common cause of MCI is generalized ligament laxity. However, it can also arise from acute trauma or chronic wrist overload, such as in paraplegic patients who rely heavily on their wrists for mobility.[8]

Palmar Midcarpal Instability

Patients with palmar midcarpal instability (PMCI) typically present with a volar sag at the midcarpal joint and a history of painful, spontaneous clunking during wrist ulnar deviation, accompanied by tenderness over the ulnar carpus.[5] Diagnosis is confirmed through a positive midcarpal shift test and videofluoroscopy.[2,9]

According to the ring concept of wrist kinematics, the two carpal rows function as a ring with two key links: The scaphotrapeziotrapezoid (STT) joint and the triquetrohamate (TH) joint. This system is supported by dynamic joint reactive forces, which facilitate reciprocal motion between the carpal rows. Radial deviation generates a flexion moment on the STT link, pushing the proximal row into flexion (physiologic VISI), while ulnar deviation produces the opposite effect, resulting in extension (physiologic DISI). In a stable wrist, smooth reciprocal movement occurs during the transition from radial to ulnar deviation, with gradual translation from physiologic VISI to physiologic DISI, driven by the activation of dynamic joint reactive forces.

In PMCI, during wrist ulnar deviation, ligament laxity allows the proximal carpal row to sag into volar flexion. This position persists due to the lack of engagement of dynamic joint reaction forces.[5,7] As the TH joint engages near the terminal phase of ulnar deviation, dynamic joint reaction forces are reactivated, resulting in a sudden shift of the proximal row from VISI to DISI, producing the characteristic "catch-up clunk."

Non-operative management is the first-line treatment for PMCI and includes patient education, pain management with analgesics, dynamic functional splinting, proprioceptive training, and activity modification. Surgical intervention is considered for persistent or severe cases and includes soft tissue procedures for mild to moderate instability and bone procedures for recurrent or advanced cases. While soft tissue procedures have been associated with variable success and limited long-term outcomes, bone fusion provides more consistent results but significantly restricts wrist motion, potentially impairing functionality.

Dorsal capsulodesis or reefing, which tightens the dorsal radiocarpal (DRC) ligament, is recommended by Niacaris et al[7] and Ming et al[10] for mild cases of PMCI. However, its outcomes are less favorable when compared with four-corner arthrodesis.[9] Efforts to strengthen the TH junction have also been explored. Ritt and de Groot[11] utilized a flexor carpi radialis brevis transposition fixed to the hamate, reporting 84% good outcomes at 6 years of follow-up. Chaudhry et al[12] reconstructed the dorsal TH ligament using a palmaris longus tendon, achieving 57% success over 2.5 years of follow-up.

Arthroscopic capsular shrinkage has been employed for mild cases of PMCI, yielding excellent results. Mason and Hargreaves[13] and Jing et al[14] reported a 100% recovery rate with only a 10% reduction in wrist motion after 42 months of follow-up in 15 wrists. A long-term follow-up of 12 years by Ricks et al[15] and Hargreaves[16] showed no significant deterioration, with 85% of patients maintaining excellent to good outcomes. In contrast, Ho et al[17] reported a lower success rate (60%) when arthroscopic capsular shrinkage was applied to the ulnocarpal and TH ligaments without addressing the DRC ligament.

For severe cases of PMCI or recurrent instability following failed soft tissue procedures, limited arthrodesis is a viable option. Among these, four-corner fusion is now the preferred technique due to its favorable outcomes.[9,10,18] Goldfarb et al[18] reported an 88% patient satisfaction rate with four-corner arthrodesis for PMCI. Similarly, Lichtman et al[9] achieved successful outcomes in all six patients treated with this procedure; however, a significant reduction in the flexion–extension arc was observed, decreasing from 135 to 75 degrees.

Radiolunate (RL) arthrodesis is emerging as an alternative, showing promising results while preserving a better range of motion (ROM). Halikis et al[19] performed RL arthrodesis in five patients, with one case of non-union, though all patients experienced resolution of the catch-up clunk. Garcia-Elias[20] reported on nine cases treated with RL fusion, with a mean follow-up of 19 months. One patient required revision surgery due to non-union.

Dorsal midcarpal instability (DMCI), caused by dynamic dorsal subluxation of the capitate from the lunate, is typically managed non-operatively through activity modification and proprioceptive training.[3] For refractory cases, volar capsular reefing has been reported as a successful surgical option by Johnson and Carrera.[20]

Indication

Our procedure is indicated for patients with MCI who have failed to improve with conservative management. We recommend a minimum of 6 months of conservative treatment, including splinting, proprioceptive training, analgesia, and activity modification, before considering surgical intervention. This technique can also be utilized in patients who have not achieved satisfactory outcomes with other soft tissue procedures, such as capsular reefing or capsular shrinkage. Additionally, we extend our indications to cases with localized cartilage defects over the carpal bones.

Contraindications for this procedure include advanced wrist osteoarthritis, generalized degenerative changes, and cases with irreducible subluxation.

Technique

Principle

Our technique, termed the "hammock procedure," utilizes the palmaris longus tendon in conjunction with the wrist capsule to achieve a triple effect. The tendon and capsule are employed to augment both the dorsal and palmar ligaments, provide hammock-like support to the proximal capitate, and enhance scaphoid stability by tightening the distal pole of the scaphoid. Additionally, the interpositional effect of the wrist capsule contributes to improved structural reinforcement and stability (**Fig. 1**).

Setup

The patient is positioned supine with the hand placed on a radiolucent arm table extension. Surgery is performed under axillary nerve block anesthesia, with a pneumatic tourniquet applied around the upper arm. A prophylactic dose of a first-generation cephalosporin antibiotic is administered 30 minutes prior to surgery. The shoulder holder is placed, and the arm is draped and prepared aseptically. Two finger traps are applied to the

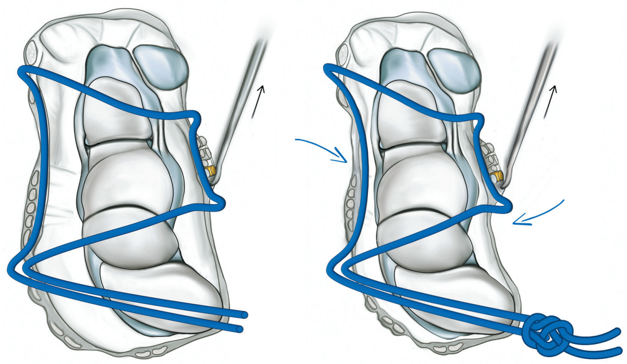

Fig. 1 Portals for arthroscopy. Schematic view showing the path and fixation of the palmaris longus tendon in the hammock technique.

index and middle fingers, and 10 lbs of traction is used, with a wide belt securing the arm for countertraction at the upper arm level.

A diagnostic arthroscopy is performed using a 2.7-mm 30-degree arthroscope through the 3–4, 6Radial, midcarpal ulnar (MCU), midcarpal radial (MCR), and STT portals to evaluate the radiocarpal and midcarpal joints. Synovitis is debrided, and any necessary releases are performed as indicated.

Exposure

The palmaris longus tendon is used as a graft for the procedure (**Fig. 2**). If the palmaris longus is unavailable, the plantaris tendon can be used as an alternative.

A volar incision is made, resembling an extended carpal tunnel approach, crossing the wrist crease in a zigzag pattern. The incision is made longer proximally than distally. The palmaris longus tendon is carefully dissected and harvested using a tendon stripper, ensuring a length of 8 to 10 cm.

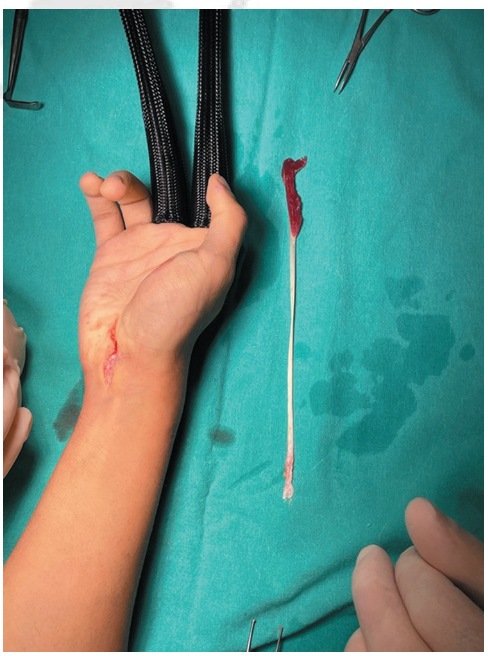

Fig. 2 Harvested palmaris longus tendon. Harvesting of the palmaris longus tendon graft through a volar wrist incision.

The transverse carpal ligament is partially released longitudinally to expose the contents of the carpal tunnel and the volar capsule of the midcarpal joint. We do not recommend a full carpal tunnel release, as it may exacerbate MCI.

Reconstruction

After retracting the contents of the carpal tunnel to the ulnar side using a Langenbeck retractor, an entry is made into the midcarpal joint through the volar capsule, using a syringe tip placed radially to the capitate. Fluoroscopy is employed to confirm the correct positioning within the midcarpal joint.

One limb of the palmaris longus graft is advanced into the midcarpal joint from the volar side, through the volar capsule, using a clamp to guide it to the previously confirmed location. The tendon is then retrieved dorsally at the wrist through the MCR portal using another clamp. The presence of the tendon within the midcarpal joint is confirmed via arthroscopy.

After passing the other limb of the graft under the carpal tunnel contents to the ulnar side (**Fig. 3A**), it is similarly advanced from the volar capsule, positioned ulnar to the capitate, and retrieved dorsally at the wrist through the MCU portal. The tendon retrieved from the MCU portal is then passed beneath the extensor tendons and over the dorsal capsule with the aid of a clamp, before being brought out through the MCR portal (**Fig. 3B, C**).

Next, the STT portal is created, and a clamp is inserted into the joint to form a tunnel dorsally through the capsule. One limb of the tendon exiting through the MCR portal is passed dorsally over the scaphoid and brought out through the STT portal. A second tunnel is created through the same STT portal, allowing the other limb of the tendon to be passed volarly over the scaphoid and brought out through the STT portal (**Fig. 3D**).

The two limbs of the graft, now exiting through the STT portal, are tied with appropriate tension and secured using polydioxanone suture (PDS) 3–0 sutures (**Fig. 3E**). The appropriate tension was determined intraoperatively under fluoroscopy by confirming realignment of the lunatum to its anatomical position without overtightening that could restrict wrist motion (**Fig. 4**). The skin is closed with 3–0 prolene sutures, and the wrist is dressed and placed in a wrist slab for immobilization.

Our Postoperative Protocol Inclusions

1. **Immobilization**
   - Weeks 1–3: The wrist is immobilized in a short arm cast to protect the surgical site and allow initial healing.
   - Weeks 4–6: After the cast is removed, the wrist is placed in a wrist splint for an additional 3 weeks to provide continued support while healing progresses.

2. **Finger Movement and Hand Therapy**
   - Immediately postoperatively, full active finger movement is encouraged to prevent swelling and stiffness in the fingers.

Fig. 3 (A–E) Step-by-step intraoperative images. (A) The other graft limb is passed ulnar to the carpal tunnel contents and retrieved dorsally through the MCU portal. (B, C) The tendon retrieved from the MCU portal is passed beneath the extensor tendons and over the dorsal capsule with a clamp and delivered through the MCR portal. (D) Through the STT portal, two capsular tunnels are created: One limb is routed dorsally over the scaphoid and the other volarly over the scaphoid, both exiting the STT portal. (E) The two limbs exiting the STT portal are tied with appropriate tension under fluoroscopic guidance and secured with PDS 3–0 sutures. STT, scaphotrapeziotrapezoid.

- Hand therapy is initiated early to promote circulation and prevent contractures.

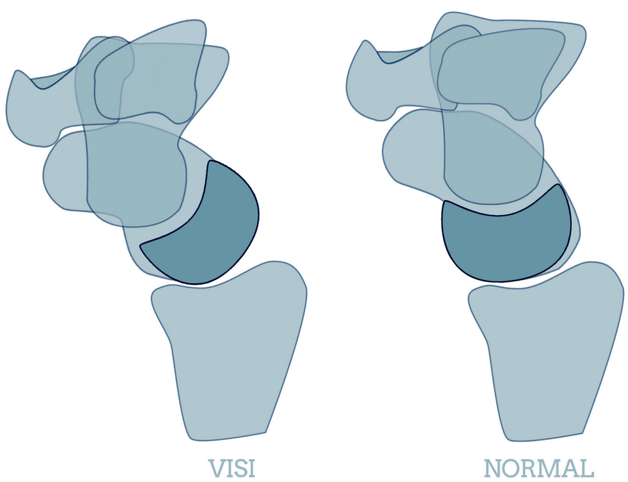

Fig. 4 Normal wrist alignment versus VISI deformity.

3. **Wrist Range of Motion**

   - Weeks 6–12: Active and active-assisted wrist ROM exercises are initiated with the assistance of a hand therapist to address wrist stiffness and maintain joint mobility.

4. **Weight Bearing and Rehabilitation**

   - Months 3–6: Gradual weight-bearing activities are introduced at around 3 months postoperatively, with gradual increases in weights and resistance exercises over the next 3 months to build strength and endurance.
   - The patient should progress cautiously, with guidance from the hand therapist, to ensure no excessive strain on the wrist during rehabilitation.

5. **Full Activity and Recovery**

   - By **1 year postoperatively**, the patient should expect to return to full activity, with restored strength and functionality of the wrist, assuming no complications. Regular follow-ups are necessary to monitor progress and adjust the rehabilitation program as needed.

This protocol may be modified depending on the individual's healing progress and the surgeon's recommendations.

Complications

Potential complications following the procedure may include

1. **Recurrence of symptoms and clunk**: There may be a return of instability symptoms, including pain, clunking, or catching sensations in the wrist, indicating that the instability persists or the surgical intervention was insufficient.
2. **Wrist stiffness**: Some patients may develop persistent stiffness in the wrist, particularly if ROM exercises are delayed or inadequate during the rehabilitation process.
3. **Extensor tendon injury**: Injury to the extensor tendons during the surgical procedure may result in functional impairment, affecting wrist and hand movement.
4. **Flexor tendon injury**: Damage to the flexor tendons can occur, leading to impaired flexion and potential weakness in the hand and wrist.
5. **Median nerve injury**: Although rare, inadvertent injury to the median nerve during surgery could result in sensory or motor deficits in the hand, such as numbness or weakness.
6. **Complex regional pain syndrome**: Complex regional pain syndrome, a chronic pain condition, can develop following surgery, leading to persistent pain, swelling, and changes in skin color and temperature in the affected limb.

Close monitoring during the postoperative period and adherence to rehabilitation guidelines are essential to minimize the risk of these complications.

Discussion

MCI is a rare but significant condition that can lead to wrist dysfunction and disability. The primary etiologies of MCI include ligamentous laxity, trauma, and chronic overload of wrist ligaments. However, there is ongoing debate regarding the exact ligaments involved in the development of MCI. Several studies have identified the DRC ligament and the ulnar arm of the palmar arcuate ligament (TH–capitate ligament) as key contributors to PMCI.[2,5,9,21,22] Additionally, other authors have highlighted the importance of the periscaphoid ligaments, particularly the anterolateral scaphotrapezium ligament, in the pathophysiology of PMCI.[7,23]

Research has demonstrated that sectioning of the dorsal and ulnar TH ligament (capsule) leads to only minimal midcarpal laxity and does not produce a characteristic clunk, further complicating the identification of the specific structures responsible for instability.[2] This suggests that the primary contributors to MCI may involve multiple ligaments working in concert, rather than a single dominant structure.

Moreover, there is considerable uncertainty regarding the specific ligaments responsible for DMCI. While some studies suggest that the DRC and related ligaments are involved, the precise mechanisms remain unclear and require further investigation to establish a consensus on the underlying pathophysiology.[23] Understanding the precise ligamentous contributions to both PMCI and DMCI will help refine diagnostic and treatment strategies for this complex condition.

Our novel technique utilizes the palmaris longus tendon to augment the dorsal wrist ligaments, support the proximal pole of the capitate, and obliterate the space of Poirier on the palmar side in a hammock-like manner. This approach also incorporates the periscaphoid ligaments during the final tightening phase, in combination with the wrist capsule. By addressing all potential ligamentous contributors to MCI, our technique is effective for both palmar and dorsal types of MCI.

A key feature of our technique is that it does not require the use of bone tunnels or drilling through the carpal bones. Instead, the procedure involves passing the tendon graft within the joint spaces with wrist capsule interposition, which may provide additional strength and stability while minimizing damage to the carpal cartilage. This approach preserves the integrity of the carpal bones and minimizes the risk of osteoarthritis or other long-term complications associated with more invasive procedures.

We recommend this technique for mild to moderate cases of MCI that have failed conservative treatments. It is applicable to all intrinsic types of MCI, including palmar, dorsal, and combined types. Furthermore, our technique may serve as a valuable surgical option for patients who have failed other soft tissue procedures, provided that the carpal instability remains reducible.

While long-term follow-up is essential to confirm the durability of this approach, we believe that the hammock technique offers a promising and effective treatment for patients with MCI who have not responded to non-operative interventions. This approach may provide a new surgical solution for managing MCI in this patient population.

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Statements and Additional Information

Conflict of Interest The authors declare that they have no conflict of interest.

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Ethical Approval This study was conducted in accordance with principles of the Declaration of Helsinki and its subsequent amendments. The research protocol was approved by the Atatürk University Faculty of Medicine Clinical Research Ethics Committee (IRB number: B.30.2.ATA.0.01.00/93). Written informed consent was obtained from all applicable patients.

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