Soft Tissue Stabilization for Palmar Midcarpal Instability Using a Palmaris Longus Tendon Graft

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Purpose To report the results of a technique of soft tissue stabilization for palmar midcarpal instability using a palmaris longus graft.

Methods In patients' symptomatic wrists with palmar midcarpal instability that had failed conservative management, we used a dorsal approach and stabilized the hamate and triquetrum by reconstructing the dorsal triquetrohamate ligament. The palmaris longus tendon graft was fixed with bone anchors. Seven wrists in 6 patients were available for follow-up at a mean of 28 months (range, 17–37 mo).

Results There was an overall meaningful improvement in function (mean preoperative Disabilities of the Arm, Shoulder, and Hand score, 49 preoperatively, 28 postoperatively). There was a significant increase in grip strength from 15 to 21 kg. At final follow-up, 2 patients had moderate pain. The others had mild or no pain. Four patients returned to their previous occupation or activity. Patients retained full pronation and supination. When compared with the normal side, flexion was reduced to 71%, extension to 81%, radial deviation to 90%, and ulnar deviation to 65% of the opposite side. Although the mean results show an improvement, one patient had a poor result with deterioration in Disabilities of the Arm, Shoulder, and Hand score in spite of a clinically stable wrist, and another had clinical evidence of recurrent instability during pregnancy. One patient had residual symptoms from a prominent bone anchor.

Conclusions Overall, this technique showed good medium-term results in most of our patients. It retained some midcarpal mobility, eliminated clunking in most patients, and provided a noteworthy improvement in grip strength and function. We continue to use this technique for patients with symptomatic midcarpal instability, but it requires further evaluation with larger patient numbers and a longer follow-up to assess its overall value. *(J Hand Surg Am. 2015;40(1):103–108. Copyright © 2015 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Therapeutic IV.

Key words Nondissociative, palmar, midcarpal, instability, stabilization.

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CARPAL INSTABILITY NONDISSOCIATIVE represents a spectrum of conditions characterized by kinematic dysfunction of the proximal carpal row. Midcarpal instability is a form of carpal instability nondissociative with instability between the proximal and distal carpal rows.[1] This is an uncommon and relatively poorly understood entity. Lichtman and Wroten classified midcarpal instability into intrinsic forms, consisting of palmar, dorsal, and combined types, and extrinsic forms, which result

from bone abnormalities outside the carpus, such as from a malunited distal radius fracture.[2]

In a normal wrist, the proximal carpal row moves smoothly from a slightly flexed position in radial deviation to an extended position in ulnar deviation. In palmar midcarpal instability, there is a loss of the smooth, coupled motion of the proximal and distal carpal rows with ulnar deviation. The proximal carpal row remains flexed, and the distal carpal row remains subluxed palmarly until near the end of ulnar deviation, when it suddenly extends, sometimes with an audible and/or a visible clunk. This phenomenon has been described using the term "the catch-up clunk".[3,4] Diagnosis is made by a positive midcarpal shift test, stress radiographs, and cineradiography. Biomechanical studies have implicated injury or laxity to the ulnar portion of the volar triquetral-hamate-capitate ligament (arcuate ligament) (Fig. 1) and the dorsal radiocarpal ligament as the cause for this phenomenon.[1]

In defining the pathomechanics of palmar midcarpal instability, researchers have tried to reproduce it in fresh cadaveric wrists. Although in cadaveric studies division of the ulnar portion of the arcuate ligament produced a similar clunk to that seen in palmar midcarpal instability, sectioning the triquetrohamate ligament also produced laxity.[5] We aimed to address the laxity of the triquetrohamate ligament with a soft tissue procedure.[6,7]

The initial treatment of symptomatic palmar midcarpal instability is nonsurgical, consisting of activity modification, nonsteroidal anti-inflammatory drugs, orthosis fabrication, and proprioceptive therapy. Evidence for operative treatment is limited mainly due to its rarity in clinical practice. Of the existing evidence, limited midcarpal arthrodesis appears to be the most successful surgical treatment, with high return to work rates and the elimination of midcarpal clunking. However, this procedure can lead to a painful radioscaphoid impingement.[6] It also results in loss of the natural midcarpal dart-throwing motion, which can eventually lead to a dorsolateral overload of the scaphoid fossa or progressive deterioration of the lunotriquetral joint.[8]

We propose that the pain associated with midcarpal instability results from the rapid dorsal translocation of the apex of the hamate, which is the terminal event in a positive midcarpal shift test. This may be directly stabilized with a soft tissue procedure aimed at preventing the painful dorsal clunk.

In this study we report on the outcomes of a technique of dorsal stabilization of the apex of the hamate for palmar midcarpal instability by reconstructing the dorsal capsule of the triquetrohamate joint using a palmaris longus tendon autograft.

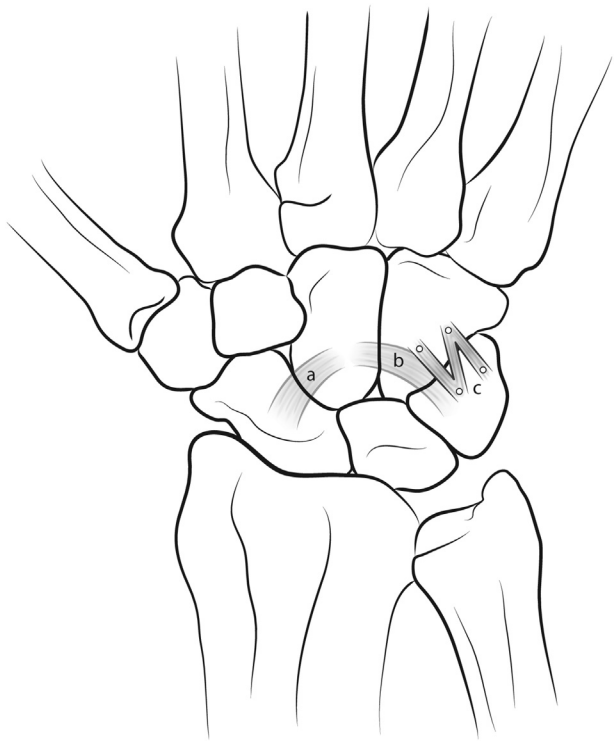

FIGURE 1: Schematic diagram of the dorsum of the wrist representing the position of the arcuate ligament on the volar aspect, in relation to the midcarpal joint with (*a*) the ulnar portion with attachments to the capitate, hamate, and triquetrum, and (*b*) the radial portion, or the scaphocapitate ligament, and (*c*) the 3 portions of the palmaris longus tendon graft arranged across the dorsum of the triquetrohamate junction.

MATERIALS AND METHODS

Informed consent was taken from all patients and the study complied with all necessary data protection / Health Insurance Portability and Accountability Act protocols. Institutional review board approval was not required at our institution.

This was a prospective study of 6 patients that underwent soft tissue stabilization for midcarpal instability over a period of 3 years. One patient had bilateral involvement. There were 5 women and 1 man. The mean patient age at time of surgery was 35 years (range, 24–42 y). The mean duration of symptoms prior to initial presentation to our hand unit was 18 months (range, 3 mo to 5 y).

All patients were initially assessed for signs and symptoms of instability. All patients complained of ulnar-sided wrist pain, and 3 patients had painful clicking of the wrist during normal usage.

Three patients had a definite history of a fall onto the affected hand prior to the onset of symptoms, and 1 had sudden onset of pain while lifting boxes. The remaining 2 had a more gradual onset of symptoms with no obvious precipitating cause identified. There were no clinical or radiological differences detected between those who had a traumatic event and those who had more insidious onset of symptoms, and all were treated in the same way. None of the injuries were work-related, and no patients were involved in compensation claims. All patients had initially undergone a trial of conservative measures that involved between 4 and 8 months of rest and oral analgesia and up to 6 weeks in an orthosis. None of our patients reported major improvement with this regimen.

Clinically, all patients had some tenderness over the ulnar side of the carpus. All patients had a positive Lichtman midcarpal shift test, which reproduced the symptoms. The grip strength was assessed with a dynamometer in the third position with the elbow flexed to 90° (JAMAR dynamometer, Asimov Engineering, Los Angeles, CA) and compared with the normal side. Range of movement was measured using a goniometer and compared with the normal side. Disability of the Arm, Shoulder, and Hand (DASH) scores were recorded preoperatively in all patients.

Initial x-rays taken were a standard posteroanterior view and a lateral wrist views. These were normal in all patients. None of the patients had a fixed volar intercalated segment instability deformity on x-ray.

Patients were selected for stabilization surgery if there was evidence of instability or pain with a positive Lichtman midcarpal shift test.[5] Any patients with additional evidence of scapholunate or lunotriquetral instability were excluded. All patients who were to undergo surgery had an ipsilateral palmaris longus tendon.

Follow-up examination

The DASH scores, range of movement, and grip strengths were determined at the final outpatient appointment. Patients were asked about their satisfaction with the procedure and return to work status and were asked to grade their pain as none, mild, moderate, or severe. Changes in DASH score and grip strength were analyzed using the Wilcoxon signed ranks test with significance set at $P < .05$.

Operative technique

At surgery, the palmaris longus tendon was identified and harvested using a standard tendon harvest technique.

The wrist was approached using a dorsal midline incision centered over the proximal carpal row between the third and fourth extensor compartments. Localized synovitis was present in 4 patients, but no specific ligamentous lesion was identified in any of the patients. There was no evidence of any osteophyte formation adjacent to the affected articulations or damage to any articular cartilage. Midcarpal instability was visualized with the capsule opened in all patients.

FIGURE 2: Postoperative lateral radiograph of the wrist showing the final position of the wrist and of the anchors used to secure the palmaris longus tendon graft.

The dorsal surfaces of the hamate and triquetrum were exposed using the approach described by Berger et al.[9] Two Mini Mitek anchors (Depuy Mitek, Inc., Raynham, MA) were placed on the dorsal surfaces in each bone (a total of 4 anchors were used, Figs. 2 and 3). The 3-0 braided nonabsorbable sutures were passed through the palmaris longus graft, and 3 limbs of the tendon graft were sutured down to each anchor in turn. The graft tension was set between each anchor and arranged in a zigzag configuration, as demonstrated in Figure 1. The wrist was in a neutral position with regard to both flexion-extension and radioulnar deviation. The most lateral limb tension was set first. The appropriate tension was determined when the graft held just enough tension to stabilize the triquetrohamate joint to prevent the rapid dorsal translocation of the apex of the hamate during an on-table midcarpal shift maneuver. If the tension was not enough to provide this stability, the

FIGURE 3: Postoperative posteroanterior radiograph of the wrist showing the final position of the wrist and of the anchors used to secure the palmaris longus tendon graft.

knot was revised. This was confirmed using on-table video fluoroscopy. The second and the third limbs tension were then set and sutured to allow sharing of the forces across the joint and to increase the security of the construct. No further tension setting was attempted. This arrangement allowed the overall force to be shared across multiple anchors. It also allowed distribution of forces across a larger area of the triquetrohamate articulation. Excess graft was trimmed, and the reflected dorsal capsular flap was sutured to the graft limbs with interrupted 3-0 absorbable sutures with the wrist in neutral flexion-extension and radioulnar deviation.

On-table fluoroscopy was performed and posteroanterior and lateral x-rays were taken to check the final position of the bone anchors.

Postoperatively, the wrist was immobilized in a below-elbow plaster of Paris cast for 1 week followed by a fiberglass cast for another 5 weeks. We did not use any form of temporary Kirschner-wire stabilization as an adjunctive measure. After 6 weeks, range of motion (ROM) and grip strengthening exercises supervised by a physiotherapist were instituted. A resting orthosis was used between periods of mobilization and during the night for a further period of 6 weeks. A typical postoperative x-ray appearance is shown in Figures 2 and 3.

RESULTS

The mean duration of follow-up was 28 months (range, 17−37 mo). Table 1 shows a summary of patient outcomes. Of the 6 patients who underwent the procedure, 4 patients were able to return to his or her previous activities or occupation. This included the patient with bilateral procedures. One patient failed to return to a manual occupation due to wrist pain on ulnar deviation, and another patient who was satisfied with the surgery failed to return to manual work due to ipsilateral tennis elbow. Overall, 3 patients had some degree of wrist pain with certain activities postoperatively. There was an overall improvement in function (mean preoperative DASH, 49, postoperative DASH 28, $P < .05$). Mean grip strength increased gradually over the postoperative period and at final follow-up had increased from a mean of 15 kg preoperatively to 21 kg postoperatively ($P < .05$). After excluding the patient with both wrists treated, the mean final grip strength was 55% (22%−104%) of the normal side. The final range of movement achieved is shown in Table 2 and is expressed as a percentage of movement on the unaffected side. Whereas preoperative motion was equal bilaterally, postoperative wrist motion was decreased. Both ulnar deviation and flexion showed greater limitations than other movements. Both were typically worse in patients who had residual pain at follow-up. Pronation and supination were unaffected.

Complications

Of the 3 patients with residual pain, 1 had irritation from a prominent bone anchor that had backed out of the bone during the early postoperative period. One patient was initially making a good recovery but developed recurrent instability during a pregnancy and is currently awaiting a midcarpal arthrodesis. One patient had residual pain on ulnar deviation without instability at her 2-year follow-up but returned to work as typist with some workplace modifications. These last 2 patients were unsatisfied with the procedure and stated that their dissatisfaction was due to moderate pain that was limiting activity.

DISCUSSION

Since Lichtman's initial report, numerous authors have described palmar midcarpal instability, a condition marked by asynchronous motion at the midcarpal joint in the absence of dissociation within the proximal carpal row.[5,10,11] The proximal carpal row lacks any tendinous attachments, and thus with any instability it can assume a flexed or extended posture.

TABLE 1. Patient Outcome Summary

Patient No./Side	Dominance	Preoperative DASH	Postoperative DASH	Pain	Return to Previous Occupation?	Satisfied With Surgery
1 Left	Left	58	67	Moderate	No	No
2 Right	Right	41	6	None	Yes	Yes
3 Left	Right	53	27	Mild	Yes	Yes
3 Right	Right	50	20	Mild	Yes	Yes
4 Right*	Right	47	36	None	No	Yes
5 Left	Right	32	10	None	Yes	Yes
6 Right	Right	62	27	Moderate	Yes	No

*Patient developed ipsilateral chronic tennis elbow that has limited her function and prevented return to work despite a good result from her wrist stabilization.

TABLE 2. Wrist ROM

Measurement	Percentage of Normal Side* (Range)
Supination	100
Pronation	100
Flexion	71 (38–90)
Extension	81 (70–100)
Radial deviation	90 (70–100)
Ulnar deviation	65 (30–100)

*One patient had both wrists operated upon and ROM was compared with her preoperative range.

A number of investigators have sought to identify the etiology of palmar midcarpal instability. Lichtman et al[5] divided the ulnar limb of the arcuate ligament and found that in 23 cadaveric specimens this exaggerated the dorsal prominence of the capitate with ulnar deviation. Trumble et al[12] were able to recreate a midcarpal instability pattern in 22 cadavers by creating an instability between the hamate and triquetrum (by dividing the ulnar limb of the arcuate ligament) and the lunate and triquetrum (by dividing the lunotriquetral ligament). They found that repair of the ulnar portion of the arcuate ligament and the lunotriquetral ligament improved the volar intercalated segmental instability position, and in some specimens, repair of the arcuate ligament alone was sufficient to improve the position of the lunate.

Other authors have highlighted a possible role for other ligaments, including the dorsal radiocarpal ligament[13] and the capitotriquetral ligament.[14]

Overall, understanding of the specific pathology of palmar midcarpal instability remains incomplete, although several authors have reported results of soft tissue treatment aimed at correcting the instability.

Lichtman et al described 9 patients who underwent soft tissue procedures with midcarpal instability, addressing the ulnar portion of the arcuate ligament as a part of the procedure.[6] Results were poor in 6 of the 9 patients, and the painful clunk returned in 5.[6] Garcia-Elias has described a method using the extensor carpi radialis brevis to reconstruct the triquetral-hamate-capitate ligament and the dorsal radiocarpal ligament, but the outcome from this procedure is uncertain.[8] Wright et al[15] performed various soft tissue stabilization procedures on 34 patients with carpal instability nondissociative and reported good or excellent results in 56% of patients. The variety of surgical procedures used makes evaluation of results difficult.

The poor results of soft tissue procedures has led many to advocate arthrodesis as a more reliable treatment that serves to eliminate instability by eliminating ulnar-sided motion between the proximal and distal rows.

Rao et al[16] reported on 10 patients who underwent triquetrohamate arthrodesis and found that pain was eliminated in 7 and clunking eliminated in all 10, but only 4 had a successful outcome overall. Lichtman et al[6] reported the results of 3 patients with triquetrohamate arthrodesis as part of a larger series. All 3 were initially reported as successes, but longer-term follow-up revealed possible dorsal radial-sided problems of crepitus and clicking.

Four-corner arthrodesis has been used in a number of series with good results reported by some authors.[6,11] Goldfarb et al[11] reviewed 8 patients who underwent four-corner arthrodesis for midcarpal instability and found that 7 out of 8 were satisfied and 6 had mild or no pain. They found that wrist movement was significantly affected with a reduction in the flexion-extension arc from 135° to 75°.

Our study represents a variation of soft tissue stabilization for palmar midcarpal instability. We feel that sudden dorsal relocation of the hamate, which is the terminal event in the Lichtman midcarpal shift test, causes the associated painful clunk.[5] We have used a palmaris longus tendon graft to reconstruct the dorsal triquetrohamate capsule to stabilize the excessive motion seen between the hamate and triquetrum. We feel that this technique eliminates the catch-up clunk, which in turn gives symptomatic relief to these patients. Our technique does not attempt to reconstruct the arcuate ligament or reduce the volar intercalated segmental instability that may be present in some of these patients.

Although we do not know exactly how the palmaris longus graft will respond to the different stresses placed upon it at the triquetrohamate junction, we postulate that it may undergo a similar biological process documented in other tendon grafts such as those used in anterior cruciate ligament reconstruction.[17]

Our patients were a group of healthy young adults, all of whom had failed a trial of conservative management. Five of our 6 patients (7 wrists) were satisfied, and 5 returned to their previous activity or occupation. Four patients (5 wrists) had either no pain or minimal pain. Preoperative and postoperative DASH scores improved to varying degrees in all but one patient, and the overall improvements in grip strength and outcome scores were significant.

The theoretical benefit of soft tissue stabilization over arthrodesis is a greater preservation of wrist motion, which our results showed except for loss of ulnar deviation and flexion.

Our data showed comparable or better outcomes than limited wrist arthrodesis in terms of complications and patient satisfaction while preserving more wrist motion. It also compared preoperative and postoperative outcome scores to make a more objective assessment of functional improvement following surgery.[11,16]

We had 3 complications in this series of 7 procedures. Although this compares favorably to other series examining both arthrodesis and soft tissue stabilization, it is nevertheless a high rate and one that we would hope would improve with added experience.[6,15,16] Setting tension of the graft may be one area where greater consistency can be achieved. Too much tension may account for the ulnar-sided wrist pain that some patients experienced as well as the anchor pull-out seen in one patient.

The limitations of our study include the small number of cases and the relatively short follow-up. We are currently developing a larger series with longer follow-up to confirm the benefits of our early results.

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