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Case Report

A novel staged wrist sensorimotor rehabilitation program for a patient with triangular fibrocartilage complex injury: A case report



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ABSTRACT

Study Design: Case report.

Introduction: Studies have highlighted the sensory innervations and stabilizing role of forearm muscles on wrist joint and implications to wrist sensorimotor rehabilitation. This case explored the novel incorporation of dart-throwing motion and proprioceptive neuromuscular facilitation in wrist sensorimotor rehabilitation.

Purpose of the Study: To describe and evaluate a staged wrist sensorimotor rehabilitation program for a patient with triangular fibrocartilage complex (TFCC) injury.

Methods: The patient participated in the staged program for 9 sessions over a 3-month period. Treatment involved neuromuscular strengthening at the wrist and movement normalization of the upper extremity. Outcome measures were grip strength, visual analog scale, joint position sense, Quick Disabilities of the Arm, Shoulder and Hand, and patient-rated wrist evaluation.

Results: The patient showed improvement in all outcome measures. Most outcomes exceeded the established minimal clinically important difference values.

Discussion: The results suggest that dart-throwing motion and proprioceptive neuromuscular facilitation are beneficial in rehabilitation of TFCC injury.

Conclusions: This is the first study that incorporated dart-throwing motion and proprioceptive neuromuscular facilitation in the sensorimotor rehabilitation of TFCC injury and yielded promising results. There is a need to further evaluate the program in prospective randomized controlled trial recruiting a larger group of patients with TFCC injury.

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Introduction

A stable and pain-free wrist is pertinent in the performance of daily activities. For a stable wrist, the ligaments, joint capsule, and bony articulations contribute to the static stability of the wrist, whereas joint proprioception and neuromuscular control of the muscles crossing the joint contribute to its dynamic stability in response to movements.¹

The human sensorimotor control system comprises kinesthesia, joint position sense (JPS), and neuromuscular control.^{2,3} Kinesthesia and JPS are conscious aware of the joints through feedback from the mechanoreceptors present in the wrist joint and its ligaments.^{2,4} Neuromuscular control involves subconscious control of the joint through reflex responses at the spinal cord for immediate joint stability and subsequent regulation of muscular activity at the cerebral level.^{2,4}

After a wrist ligament injury, the sensorimotor control and neuromuscular reflex pattern is altered.^{2,5} In a ligament-deficient wrist, neuromuscular stabilization within the wrist must be inherent for wrist stability. Previous studies have illuminated the stabilizing role of different forearm muscles on carpal stability in various ligament-deficient wrists.⁶ With adequate wrist sensorimotor control, contractions of specific stabilizing muscles can enhance dynamic stability of the wrist.^{6,7}

In a triangular fibrocartilage complex (TFCC) injury, strengthening of extensor carpi ulnaris (ECU) and pronator quadratus (PQ) stabilizes the distal radioulnar joint (DRUJ).⁸ The PQ contributes to the stability of the DRUJ due to its insertion on the DRUJ capsule, which tightens the capsule during its contraction,⁹ whereas contraction of ECU is hypothesized to stiffen the ulnocarpal joint, hence increasing stability.¹⁰

Sensorimotor interventions in musculoskeletal disorders have been known to reduce injury risks.¹¹ Hagert² and Karagiannopoulos and Micholovitz⁸ have concluded in their reviews that there is value of sensorimotor rehabilitation after wrist trauma. The

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sensorimotor retraining in other joints, such as the ankle or the shoulder, is a standard component in the rehabilitation of joint stability.^{12,13} However, with regard to the wrist joint, there is a dearth of evidence on the efficacy of sensorimotor rehabilitation. Coupled wrist motions, such as dart-throwing motion (DTM), have been found to enhance sensorimotor control and stability of the wrist in scapholunate ligament injuries.^{14,15} These motions are associated with performance of daily functional tasks and are useful parameters of wrist function.¹⁶ Therefore, incorporating DTM exercise in the rehabilitation of TFCC injury could be beneficial in enhancing the dynamic stability of the wrist in daily functional activities, on top of specific strengthening of PQ and ECU for dynamic stability of the DRUJ.

The purpose of this case report is to explore a novel intervention combining DTM and proprioceptive neuromuscular facilitation (PNF) in the sensorimotor rehabilitation of a patient with TFCC injury. The staged wrist sensorimotor rehabilitation program described in this study was developed taking reference to the foundational concepts delivered by Hagert.²

Methods

Patient characteristics

A 23-year-old right-handed female was diagnosed with a right TFCC injury and referred to hand therapy for conservative management. Fractures of the wrist and carpal bones were ruled out through X-ray investigations. The patient described of right ulnar-sided wrist pain since carrying a heavy object 2 months ago. No treatment was received since injury.

During the first therapy visit, patient complained of persistent wrist pain during tasks especially with carrying heavy load and on prolonged writing. There was no limitation in range of motion (ROM), but the patient reported pain with wrist and forearm movements toward end range.

The injury was disabling as patient is right-hand dominant. The patient worked as a spa receptionist with job demands requiring picking up phone calls, typing on the computer, and writing. Patient's goal was to return to pre-morbid level of pain-free wrist functions in daily activities.

Evaluation/assessment

At the start of each therapy session, the therapist examined the patient's wrist in a systematic manner. In addition, the patient completed pain measures via visual analog scale (VAS), grip strength, JPS, weight-bearing capability via Push Off test, Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH), and patient-rated wrist evaluation (PRWE) at selected time points during the rehabilitation process. These measures were completed pretreatment at the start of the therapy session. The therapist had 2 years of clinical experience in hand rehabilitation and was responsible for both conducting assessments and interventions for the patient in this study.

Wrist examination

The wrist was examined in a systematic sequence: active ROM (AROM), followed by passive ROM, and progressed to resisted ROM. Forearm rotation and cardinal planes of wrist movements—extension, flexion, radial deviation, and ulnar deviation—were assessed. Although passive ROM served to assess joint integrity and joint end-feel, measuring the AROM could provide further information on patient's willingness to perform a movement. If pain was significant at any stage, the assessment ceased. The wrist examination was performed at each therapy session pretreatment to

determine patient's readiness in the various stages of training. This systematic sequence of assessments has been suggested by Porretto-Loehrke et al¹⁷ in the assessment of the wrist joint.

The ulnar fovea sign¹⁸ was performed during the initial phase to determine the source of pain for a targeted intervention. The ulnar fovea sign has a 95% sensitivity and 86% specificity in clinical detection of fovea disruptions or ulnotriquetral ligament injuries.¹⁸

Pain assessment

Wrist pain was measured by VAS on active movements of the wrist. VAS measured pain intensity along a continuum on an 11-point (0–10) scale, with 0 being no pain and 10 being most pain. Minimal clinically important difference (MCID) for VAS has been established as 1.4 in upper extremity.¹⁹

Grip strength

Grip strength was measured using JAMAR dynamometer (Sammons Preston Rolyan, Chicago, IL, USA) according to published standards.²⁰ The handle of the dynamometer was set on the second position. Three attempts of maximal grip strength were taken on bilateral upper limb, and the average of the 3 readings was obtained. The MCID has been established as 6.5 kg for individuals with wrist injuries.²¹

Joint position sense

JPS measures the ability of joint to reproduce a specific joint angle. Testing position required the patient's elbow supported on table with forearm in neutral and vision occluded. The therapist passively moved the affected wrist to a specific angle, and the patient was asked to reproduce the joint angle on the affected wrist. In this study, the angles used were 25° and 45° of wrist extension. Each joint angle was measured once using wrist goniometer (Smith & Nephew srl, Agrate Brianza, MI, Italy), and the absolute difference between the positioned angle and reproduced angle was determined. The average of 2 readings was obtained. In a normal healthy joint, JPS deficit was reported to be 3°,²² and MCID value has been established as 7° in the wrist joint.²³

Weight-bearing capability

The ability to tolerate weight through the upper limb was measured using JAMAR dynamometer according to the setup described in the Push Off test developed by Vincent et al.²⁴ The average of 3 readings was obtained. The test arm was positioned in about 10°–40° of shoulder extension and 10°–40° of elbow flexion, with forearm in neutral.

Functional assessment

QuickDASH and PRWE were used as functional outcome measures. Both QuickDASH and PRWE have demonstrated good reliability, validity, and internal consistency²⁵ and are able to reflect limitations in hand functions.²² Both measures have an established MCID value of 14 points within the wrist population.²⁵

Intervention

The 4-stage wrist sensorimotor rehabilitation program incorporated all evidence discussed previously on wrist biomechanics and neuromuscular control of forearm muscles. [Table 1](#) shows a quick overview of the rehabilitation program with specific goals at each stage. [Table 2](#) describes the wrist sensorimotor treatment

Table 1
Overview of 4-staged wrist sensorimotor rehabilitation program

Stage of rehabilitation	Treatment techniques							
	Laser/ ultrasound	External support	Graded AROM	Graded strengthening	Reactive muscle activations	Graded axial loading	Coordination training	Resistive coordination training
Stage 1 Goal: Edema and pain control, ROM maintenance	✓	✓	✓					
Stage 2 Goal: Regaining wrist motions and stability		✓	✓	✓				
Stage 3 Goal: Neuromuscular rehabilitation				✓	✓	✓	✓	
Stage 4 Goal: Movement normalization & functions							✓	✓

AROM = active range of motion; ROM = range of motion.

techniques used at each stage. The training parameters in terms of training frequency and duration were determined based on the guide of Reinman and Lorenz²⁶ on strength and conditioning principles in rehabilitation. Progression to each stage was guided by pain response and meeting the defined criteria established for this case report at the end of each stage (Table 2).

The patient was seen for a total of 9 sessions during a 3-month period (Fig. 1). The duration between therapy sessions varied and agreed between the therapist and the patient. The treatment approach encouraged the patient to take charge of recovery with prescribed home exercises (Table 3). Each therapy session was a re-evaluation of the patient's wrist condition and a progression of exercises as appropriate. Patient performed the exercises under direct one-on-one supervision during therapy sessions to ensure competence in the exercises. Patient was taught to monitor wrist pain during exercises, and pain on VAS should not exceed 2 points with exercise. The exercises performed were subsequently prescribed as home exercises. There was no formal measure of compliance, but patient reported adhering to the prescribed exercise frequency.

The first stage of rehabilitation that lasted 5 weeks began with pain control and ROM maintenance. Pain control was emphasized at the early stage because pain has been purported to be barriers

against proprioception and sensorimotor training of the joint.^{11,27} As patient reported pain with wrist and forearm movements toward end range, weekly laser treatment was initiated to alleviate pain and promote healing of the ligament. Class 3b laser with wavelength of 850 nm, frequency of 2.5 Hz, mean output of 100 mW, and therapeutic window of 2.2 J/cm² was used. Two rounds of 20 seconds of therapeutic laser were applied at the tenderness spot between the ulnar styloid process and flexor carpi ulnaris tendon each time, for a total of 5 sessions. The use of laser therapy to relieve pain has been reported in the literature.^{28,29} Laser has shown to reduce inflammation and promote angiogenesis by inducing biochemical changes in the cells and the distribution of inflammatory cells, thereby reducing the development of edema, hemorrhage, and necrosis.^{28,29}

Patient was also prescribed a wrist cock-up orthosis for support during daily activities and advised to avoid any activities that caused pain. Other than pain control, treatment sessions also comprised gentle DTM AROM and wrist movements in a modified closed chain activity using a weighted theraball (Fig. 2). It has been purported that controlled stress to tissues improves conscious perception of joint movement, maintains cortical representation of the upper extremity, and helps with alleviating pain.^{2,5}

Table 2
Description of the wrist sensorimotor treatment techniques

Stage of intervention	Treatment techniques	Gradation	Frequency	Criteria for progression
Stage 1	Modified close chain wrist motion Open chain AROM in DTM plane	Start with comfortable range and progress to end range with 6 s of active terminal hold	15 repetitions every 2-3 h	No pain with full AROM VAS <2 with resisted isometric wrist motions
Stage 2	Isometric strengthening Isotonic strengthening in DTM plane	Manual resistance Start with 0.5 kg free weights, from available range and progress to end range with 6 s of active terminal hold	30 s hold × 5 sets, once daily 10-15 repetitions × 3 sets, every alternate days	Reducing pain at rest with VAS <2 Able to complete 10 repetitions × 2 sets of exercise Able to maintain control through range of movements with free weights
Stage 3	Progress isometric and isotonic strengthening Reactive muscle activations Graded axial loading Coordination training	Increase resistance/free weights, 0.5 kg increment each time Anticipated to unanticipated From bilateral hands to one handed Prepare for upper limb movements with proximal joint coordination only and progress to include distal wrist and hand coordination	10-15 repetitions × 3 sets, every alternate days	No pain at wrist extension with overpressure VAS <2 with weight bearing Good multijoint coordination in active upper extremity movements
Stage 4	Coordination training with resistance	Strengthening in PNF upper extremity patterns with varying resistance bands Return to high-demand activities requiring specific movement patterns	10-15 repetitions × 3 sets, every alternate days	Return to pre-morbid level of upper extremity functions

AROM = active range of motion; DTM = dart-throwing motion; VAS = visual analog scale; PNF = proprioceptive neuromuscular facilitation.

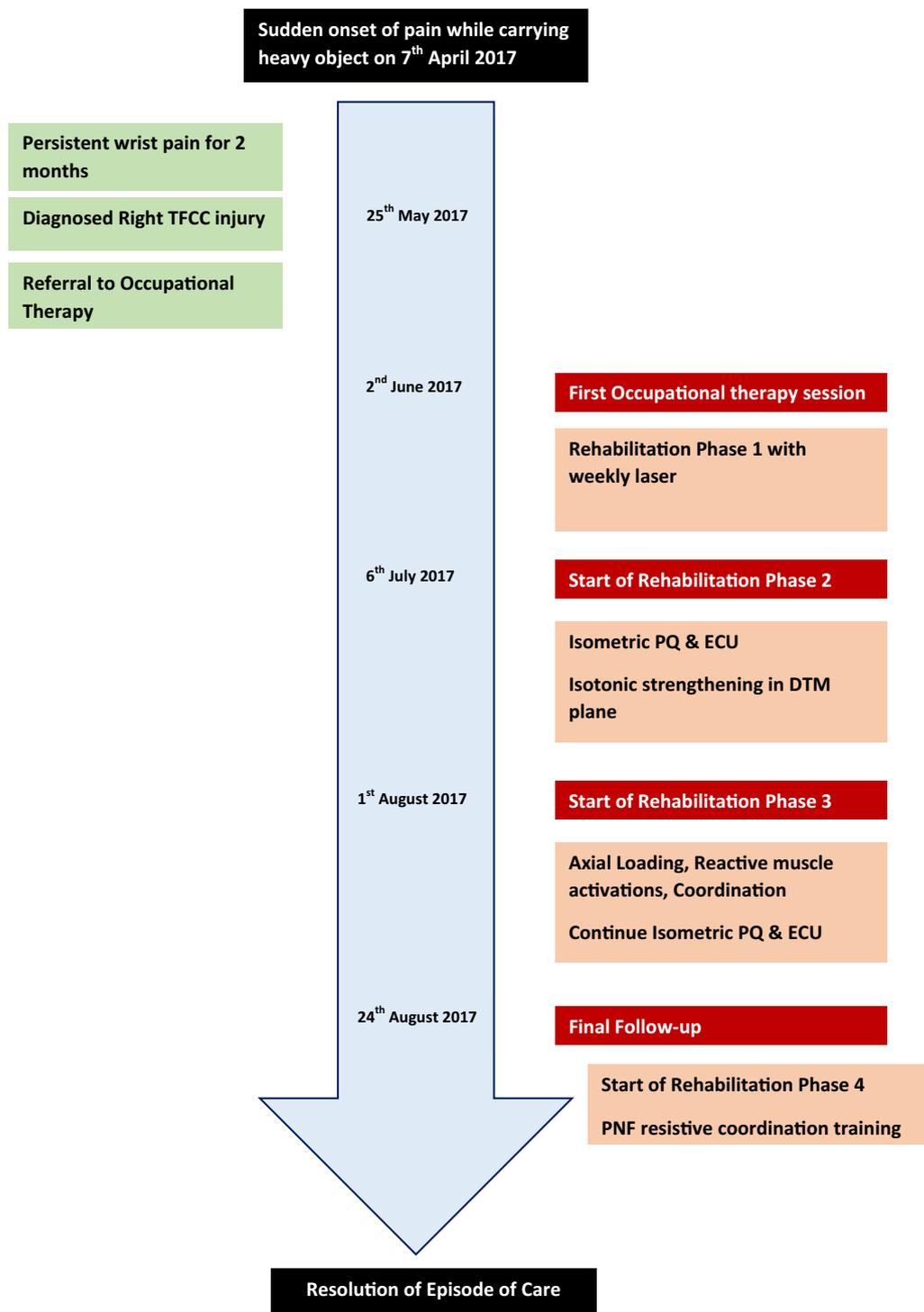


Fig. 1. Timeline of intervention. TFCC = triangular fibrocartilage complex; PQ = pronator quadratus; ECU = extensor carpi ulnaris; DTM = dart-throwing motion; PNF = proprioceptive neuromuscular facilitation.

The second stage of rehabilitation commenced on the sixth session. The goal of rehabilitation was to regain wrist stability within ROM. The patient performed isometric strengthening of the DRUJ stabilizers, PQ and ECU. These isometric exercises provided early proprioceptive inputs to the joint. The therapist applied manual resistance in the following planes of wrist and forearm motions for strengthening of the respective PQ and ECU muscles: forearm pronation with wrist in neutral and wrist extension with forearm in

some degree of pronation (Fig. 3). A slightly pronated position was chosen for ECU strengthening as patient was able to activate the right muscles more consistently in this forearm position, despite studies that recommended training ECU in a supinated position.^{6,30} If patient did not experience any pain beyond 2 points on VAS, strengthening progressed to isotonic with free weights in DTM plane. Pain score was monitored closely as significant pain, or fatigue has shown to negatively affect proprioception and motor learning.¹¹

Table 3
Description of the home exercises

Session	Stage of intervention	Exercise	Frequency
1-5	1	Pain-free DTM AROM Modified closed chain rolling weighted theraball on table (within comfortable range and progressed to full range) (Fig. 2)	15 repetitions every 2-3 h
6	2	Isometrics ECU and PQ (Fig. 3) DTM with 0.5 kg	30 s hold, 5 repetitions daily 10-15 repetitions × 3 sets, every alternate days
7-8	3	Continue isometrics ECU and PQ Progress DTM with 1 kg 0.4 kg ball flip (Fig. 4) Weight-bearing against wall with gym ball, with perturbation (Fig. 5) Wall push up with gym ball (Fig. 6)	30 s hold, 5 repetitions daily 10-15 repetitions × 3 sets, every alternate days 10-15 repetitions × 3 sets, every alternate days 1-2 min × 3 sets, every alternate days 10-15 repetitions × 3 sets, every alternate days 10-15 repetitions × 3 sets, every alternate days
9	4	Bilateral upper extremity AROM in PNF upper extremity pattern (Fig. 7) Axial loading on therball on table and with controlled wrist movements (Fig. 8) PNF D2 pattern with theraband (Fig. 9)	15 repetitions every 2-3 h 10-15 repetitions × 3 sets, every alternate days 10-15 repetitions × 3 sets, every alternate days

DTM = dart-throwing motion; AROM = active range of motion; ECU = extensor carpi ulnaris; PQ = pronator quadratus; PNF = proprioceptive neuromuscular facilitation; D2 = diagonal 2.

The third stage of rehabilitation commenced on the seventh session. Goal of rehabilitation focused on neuromuscular training that comprised reactive muscle activations, axial loading across wrist, and coordination training. Adequate muscular endurance must be present before commencement to prevent further wrist injury. It has been shown that muscle fatigue can negatively affect muscle activation patterns and sensorimotor control, which increases the risk of injury.^{8,11} Once the patient was able to complete 2 sets of 10 repetitions of isotonic strengthening exercises without significant increase in pain, a variety of balance, weight-bearing, and coordination activities were performed (Figs. 4-8). These exercises enhanced synergistic and reciprocal muscle activations through the feed-forward and feedback mechanism to maintain dynamic joint stability.^{8,27} Isometric strengthening of the DRUJ stabilizers, PQ and ECU, continued through this phase.

The last stage of rehabilitation commenced on the ninth session with movement normalization and functions as the goals. Patient performed strengthening with theraband in PNF upper extremity patterns (Fig. 9). PNF upper extremity patterns were adopted to integrate the entire upper extremity into a kinetic chain. The PNF patterns essentially mimicked functional movement patterns,³¹ hence training in these movement patterns would be beneficial to enhance the stability of the upper extremity in daily activities. In particular, PNF upper extremity diagonal 2 flexion/extension pattern incorporates DTM at the wrist. This would integrate earlier stages of isolated DTM training into the kinetic chain of the entire upper extremity. As the patient did not have any specific high-level activity demand, there was no further specific retraining required

at this stage, and the patient was subsequently discharged from therapy.

Results

On initial evaluation, patient demonstrated full and pain-free AROM of the shoulder and elbow. Forearm rotation and wrist ROM were within normal limits, although pain was reported with wrist and forearm AROM toward end range. Ulnar fovea sign was positive. VAS ranged between 3 and 4/10 in the initial 5 sessions. Other evaluations such as grip strength, JPS, QuickDASH, and PRWE were administered at the sixth session pretreatment when patient started stage 2 of rehabilitation to ascertain a baseline before proprioceptive training. All assessment tests were readministered on the last session before discharge.

A summary of pretreatment and post-treatment outcomes is presented in Table 4. Most outcome measures demonstrated a clinical significant improvement. Patient did not experience any adverse events during the course of intervention.

Discussion

The 4-stage wrist sensorimotor rehabilitation program is the first to incorporate DTM and PNF in the rehabilitation of TFCC injuries. This case report describes a patient who responded favorably after the 4-stage wrist sensorimotor rehabilitation program for TFCC injury. Results of this case report were compared against the established MCID values of the respective outcome measures as

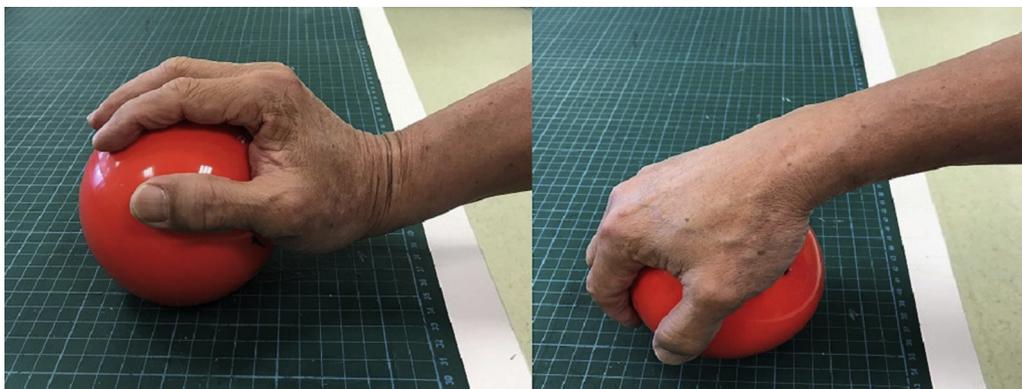


Fig. 2. Modified closed chain rolling weighted theraball on table.

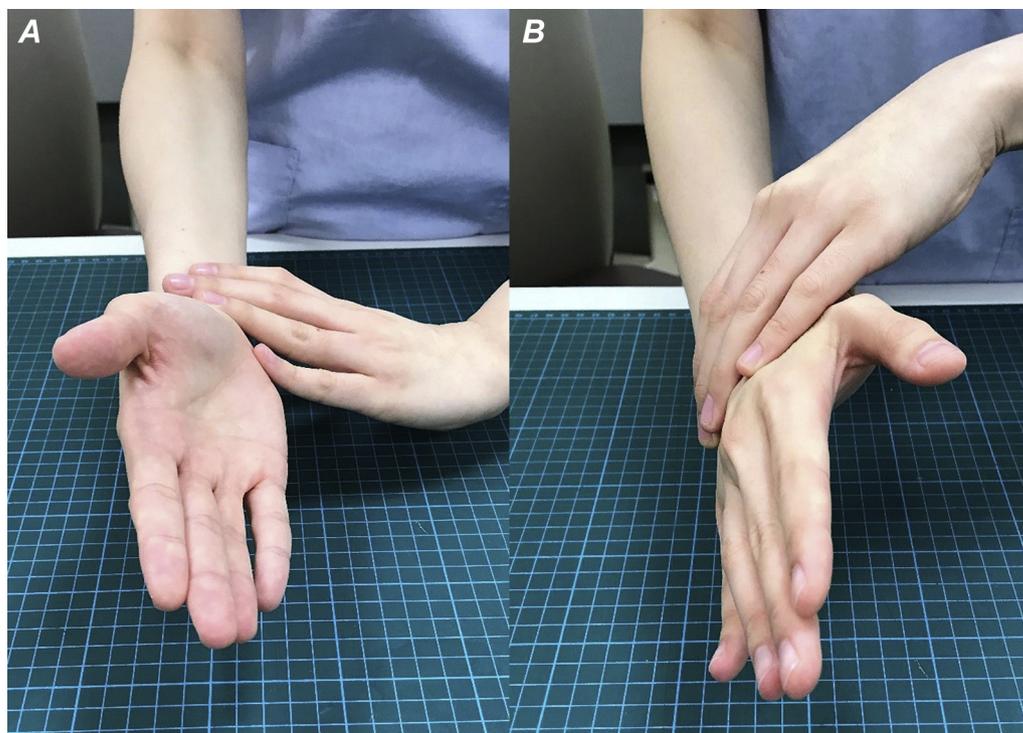


Fig. 3. Isometric (A) pronator quadratus, isometric (B) extensor carpi ulnaris.

there is limited evidence on the outcomes after rehabilitation of TFCC injury.

Other than QuickDASH, all outcome measures performed in this study exceeded the established MCID values at the end of treatment. The change in QuickDASH score of 11.4 is lower than the MCID value of 14, whereas the change in PRWE score of 14.5 is

more than the MCID value of 14. Although both QuickDASH and PRWE evaluate hand functions, the PRWE is a more sensitive outcome measure for wrist ligament injuries as it incorporates axial loading across the wrist, which is not captured in QuickDASH. This aspect is pertinent to reflect upper extremity function as the load-bearing capability is often affected after wrist

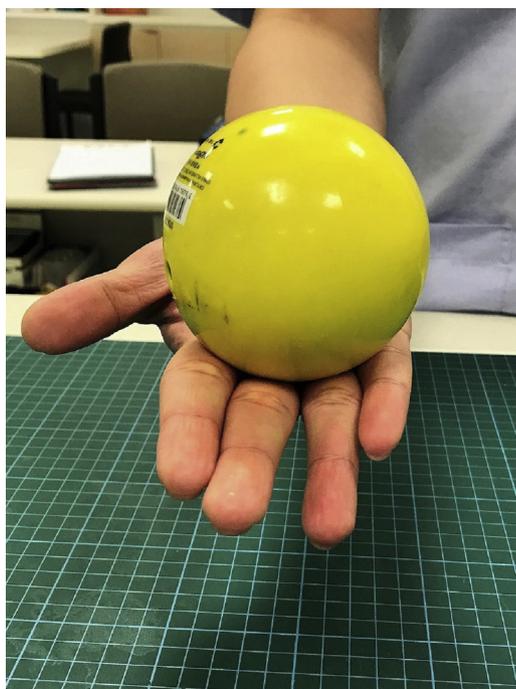


Fig. 4. 0.4 kg ball flip.



Fig. 5. Weight-bearing against wall with gym ball, with anticipated perturbations.



Fig. 6. Wall push up with gym ball.

injuries,²⁴ especially in TFCC injury.³² Therefore, Push Off test was administered on the last session to ascertain patient's ability to bear weight through the affected hand, using the unaffected hand as a comparison. In this study, the result of the Push Off test

showed comparable performance on bilateral hands, implying a good recovery.

Through this case study, however, the exact mechanism of DTM leading to recovery is not fully understood. There is currently no biomechanical study investigating the effects of DTM in TFCC injuries. Wrist motions in DTM plane have demonstrated stabilizing effect on the carpal rows in biomechanical studies.^{14,33} In scapholunate ligament injuries, incorporating DTM exercises had produced promising results.^{34,35}

The DTM occurs mainly at the midcarpal joint with minimal radiocarpal joint involvement.³⁶ This oblique plane of DTM has shown to be inherent in the movement of the wrist in performance of daily activities.³⁷ Functional activities, such as hammering, drinking, pouring water from jar, and twisting lid of a jar, occur in this DTM path.^{38,39} Preliminary studies have also implied coupling motions of the wrist and forearm during DTM, with forearm pronation during radial extension of the wrist and forearm supination during wrist ulnar flexion.^{40,41} Hence, incorporating DTM exercise in rehabilitation of TFCC injury is hypothesized to be beneficial in enhancing the dynamic stability of the wrist and coordination of the forearm in performance of daily functional activities, although it does not strengthen muscles of interest that enhance DRUJ dynamic stability. Knowing this, strengthening of PQ and ECU continued through the latter stages of rehabilitation in addition to DTM and PNF techniques in order to ensure these muscles assisted with DRUJ stabilization.

In addition, the DTM plane yields the greatest total ROM at the wrist as the mechanical axis of the wrist is oriented along this plane.⁴² Orientation of muscle insertions at the wrist is also favorable in DTM plane, allowing the motion to be performed with minimal muscle force.^{16,36} Hence, movements along the DTM plane require lesser effort that could help to maintain or restore wrist ROM in patients experiencing wrist pain.



Fig. 7. Bilateral upper extremity active range of motion in proprioceptive neuromuscular facilitation upper extremity pattern.



Fig. 8. Axial loading on theraball on table, and with controlled wrist movements.

This is an approach incorporating DTM exercise, on top of specific strengthening of ECU and PQ, in the rehabilitation of TFCC injury. It may be worthwhile to consider enhancing

wrist dynamic stability with DTM exercise, given the prevalence of the DTM plane of wrist movements during performance of functional activities. Evidently, strengthening of ECU and PQ should still continue to enhance the dynamic stability of DRUJ.

Limitations

This case report has some limitations that include the low level of evidence (level 5). The results of this study need to be interpreted with caution. The overall case design does not allow evaluation of treatment effect. In this study, natural resolution of symptoms with rest and routine strengthening cannot be dismissed. The short follow-up period does not enable monitoring of outcomes over time. In this case, the patient was discharged at the last stage of the wrist sensorimotor rehabilitation program, and there was no subsequent follow-up to ascertain if the effects of intervention were maintained.

The findings of this study need to be investigated in larger randomized controlled trials to determine the effect size of the proposed rehabilitation paradigm. Potential biomechanical studies could also investigate the influence of DTM on DRUJ dynamic stability using electromyogram to illuminate the physiological basis of how DTM exercise contributes to the function and dynamic stability of DRUJ after a TFCC injury.

Another limitation of this study is the unilateral measurement of JPS. JPS was not measured on the contralateral hand, which could otherwise have provided a more accurate reference point for the affected hand. Using published MCID values and normative data for individuals need to be interpreted with caution as it may not be generalizable to individuals.⁴³



Fig. 9. Strengthening in proprioceptive neuromuscular facilitation upper extremity pattern with theraband.

Table 4
Summary of pretreatment and post-treatment outcomes

Outcome measure	Initial	Discharge	Change	MCID
VAS raw score	4	0	4	1.4
JPS, °	14	5	9	7
QuickDASH raw score	18.2	6.8	11.4	14
PRWE composite score	16	1.5	14.5	14
Grip strength, kg	10.6 (R) 16 (L)	18.3 (R) 17 (L)	7.7 1	6.5
Push Off test, kg		8 (R) 7.5 (L)		

MCID = minimal clinically important difference; VAS = visual analog scale; JPS = joint position sense; QuickDASH = Quick Disabilities of the Arm, Shoulder and Hand; PRWE = patient-rated wrist evaluation; R = right; L = left.

Conclusion

A pain-free and functional hand is of utmost priority in hand rehabilitation. The 4-stage wrist sensorimotor rehabilitation program described in this study is pioneer in incorporating DTM and PNF exercises in the rehabilitation of TFCC injuries. The 4-stage wrist sensorimotor rehabilitation program has clear criteria for progression at each stage that could guide therapists in rehabilitating patients with TFCC injuries. In spite of its low level of evidence and the aforementioned limitations, this study has the potential to enhance our clinical practice and contribute to the evidence base of sensorimotor rehabilitation of TFCC injury. Larger prospective study with control group is warranted to investigate the effectiveness of the proposed rehabilitation paradigm.

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Quiz: # 649

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- # 1. The study design was
 - a. RCTs
 - b. prospective cohort
 - c. case series
 - d. case report
- # 2. Results included improvement in
 - a. the DASH
 - b. the VAS
 - c. all outcome measures
 - d. the PRWE
- # 3. Treatment consisted of
 - a. 9 sessions over 3 months
 - b. 3 sessions over 9 months
 - c. 12 session over 4 weeks
 - d. 4 sessions over 12 weeks
- # 4. Many of the exercises consisted of
 - a. bouncing a variety of balls
 - b. weight bearing over an unstable base, often a ball
 - c. eccentric strengthening of the muscles of the wrist
 - d. grip strengthening
- # 5. The author was encouraged with the result but recommended performing RCTs before completely endorsing the method
 - a. false
 - b. true

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