Wrist Injuries: Evaluation and Treatment

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Learning Objectives

- **1. Assess proprioceptive and sensorimotor dysfunction of the wrist quantitatively.**
- **2. Describe the components of proprioception and their implications for rehabilitation of wrist injuries**
- **3. Discriminate between appropriate interventions to minimize edema and finger stiffness to optimize patient recovery following wrist injury.**
- **4. Explain the role wrist carpal ligament proprioception plays in the functional recovery of wrist balance and stability.**

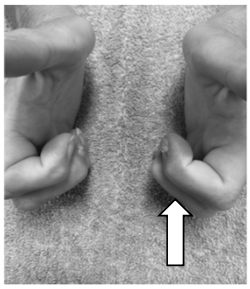
Evaluation following Wrist Injury

- ROM of the wrist, digits, and forearm
- Joint position sense of the wrist
- Edema assessment using figure of 8 method
- Sensory function using the Ten test
- PRWE functional outcome measure
- Provocative Testing for wrist injuries

Assessing ROM

- Clinical Pearls
  - Assess composite motion of the hand and wrist to determine the presence of extrinsic tightness
  - Assess Intrinsic tightness

Intrinsic tightness



Extrinsic tightness

- 1) Make fist with wrist in neutral
- 2) Make fist with wrist in full flexion
- 3) If motion is greater with wrist in neutral, extrinsic extensor tightness is present

Extrinsic Flexor tightness

- Straighten digits
- Straighten digits and fully extend wrist
- If finger extension is greater with wrist in neutral, extrinsic flexor tightness is present

Journal of Hand Therapy

- **A descriptive study on wrist and hand sensori-motor impairment and function following distal radius fracture intervention**
- **Karagiannopoulos C, Sitler M, Michlovitz S,, R Tierney R**
- **http://dx.doi.org/10.1016/j.jht.2013.03.004**

Joint position sense testing

- The patient has been asked to position the wrist joint in the predetermined target position, and the accuracy of JPS is measured as the degree of wrist flexion in relation to the desired position.

- Both treatment groups had significant total grip force deficits as compared to the control group with the non-surgical group deficit being greater than the surgical group
- JPS and total grip force were the most clinically meaningful impairments assessed in the study
- Determination that sensory impairment still existed at 8 weeks following DRF treatment is important due to its integral role in the function of the sensori-motor system.

- Of the two sensory variables assessed in this study, JPS test had the highest clinically meaningfulness for determining sensori-motor impairment during a functional gripping task, resulting in the strongest correlation with the PRWE.
- Higher JPS impairment was associated with greater functional deficit among DRF participants.
- The clinical importance of JPS assessment is its usefulness for identifying deficits in conscious dynamic joint control, which leads to decreased function following DRF

Found in Data Analysis & Results

- Statistical significance was set at p .05 for both the primary and secondary study aims

Variables	F	Sig.	Partial eta sq.	Observed power
Ten Test	5.20	.009*	.188	.80
JPS	52.19	.000*	.699	1.00

After Distal Radius Fracture

- Statistically significant minimum detectable change values were 4.28 and 4.94 at 8 and 12 weeks, respectively.
- Clinically meaningful MCID values were 5.00 and 7.09 at 8 and 12 weeks, respectively.


Journal of Hand Therapy

journal homepage: www.jhandtherapy.org

JHT Read for Credit Article #445.
Scientific/Clinical Article

Responsiveness of the active wrist joint position sense test after distal radius fracture intervention

Christos Karagiannopoulos MPT, PhD*,†, Michael Sitler EdD, ATC, FNATA‡, Susan Michlovitz PT, PhD§, Carole Tucker PT, PhD§, Ryan Tierney PhD, ATC‖

Edema

- Figure of 8 method
- Figure-of-eight technique is a reliable and valid measurement tool for measuring hand edema

Ten Test

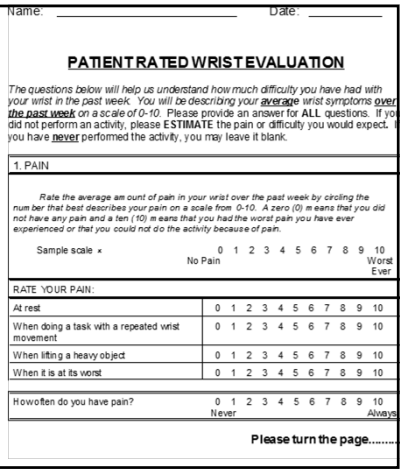
Bassini & Patel

- Compares sensation in injured/non-injured areas in response to light-moving touch where 10/10 is normal and 0/10 is no sensation.

- Examiner's finger is applied to the area to be tested as well as to an area of normal sensation (such as the contralateral uninjured finger)
- The patient is asked to rate the best level of sensation they feel in the test area.
- Ten is normal sensation, diminished sensation is rated on a scale of 0-10*, with 0 being no sensation, 5 being half of normal, etc.

Patient-rated Wrist Evaluation

- Pain Scale
- 5 items
  - 0-10
  - intensity
  - frequency


Name: _____ Date: _____

PATIENT RATED WRIST EVALUATION

*The questions below will help us understand how much difficulty you have had with your wrist in the past week. You will be describing your **average** wrist symptoms **over the past week** on a scale of 0-10.* Please provide an answer for **ALL** questions. If you did not perform an activity, please **ESTIMATE** the pain or difficulty you would expect. If you have **never** performed the activity, you may leave it blank.

1. PAIN

Rate the average amount of pain in your wrist over the past week by circling the number that best describes your pain on a scale from 0-10. A zero (0) means that you did not have any pain and a ten (10) means that you had the worst pain you have ever experienced or that you could not do the activity because of pain.

Sample scale × 0 1 2 3 4 5 6 7 8 9 10 (No Pain — Worst Ever)

RATE YOUR PAIN:

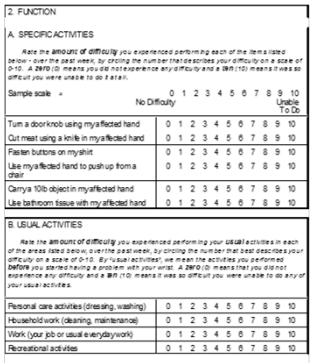
At rest	0 1 2 3 4 5 6 7 8 9 10
When doing a task with a repeated wrist movement	0 1 2 3 4 5 6 7 8 9 10
When lifting a heavy object	0 1 2 3 4 5 6 7 8 9 10
When it is at its worst	0 1 2 3 4 5 6 7 8 9 10
How often do you have pain?	0 1 2 3 4 5 6 7 8 9 10 (Never — Always)

Please turn the page.....

Patient-rated Wrist Evaluation

- Function
- 6 wrist-specific activities
- 4 usual role

- Total score
  - 50% pain
  - 50% disability


2. FUNCTION

A. SPECIFIC ACTIVITIES

*Rate the **amount of difficulty** you experienced performing each of the items listed below - over the past week, by circling the number that describes your difficulty on a scale of 0-10. A **zero** (0) means you did not experience any difficulty and a **ten** (10) means it was so difficult you were unable to do it at all.*

Sample scale × 0 1 2 3 4 5 6 7 8 9 10 (No Difficulty — Unable To Do)

Turn a doorknob using my affected hand	0 1 2 3 4 5 6 7 8 9 10
Cut meat using a knife in my affected hand	0 1 2 3 4 5 6 7 8 9 10
Fasten buttons on my shirt	0 1 2 3 4 5 6 7 8 9 10
Use my affected hand to push up from a chair	0 1 2 3 4 5 6 7 8 9 10
Carry a 10lb object in my affected hand	0 1 2 3 4 5 6 7 8 9 10
Use bathroom tissue with my affected hand	0 1 2 3 4 5 6 7 8 9 10

B. USUAL ACTIVITIES

*Rate the **amount of difficulty** you experienced performing your **usual** activities in each of the areas listed below, over the past week, by circling the number that best describes your difficulty on a scale of 0-10. By 'usual activities', we mean the activities you performed **before** you started having a problem with your wrist. A **zero** (0) means that you did not experience any difficulty and a **ten** (10) means it was so difficult you were unable to do any of your usual activities.*

Personal care activities (dressing, washing)	0 1 2 3 4 5 6 7 8 9 10
Household work (cleaning, maintenance)	0 1 2 3 4 5 6 7 8 9 10
Work (your job or usual everyday work)	0 1 2 3 4 5 6 7 8 9 10
Recreational activities	0 1 2 3 4 5 6 7 8 9 10

Reasons to use PRWE vs DASH for wrist/hand

- International consensus panel supported use of PRWE pain and function subscales as core outcome measures in DRF
- The PRWE was more able to detect changes in:
  - ulnar side wrist pain populations syndrome
  - in DRF
  - General hand therapy population
- Highly correlated, but DASH more affected by other joint problem
- ½ as many questions (less burden)

Therapy: Open Reduction Internal Fixation (ORIF) of DRF

WEEK 1:

- Edema reduction techniques
- Wrist splint with 20 degrees extension.
- Wrist control splint to be removed for ROM and hygiene only. Splint should be worn for other ADL's.

Retrieved on 09/26/09 from: http://image.wisdomking.com/images/pictures/01/75/photo_108.jpg

20 Degrees Wrist Extension Splint

Retrieved on 09/26/09 from: http://www.ashsumed.com/

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Rehabilitation: Open Reduction Internal Fixation (ORIF)

WEEK 1 (cont.)

- AROM to digits and non-involved joints.
- Passive ROM to stiff non-involved joints.

Retrieved and modified on 09/26/09 from: http://www.rachelnhdemd.com/Tendon_Gliding_Exercises_files/nervestretch.jpg

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PROM for Digit Extrinsic Extensor Tightness

PROM for Digit Intrinsics

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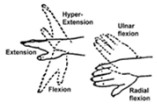
Rehabilitation: ORIF

WEEK 2:

- Scar management
- Edema reduction
- Continue AROM to the digits and non-involved joints
- May begin gentle AROM of the wrist with surgeon approval.
- Continue PROM to non-involved joints
- Continue splint wear



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Rehabilitation: ORIF

WEEK 4:

- Continue scar management and edema reduction
- Continue AROM to wrist, forearm, and non-involved joints
- Begin gentle PROM to wrist and forearm
- Continue splint wear
- Consider static progressive or dynamic splinting as needed for the wrist or forearm

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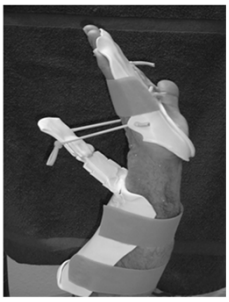
Rehabilitation: ORIF

WEEK 6:

- **Continue active and passive ROM.**
- **Initiate splinting for mobility as needed.**
- **Begin to wean from static wrist control splint.**



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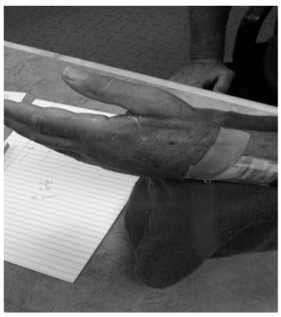
Finger Stiffness



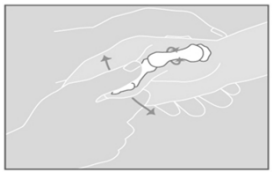
- Clinic-based therapy may be preferable for patients with noteworthy complications after a distal radius fracture with volar plate fixation. Patients with decreased finger motion and various comorbidities may benefit from therapy provided in a clinic
- Valdes et al. 2015

Structure	Provocative Testing of the Wrist
CMC joint	**Grind Test**
Schapholunate Ligament	**Scaphoid Shift test**
Lunotriquetral ligament	**Lunotriquetral ballottement test**
Arcuate Ligament	**Midcarpal test**
Triangular Fibrocartilage complex	**TFCC stress test, Ulnar Fovea sign, Press Test, TFCC load test**
Extensor Carpi Ulnaris Tendon	**ECU Synergy**
Finkelstein's	**DeQuervain's**

Grind test for CMC OA

Clinically Reasonable Test

- High predictive value (92%),
  +LR 4.45 -LR .60
- \+ grind test would indicate a high probability of CMC OA, but a - grind test would not necessarily rule out the presence of CMC OA



The grind test is performed by gripping the patient's metacarpal bone of the thumb and moving it in a circle and loading it with gentle axial forces. A patient with thumb joint arthritis generally complains of a sudden sharp pain at the CMC joint.

Merritt et al. 2009

Retrieved 5/3/10 from: //www.handspecialists.com/images/thumb_arthritis1.jpg&imgrefurl=http://www.handspecialists.com/Pain/arthritis_thumb.html&usg=__

Scapholunate Dissociation

- Scaphoid shift test
- Pressure applied by examiner's thumb to the scaphoid tubercle, The wrist is axially loaded at the metacarpals and ulnarly deviated

+LR 2.76
-LR .25

Treatment Strategies: Scapholunate Dissociation

- Dorsal wrist pain
  - Scapholunate interval
    - Distal to Lister's tubercle

Extends & Supinates

•Scaph

•LUN

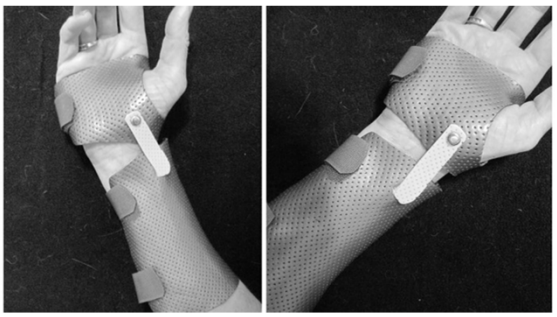
TQ

Flex & Pronates

Non-Operative Management

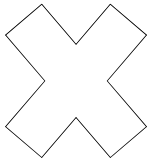
- Protective Phase: Wrist immobilization 4-8 weeks
  - Finger ROM & tendon gliding exercises
- Mobilization Phase 8-12 weeks
- intermittent use of orthosis
  - Begin AROM of the wrist
  - Start with dart-throwers path of wrist motion until well tolerated
  - Dart-throwers motion allows radiocarpal stability
  - 12 weeks Start with isometric strengthening initially

Dart Throwers Orthosis



During Protective Phase

- Avoid
  - Repetitive loaded wrist motions
  - Power Gripping
  - Axial loading in pronation



Strengthening exercises

- Strengthen FCR: Contraction can produce a volar restraint for the unstable scaphoid and extension moment as long as the dorsal scapholunate ligaments are intact
- Wrist should be pronated
- If scapholunate ligaments are not intact
  - Isometric radial deviation may help reinforce scaphoid stability

Avoid Triggering Persistent Wrist Pain or Discomfort

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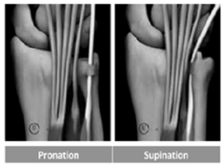
Muscles to Strengthen for wrist instability

Types of Instability	Dynamic stabilizers (Carpus Supinators)	Avoid (Carpus Pronators)
SL	ECRL/B, APL, FCU, FCR	ECU
LT	ECU	ECRL/B, APL, FCU, FCR
Mid-Carpal	ECU, FCU	
DRUJ	Pron Quad, ECU	

Is wrist Position Important ?

- ECU tendon is max taught and angled in supination
  - Biomechanical advantage to pronate carpus



SL interval injury:

- Wrist strengthening in pronated or neutral position
  - Minimized ECU pronation effect
  - Optimum ECRL/B, APL, FCR mechanical advantage

Garcia-Elias, 2015

Selective Muscle Loading

- S-L friendly muscles: APL, ECRL/B, FCU – they relax the S-L ligament by supinating the scaphoid
- S-L unfriendly muscle: ECU – pulls S-L ligament by pronating the scaphoid.
- L-T and Mid-carpal instability: ECU and hypothenars are dynamic stabilizers. ECU is the only wrist muscle which acts as a carpal pronator.

Lunotriquetral tear

2nd most frequent carpal instability

Volar intercalated segment instability= VISI

Extends& Supinates

•Scaph

•Lun

TRI

Flex & Pronates

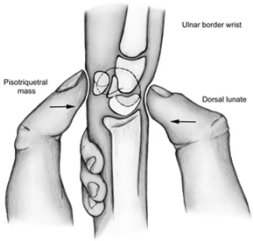
Tests for L-T involvement

- Ballottement test:
  - Reagan: stabilize the lunate firmly with the thumb and index finger of one hand while the pisotriquetral unit is rocked ("ballotte")with the other hand
  - Positive results in pain, crepitus, and laxity
  - Shear test:
    - Kleinman: rest elbow on the table with neutral forearm, contralateral thumb is placed over the dorsal aspect of the lunate just beyond the medial edge of the distal radius. With lunate stabilized, opposite thumb loads the pisotriquetral joint with palmar to dorsal plane to create shear force at LT.

Lunotriquetral ballottement test (Reagan's test): for Lunate Triquetrium instability

- Procedure: The examiner stabilizes the lunate with the thumb and index fingers of one hand while the other hand attempts to displace the pisotriquetral unit volarly then dorsally.
- Positive result: Laxity, pain, or crepitus.
- Sensitivity: varies from 33-100%
- Specificity: not determined
- limited clinical usefulness in terms of diagnostic accuracy

Kleinman shear



Reagan shuck

LT Instability Treatment

- Protective
  - Acute injuries immobilized 3-8 weeks in short arm or above elbow orthotic (eliminates forearm rotation)
  - Pad below pisiform and over dorsal distal radius can be used to maintain optimum alignment
  - Finger ROM and digital tendon gliding
- Mobilization, next 4-10 weeks
  - Removable orthotic to protect wrist against stress during ADL
  - Isometric exercises are better tolerated than isotonic
  - Avoid repetitive ROM exercises under load that would exacerbate symptoms

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Forearm Position for LT stability exercise

- Supination
- Inhibits carpal supinators
- ECU is in optimal position

Midcarpal Instability

- Example of CIND
- Instability between proximal and distal carpal rows
- 3 types
  - Palmar- Most Frequent:
    - Characterized by volar sag on ulnar side of wrist
    - Clunk that occurs at end range of UD with forearm pronation
    - Tenderness over the triquetral-hamate & capitolunate intevals
    - Weakness of grip
  - Dorsal
  - Extrinsic occurs as a result of extrinsic cause such as DRF malunion

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Midcarpal shift test: Provocative test for midcarpal instability

- Procedure: The examiner stabilizes the patients forearm in pronation with the wrist in 15 degrees of ulnar deviation and the examiner exerts pressure volarly at the distal capitate. The wrist is axially loaded at the metacarpals and ulnarly deviated.
- Positive result: Only positive if clunk occurs with ulnar deviation.
- +LR2.67

Clinical Findings

- Clunk on active ulnar deviation of pronated wrist
- Volar sag reduces on ulnar deviation after the clunk
- Midcarpal shift test

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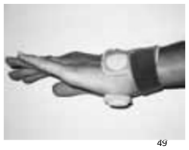
Rehabilitation Principles

- Carpal Stability is the first priority!!
  - May mean loss of motion
  - Address edema and stiffness
  - Communicate with your physician
  - Ultimate goal is a stable and pain-free joint that has sufficient ROM and strength to allow return to previous level of activity

Midcarpal Instability Treatment

- Conservative
  - Milder cases respond to activity modification
  - ECU & FCU strengthening isometric strengthening. Exercises should be done in supination initially & progress to pronation (more stable wrist position)
  - Grip strengthening in supination
  - Ulnar carpus splinting with stabilizing force dorsally
  - Dorsally directed pressure on the volar side of the wrist (pisiform boost)





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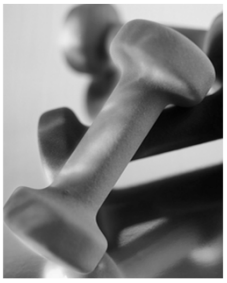
Wrist stabilization with muscle contraction

- Voluntary contraction of hypothenar muscles in supination
- Activation of ECU and FCU
- Isometric Exercises
- No radio-ulnar motion



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DRUJ for DRUJ pathology

- Gliding the ulna to its maximum dorsal and volar positions in neutral, supination, and pronation
- + test: Reproduction of pain with or without hypermobility
- +LR 1.79 – LR 0.30
- Prosser 2011

- Reasonable Test

Press Test for determining DRUJ pathology

- Seated patient grips both sides of the chair. The patient pushes body weight up from chair using the affected wrist
- + test focal ulnar wrist pain
- +LR Infinity –LR 0

- Lester 2005

Retrieved on 3/1/12 from http://namemypain.com/Body_Hand-Wrist_T-Back-C.html

DRUJ & Instability Causes

- Acute traumatic events involve axial load-bearing with rotational stress
- Overuse
- Repetitive trauma
- Fracture of distal radius with radial shortening

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Non-Surgical Treatment for TFCC

- The Wrist Widget was designed by a Certified Hand Therapist to reduce wrist pain associated with grip, wrist rotation and weight bearing. Indicated for ulnar-sided wrist pain, TFCC injuries and ECU subluxation

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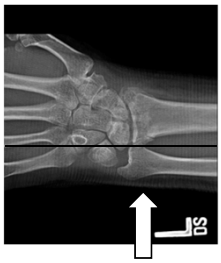
Ulnar Impaction Syndrome

- Develops from chronic compression of the TFCC between carpus and ulnar pole
- Any factor increasing the relative length of the ulna will shift load bearing from the radiocarpal joint to the articular disc of TFCC

Functional Implications

- Upper limb function is performed with elbow flexed & forearm neutral
- Upward pointing ulnar seat acts as fulcrum supporting the compressive load from the radius
- Elbow at 90, ulnar seat supports entire hand forearm unit



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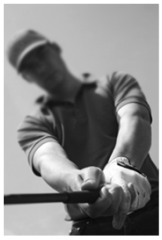
Precautions

- Activities that involve forearm pronation and grip increase ulnar variance and can exacerbate symptoms of ulnocarpal abutment



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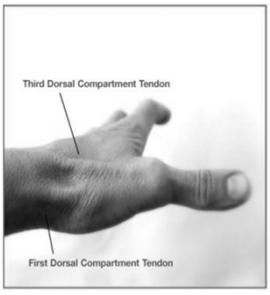
DeQuervain's

- The inflammation of the wrist tendons at the base of the thumb causes the compartment (a tunnel or a sheath) around the tendon to swell and enlarge, making thumb and wrist movement painful
- Making a fist, grasping or holding objects are common painful movements



Retrieved 2/29/12 from http://www.assh.org/Public/HandConditions/Pages/deQuervainsTendonitis.aspx

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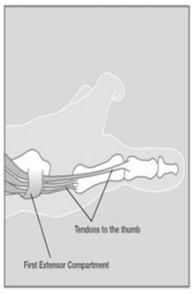
Causes

- Irritation of the tendons at the base of the thumb, usually caused by taking up a new, repetitive activity
- New mothers are especially prone
- A wrist fracture can also predispose a patient to deQuervain's tendonitis
- Repetitive prolonged thumb exertions in combination with non-neutral wrist postures (Moore 1997)



Retrieved 2/29/12 from http://www.assh.org/Public/HandConditions/Pages/deQuervainsTendo

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Finkelstein's Test: Provocative test for radial sided wrist and thumb pain.

- Procedure: The examiner grasps the patient's thumb and ulnarly deviates the hand and wrist. The patient may also perform this motion independently.
- Positive result: The patient's pain is reproduced over the first dorsal extensor compartment.
- Sensitivity and specificity have not been determined.

Significance: diagnostic accuracy has not been established

Finkelstein's test

- The compartment is stretched during the maneuver which elicits pain

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Signs & Symptoms

- Pain over the thumb-side of the wrist is the main symptom
- Pain may radiate down the thumb or up the forearm. Hand and thumb motion increases pain, especially with forceful grasping or twisting
- Because of the pain and swelling, motion such as pinching may be difficult

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Treatment

- Rest the thumb and wrist by wearing a splint
- Activity modification: avoid wide grasp and try to maintain wrist neutral posture during activity
- Joint mobilization to carpal bones (Anderson & Tichenor 1994)
- Tendinosis responds to eccentric strengthening. Is there a role in DeQuervain's?

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- Neovascularisation in de Quervain's disease of the wrist: novel combined therapy using sclerosing therapy with polidocanol and eccentric training of the forearms & wrist- a pilot study

  3 Females VAS score 7/10

  Eccentric training with Thera-Band flex bar 6x15 reps of forearm & wrist extensor & flexors and polidocanol sclerosing therapy (0.25% 1 ml)

Results: 2 patients resolved pain, 1 pain from 6/10 to 2/10

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Evidence for splinting

- Prospective study of 95 patients with De Quervain's that used injection of steroids and immobilization in a splint
- Fifty-four (62%) had a satisfactory outcome at a mean of 18 months.
- Thirty-three wrists (38%) had an unsatisfactory outcome and had surgery
- Combination of injection of steroids and immobilization in a splint is an effective method of treatment for de Quervain's

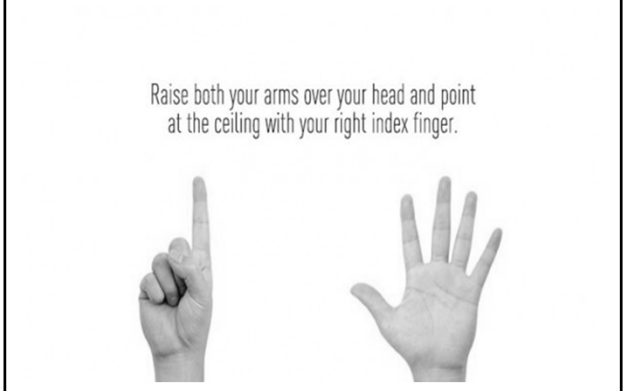
Witt et al. 1991

Sensorimotor & Proprioceptive Training for the Hand and Wrist : Evidence Based Hands-on Treatment Strategies

What is Sensorimotor the system?

A component of the motor control system responsible for providing coordination and dynamic stability which includes

- Perception of force
- Joint position sense
- Neuromuscular control mechanisms



Sensorimotor Function

- Object recognition
- Moving in dark spaces
- Manipulating objects
- Regulate movement and force

Negative Influences on the Sensorimotor System

- Injury

- Aging

Pain and Proprioception

- During local muscle tendon pain, the nociceptive afferent nerve endings are sensitized, and this in turn maintains the painful condition
- This has a negative influence on the quality of sensory information because there is a sensory mismatch between the actual input from the primary muscle spindle afferents and the expected sensory pattern, thereby reducing proprioception

Sensorimotor Approach

Encourage positive changes to the sensorimotor system with sensorimotor training.

Hand & U.E. use impacts the brain and information pathways

Traditional Rehabilitation

- Rehabilitation exercises are often completed with attention on the aspects of movement (increasing shoulder ROM or preventing hiking during shoulder flexion)
- Typical ADL's require awareness of the constant interactions and dynamic environment. Attention is directed to the environment while the body is controlled automatically to maintain joint stability and integrity

Sensory System: 3 Afferent Pathways

- Vestibular
- Visual: The visual system provides a fundamental mechanism for coordination, regulation, and control of movement while managing environmental interactions
- Somatosensory: changes to visual or sensory feedback lead to subsequent alterations in neuromuscular control during movement

Visual Feedback

- Visual feedback is required for executing movement sequences and increases with task complexity and variability.
- The interplay between vision and somatosensation is vital to provide sufficient afferent input to the central nervous system (CNS) to regulate motor control and maintain neuromuscular integrity

Following an Injury

- CNS afferent input is disrupted due to the lost somatosensory signals from injured ligaments and increased nocioceptor activity associated with pain, swelling, and inflammation
- The disrupted sensory input and injury-associated joint instability, muscle atrophy, and movement compensations combine to facilitate motor control adaptations
- The reconstruction process leads to further deafferentation of the joint, causing continued neuroplastic modifications that result in maladapted efferent neuromuscular output

- Comprised of sensorial, motor, and central integration of information received from the sensory end organs
- The efferent control, neuromuscular control, of joint is provided from other somatosensory, vestibular, and visual inputs of central nervous system

Proprioceptive Sense Mechanism

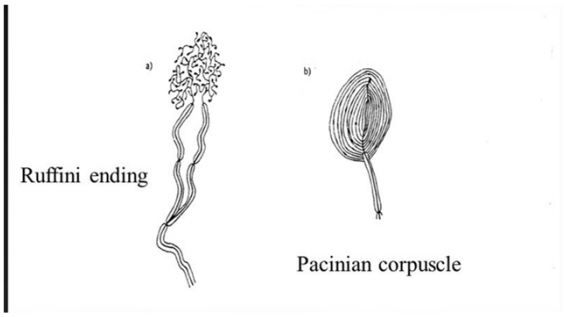
- Joint receptors work in higher rates during active motion
- The motor components of the sensorimotor system assist dynamic joint stability.
- The motor control is provided from 3 levels
  - Spinal cord
  - Brain stem
  - Cerebral cortex (two assistant area cerebellum and basal ganglia)

Mechanoreceptors: Organs of Proprioception:

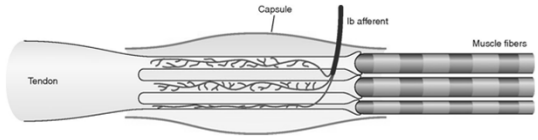
- Mechanoreceptors – react to joint pressure, motion, and velocity
- Four Types:
  - Ruffini Ending: They are both static and dynamic receptors and they have low threshold and slow adaptation.
  - Pacinian Corpuscle: They are dynamic receptors and they have low threshold and fast adaptation.
  - Golgi-like receptors
  - Free nerve endings

Neuroreceptor function characteristics	Meissner	Merkel	Ruffini	Pacinian	Golgi-like
Slow response		✓	✓		✓
Fast response	✓			✓	
Superficial skin	✓	✓			
Deep skin			✓	✓	✓
Joint capsule/ligaments			✓	✓	✓
Initial joint motion	✓			✓	
Throughout joint motion		✓	✓		
End-range joint motion					✓

Mechanoreceptors



Diagrammatic representation of the mammalian Golgi tendon organ. Ask for permission from author http://physrev.physiology.org/content/92/4/1651



Proske U , and Gandevia S C Physiol Rev 2012;92:1651-1697

Physiological Reviews

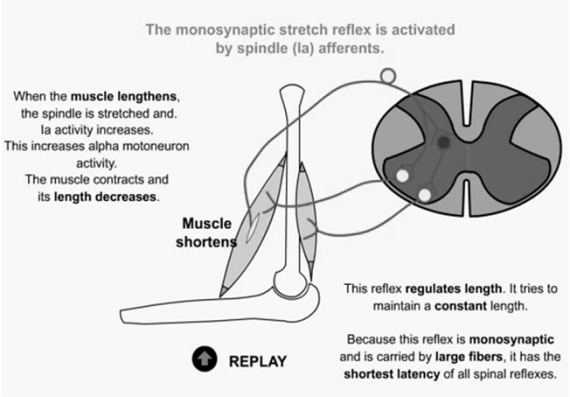
Receptors in Musculotendinous tissue

- Golgi tendon organ (GTO):
- GTO is in a shape of little bands connecting tendon fibers to muscular fibers. It has very low threshold and high dynamic sensibility.
- Provide muscle tension information to the central nervous system.
- Goal of the GTO is to transfer highly active muscle tension signal (resulted from contraction) more than passive muscular tension (the tension produced by inactive muscular stretching)

Muscle spindle

- The localization of the muscle spindle is on muscle tissue.
- Responsible for transferring the information of muscle length and changes in length of the muscle.
- The muscle spindles include specialized afferent endings, surrounds intrafusal fibers and are placed in capsular connective tissue

- Joint receptors work in higher rates during active motion
- The motor components of the sensorimotor system assist dynamic joint stability.
- The motor control is provided from 3 levels
  - Spinal cord
  - Brain stem
  - Cerebral cortex
  - two assistant area cerebellum and basal ganglia



Proprioceptive Function

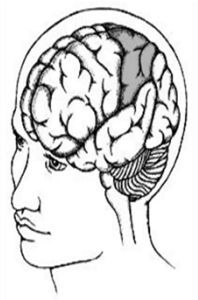
- Proprioception can supply a major part of the information needed for restoration of the movement problem
- The aims of the all-motor a preparation, providing and r of the stability of the body (postural stability) and segments (joint stability)

3 Components of proprioception

- Kinesthesia: The sense of joint motion.
- Joint position sense: The sense of joint position.
- Force sensation: The sense of amount of the produced strength.

Sixth Sense of Body Awareness

- Capsuloligamentous struct primarily responsible for kir and joint position sense, GT and muscle spindle are resp force sensation mostly, but receptors have a role in perception of the sense



Representations of the Body

Body Image

- Cognitive representation
- Based on stored knowledge
- Underlie perceptual judgement

Body Scheme

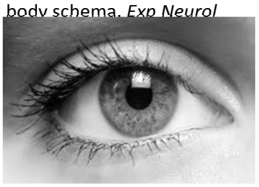
- Dependent on ongoing proprioceptive input
- Mostly on an unconscious level
- Concerned with body movement

Vision affects localization of pain

Vision Influences Body Scheme

- Normal subjects were asked to point with their left index finger to different parts of the hidden right arm
- The resting arm was systematically perceived to lie closer to the midline as well as closer to the body than its true position. Errors increased the longer the arm remained hidden.

- Gross Y, Webb R, Melzack R. Central and peripheral contributions to localization of body parts: evidence for a central body schema. *Exp Neurol*



Modify Visual Feedback

- Disrupting visual feedback as an adjunct to traditional rehabilitation may more closely mimic actual activity demands

- Eyes closed
- Blindfolded
- Nike Vapor Strobes: Using the same technology as the active shutter glasses of some 3D TV sets, these shade both lenses that switch between clear and blocked, helping you to anticipate what's coming before you even see it.

- **Vapor Strobe** is training equipment designed to help strengthen the connection between the eyes, the brain and the body
- During training, the SPARQ Vapor Strobe blocks or more accurately disrupts vision using a flicker effect (strobe – hence the name) that can be varied in speed – helping develop quicker reaction times and motor skills

The Wrist

- Wrist exteroceptive and articular proprioceptive mechanoreceptors consist of the Meissner corpuscles, Merkel discs, Ruffini endings, Pacinian corpuscle, and Golgi-like ending receptors.

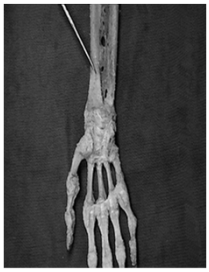
- Most of these receptors exist within the midportion of the dorsal (ie, radiocarpal, intercarpal) and volar wrist ligaments.

Wrist Evidence

Objective

- To investigate the possible existence of wrist ligamento-muscular reflexes (scapho-lunate interosseous ligament), and their potential influence on muscles acting on the wrist

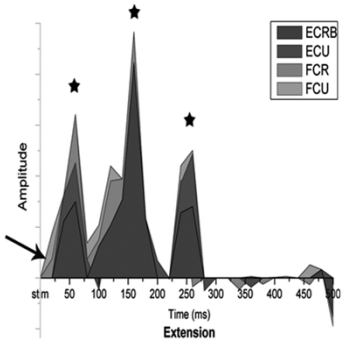
Hagert, Persson, Werner, and Ljung 2008



Methods

- Stimulated scapho-lunate interosseous ligament (SLIL)
- Recorded electromyographic (EMG) activities:
  - Extensor carpi radialis brevis (ECRB)
  - Extensor carpi ulnaris (ECU)
  - Flexor carpi radialis (FCR)
  - Flexor carpi ulnaris (FCU)
- In wrist extension, flexion, and radial and ulnar deviation

Electromyographic (EMG) Reaction Patterns During Wrist Extension



Evidence on the Wrist and Hand

- Desciptive Cross Sectional Study
- Objective:
  - To determine the magnitude of wrist and hand sensorimotor (SM) impairment after distal radius fracture (DRF)
  - Determine relationships among wrist and hand SM impairment with function and pain
  - Determine relationships among wrist and hand SM impairment and function and age following DRF
- **Karagiannopoulos C, Sitler M, Michlovitz S, Tierney R. *J Hand Ther* 2013**
- **http://dx.doi.org/10.1016/j.jht.2013.03.004**

Outcome Measures

- Ten Test (TT)
- Joint Position Sense (JPS)
- Electromyelography (EMG)
- Computerized hand grip dynamometer (CHD)
- Patient-Rated Wrist Evaluation (PRWE)

Proprioception of the wrist joint

Figure 11. Gc
rehabilitation of the wrist," by E. Hagert, 2010, *Journal of Hand Therapy*, 23(1), p.9. Copyright © 2010 Hanley and Belfus. Reprinted with permission.

- A JPS deficit of near 3° is considered to be normal among healthy adults
- The intratester reliability of this test has been determined to be high (intraclass correlation coefficient = 0.85)
- Correlation to function .645
- Statistically significant minimum detectable change values were 4.28 and 4.94 at 8 and 12 weeks, respectively. Clinically meaningful MCID values were 5.00 and 7.09 at 8 and 12 weeks, respectively.
- Statistically significant minimum detectable change values were 4.28 and 4.94 at 8 and 12 weeks, respectively. Clinically meaningful MCID values were 5.00 and 7.09 at 8 and 12 weeks, respectively.

- There was a significant difference on the TT between both DRF treatment groups and the control group. There was a significant difference on total EMG activity produced between both DRF treatment groups and the control group for all four assessed muscle sites. These differences had a strong effect size
- Both the surgical and non-surgical groups had significantly higher sensory (i.e., TT, JPS) and motor (i.e., total EMG and grip force) functional deficits than the non-injured healthy control group, but not between themselves

Two sensory variables assessed:

- JPS test had the highest clinically meaningfulness for determining sensori-motor impairment during a functional gripping task, resulting in the strongest correlation with the PRWE.
- Higher JPS impairment was associated with greater functional deficit among DRF participants.
- The clinical importance of JPS assessment is its usefulness for identifying deficits in conscious dynamic joint control which leads to decreased function following DRF.

Utility of Powerball in the invigoration of the musculature of the forearm

Balan & Garcia-Elias 2008

- 105adults without pathology exercised with device for 1 month
- Grip & forearm muscle endurance
- The reactive muscle contraction is likely to stimulate more efficient neuromuscular control of the wrist and justified to use with proprioception deficient patients

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Wrist Interventions

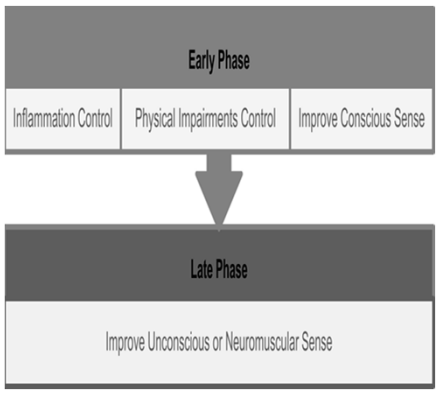
Journal of Hand Therapy

- Rehabilitation strategies for wrist sensorimotor control impairment: From theory to practice
- Christos Karagiannopoulos, MPT, PhD

Susan Michlovitz, PT, PhD

April–June, 2016Volume 29, Issue 2, Pages 154–165

Fig. 6



Journal of Hand Therapy 2016 29, 154-165DOI: (10.1016/j.jht.2015.12.003)

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Clinical priorities

- Pain
- Sensibility- Sensory reeduction
- AROM
- Conscious Proprioception

Early

- Early emphasis on pain control can be achieved via proper education for activity modifications, visual feedback input (ie, mirror therapy)
- Vibration and or Tactile Stimulation
- Closed Chain wrist ball rolling

Mirror Therapy & Wrist Pain

- Visual input from moving unaffected limb reestablishes the pain free relationship between sensory feedback and motor execution
- Helps patients understand pain is not an accurate representation of actual condition

- Photo courtesy Hss.edu

Sensory Re-education Hot pack/cold pack

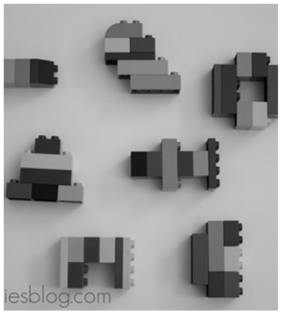
- Select pack of certain temperature from within a bag with multiple packs of varying temperature (warm, room, cold). Remove pack and place on table.

Sensory Re-education Texture dowels

- Wooden dowels with center openings are created with different thickness and/or different textures. Create a target object with 3 dowels on a rod. After manual exploration, participant is asked to recreate the same pattern on another rod. Dowel widths and textures can be varied.

Sensory Re-education Lego Rebuilding

- Trainer constructs an object of Lego™ that is manipulated behind a curtain; reconstruction of the object is completed on the visualized side of the curtain. Trainer can alter the number, orientation, and size of blocks used.

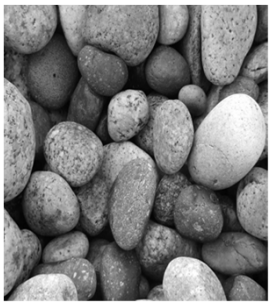


Manual Techniques

- Passive placement of the wrist by the therapist and active reproduction of the reference wrist positions with vision blocked may enhance the conscious JPS.

Object Manipulation and Grasping

- Simple activities such as grasping and turning a light hammer, grasping and placing stones in a bucket, rolling a ball on a table, and wiping a table with a towel can provide functional active ROM activities that encourage SM control



Intervention Ide

- Pick up objects with chop sticks
- Find objects hidden in putty, rice
- Coin, puzzle piece, shape or weighted plastic egg sorting
- Putty rolling

Interventions & Ideas

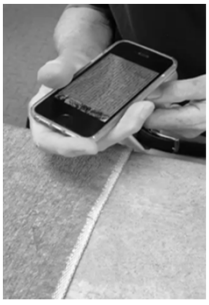
- Chinese balls
- Wrist Maze

Technology: There's an app for that

- To improve patient compliance with home program
- As a purposeful activity
- To keep people engaged in a task
- As part of a home program

Lab: Download these Apps

- Aerox
- Magic Broom
- Big Mountain Snowboarding
- Gyrosphere
- Retro Labyrinth



Tilt Maze

Labyrinth

Late phase of SM control: Once tissue healed

- Goal: enhance individual muscle strengthening and joint stability via reactive muscle activation patterns

Conscious Neuromuscular Rehabilitation

- Isometric exercises: static and serve to strengthen muscles at specific joint angles. They are, furthermore, easy to use, will quickly build muscle strength and are the type of exercise most frequently used in hand therapy training after carpal instabilities

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Resistance Training

- Resistance training plays a vital role to play in laying the foundations for greater power (power = strength x velocity) and pre-conditioning an athlete for plyometrics. Resistance training can facilitate a larger and stronger muscle, which will be able to generate greater force plyometrically; additionally, strengthened tendons and muscles will be less prone to strains and pulls

- Eccentric exercises designed to strengthen the muscle while it is lengthened, usually because of an opposing load
- Influence co-activation patterns of wrist flexors which will undoubtedly influence the global stability of the wrist joint

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Co-activation

- Simultaneous contraction of agonist and antagonist muscles across a joint demand the use of eccentric, concentric, and isometric exercises
- Exercises will likely produce a re-education of wrist "balance

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Unconscious Neuromuscular Rehabilitation

- Reactive muscle activation aims at restoring the neuromuscular reflex patterns that exist in a normal joint and which have been shown to be disturbed in a ligament-deficient joint
- Multidirectional motion generated by the gyroscope, which demands a reflex activation of the wrist muscles and an unconscious activation of both agonist and antagonist muscles

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Dynaflex ball comparison

Closed Chain Activity

Plyometric exercises: muscle achieves max contraction in shortest amount of time

- **1st phase:**
  - Eccentric loading: The eccentric phase, or landing phase, involves the preloading of the agonist muscle group.
  - During this phase elastic energy is stored & muscle fibers are stimulated
  - Example: Ball coming into contact with hand during catch

- **2nd phase:**
  - Amortization: or transition phase, is the time between the concentric and eccentric phases
  - This phase of the stretch shortening cycle is perhaps the most crucial in production of power as the duration of amortization must be kept at a minimum.
  - If the transition phase lasts too long, the energy stored during the eccentric phase dissipates, thereby negating the plyometric effect. Then it becomes just a standard exercise.

- **3rd phase:**
  - **Concentric Phase**
  - The concentric phase, or take-off phase, is the response to the eccentric and amortization phases.
  - During this phase, elastic energy is utilized to increase the force of the subsequent movement or is dissipated as heat. The force is increased beyond that in isolated concentric muscular action.
  - An example of this is the forceful throw of the ball

Performing the repeating, perturbing plyometric tasks

- Creates increased muscle tension in preparation to the task being performed, which may have increased awareness of joint position

Hammering

- Make your own device
  - Wooden Hammer
  - Florist Foam Block
  - Golf Tees

Interventions & Ideas

- Push/Pull Weight Box
- Tug of War

Journal of Hand Therapy 29 (2016) 183–190

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journal homepage: www.jhandtherapy.org

JHT Read for Credit Article #413.

Special Issue: Wrist

Proprioception retraining for a patient with chronic wrist pain secondary to ligament injury with no structural instability

Olga L. Hincapie PT, DPT, CHT[a,*], Jeananne S. Elkins PhD, DPT, MPH[b], Laura Vasquez-Welsh MsOT, CHT[a]

[a] NYU Langone Medical Center, Center for Musculoskeletal Care, Hand Therapy Service, New York, NY, USA

[b] Northeastern University College of Professional Studies, Boston, MA, USA

Client was seen for 20 Therapy visits

Table 1
Six-stage rehabilitation program[24]

Stage of proprioception rehabilitation	Rehabilitation plan
Stage 1	Basic rehabilitation: edema, pain control, and ROM
Stage 2	Proprioception awareness
Stage 3	JPS
Stage 4	Kinesthesia
Stage 5	Conscious neuromuscular rehabilitation
Stage 6	Unconscious neuromuscular rehabilitation

ROM = range of motion; JPS = joint position sense.

Interventions

- Early
  - Mirror therapy
  - Blinded reproduction of passive angle
  - Dart Throwers Motion without weight
  - Isometric exercises
- Late
  - Dart throwers motion with weight
  - Reactive Muscle Activation
  - Rhythmic stabiliation
  - Gyroscope
  - Body Blade
  - Throws into rebounder
  - Upper Body Ergometer

Table 3
Description of the home exercise program

Session	Exercise	Frequency
1-4	DTM with no weight (crumbled paper) Isometrics in the DTM plane Controlled weight bearing in standing and pressing the soft ball against the wall	10-20 repetitions, 2 times/d 10 repetitions, 2 times/d 10 repetitions/d
5-8	DTM starting with 1 lb medicine ball Controlled weight bearing in standing and pressing the soft ball against the wall PNF D2 flexion with light elastic band (simulating taking out a sword)	2 sets of 10 repetitions, 2 times/d 10 repetitions, 2 times/d 10 repetitions/d
9-20	DTM with 3 lb medicine ball Controlled weight bearing in quadruped (as tolerated) PNF D2 flexion with moderate resistance elastic band	2 sets of 10 repetitions, 2 times/d 10 repetitions/d 2 sets of 10 repetitions once a day

DTM = dart-throwing motion; PNF = proprioceptive neuromuscular facilitation.

Outcomes

Description of outcome measures at initial evaluation, re-evaluation, and discharge

Outcome Measures	Initial evaluation	Re-evaluation	Discharge
		9th session	20th session
JPS	Absolute error	Absolute error	Absolute error
30°	15°	10°	0°
45°	20°	15°	5°
35°	18°	15°	0°
Grip strength	(R) 36.6 lb (L) 60 lb	(R) 58 lb (L) 60 lb	(R) 65 lb (L) 60 lb
QuickDASH raw score	33	21	18
PRWE total score	61.5/100	19.5/100	17.5/100
PRWE pain	33	9	8
PRWE function	28.5	10.5	9.5

JPS = joint position sense; R = right; L = left; QuickDASH = Quick Disabilities of the Arm, Shoulder and Hand; PRWE = patient-rated wrist evaluation.

Hand Therapy

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Early outcomes of 'The Birmingham Wrist Instability Programme': A pragmatic intervention for stage one scapholunate instability

Martin K Holmes , Sarah Taylor , Caroline Miller , MBS Brewster

5 patients with stage 1 scapholunate instability completed a program of dynamic stability for 16 months
Mean grip increased by 45%
VAS improved by 5.5 points
Quick Dash improved 33.9%

Questions


Thank You