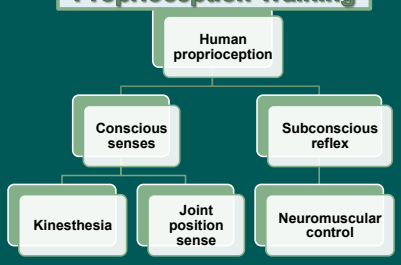
Conservative management

Proprioception Training



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Proprioception: Conscious senses

Kinesthesia (Ability to sense motion of a joint): Primarily influenced by muscle spindles +++ and skin receptors.

Kinesthesia is measured as the smallest change in joint angle needed to elicit a conscious awareness of joint motion "threshold to detection of passive movement" (TTDPM).

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Proprioception: Kinesthesia

Clinical application:
Professional training devices such as an Upper Limb Exerciser (Biometrics Ltd, Ladysmith, VA) or a Biodex Dynamometer (Biodex Medical System Inc., Shirley, NY) is recommended to adequately control the speed and degree of motion.

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Proprioception: Conscious senses

Joint Position Sense (JPS):
Sense of position is influenced by muscle command and muscle conditioning.

JPS is defined as the ability to reproduce a specific joint angle.

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Proprioception: Conscious senses

Clinical application:
Passive: The therapist moves the wrist and the patient signals when the target position is reached.
Active: The patient moves the wrist actively to the predetermined target position.

Note:
This can be done either passively or actively, with visual cues of blinded.
Easily assessed using a goniometer, however high inter and intraobserver variability and lack of reliability.

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Proprioception: Conscious senses

Kinesthesia and JPS are well suited for early stage of proprioception re-education as they can be used in all stages of wrist rehabilitation without risk of inducing harm.

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Proprioception: Subconscious sense

Neuromuscular sense:
Pertaining to this sensation is the feed-forward anticipatory control of muscles around a joint, as well as the ability to unconsciously retain an adequate posture and maintain joint stability and equilibrium.

Greatly influenced by spinal reflexes for immediate joint control, as well as integration in the cerebellum for planning, anticipating, and executing joint control.

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Proprioception: Neuromuscular sense

Goals of neuromuscular rehabilitation:

1- Regain smooth and balanced global motion of the wrist.
2- Use dynamic muscular compression to compensate for decreased ligamentous restraint.
3- Promote motion in muscles that are joint protective and avoid activation of muscles that are potentially joint damaging.

Design details depend on type of injury/surgery and purpose of rehabilitation regime.

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Proprioception: *Conscious* Neuromuscular Rehab

Types of neuromuscular rehabilitation:
Isokinetic: (constant angular speed)

-Improves strength, endurance, overall proprioceptive joint functions.
-Of more value for patient with extreme demands on wrist function (professional athletes or musicians).
-Demands special equipment, as well as being costly and time consuming.

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Proprioception: *Conscious* Neuromuscular Rehab

Types of neuromuscular rehabilitation:
Isometric: (fixed joint angle, constant muscle length)

-Easy to use.
-Quickly builds muscle strength.
-Safe to use early after surgery.
-Most frequently used in hand therapy training after carpal instabilities.

Note: unilateral isometric exercises of the wrist have been shown to increase voluntary muscle activation bilaterally.

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Proprioception: Isometric exercise examples

Ulnar or midcarpal instability pattern:
FCU compresses pisiform against the triquetrum and prevent volar subluxation.

SL instability (partial injury or SL laxity only):
FCR is an important dynamic stabilizer of the scaphoid through its compressive action on the STT joint.

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Proprioception: Isometric exercise examples

Optimization of the time response of flexor carpi radialis (FCR) muscle to wrist loading may play an important role in reestablishing the necessary equilibrium for adequate transfer of loads.

Dorsal RS capsule and dorsal SL ligament must be INTACT.

Linscheid RL, Dobyns JH. Dynamic Carpal Stability. Keio J Med 2002; 51(3):140-147.

Green DP, Pederson WC, Hotchkiss RN, Wolfe SW. Green's Operative Hand Surgery 5th ed. Elsevier Inc. Philadelphia. 2005.

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Proprioception: Isometric exercise examples

FCR strengthening exercises are totally ***contraindicated*** when the dorsal SL ligament is torn.

Scaphoid dorsal translation + Subluxation of its proximal pole

Green DP, Pederson WC, Hotchkiss RN, Wolfe SW. Green's Operative Hand Surgery 5th ed. Elsevier Inc. Philadelphia. 2005.

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Proprioception: Isometric exercise examples

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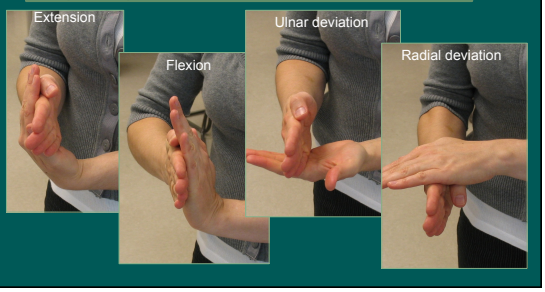
Proprioception: Isometric exercise examples



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Proprioception: ***Conscious*** Neuromuscular Rehab

Types of neuromuscular rehabilitation:

Eccentric: (muscle contraction with elongation)

-Most frequently used in the rehabilitation of chronic tendinopathies.
-Beneficial in dynamic action throughout joint motion.
-Primary gain of eccentric training lies in the secondary concurrent effects on antagonist muscles.
-Have been shown to have an influence on the co-activation pattern of wrist flexors, influencing stability.

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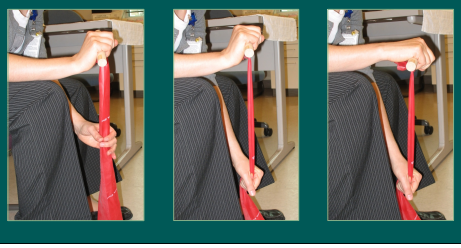
Proprioception: ***Conscious*** Neuromuscular Rehab

Eccentric: Theraband

Eccentric wrist extension



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Proprioception: ***Conscious*** Neuromuscular Rehab

Eccentric: Flexbar

Thera-Band.com

Weight and dowel

Eccentric wrist extension

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Proprioception: *Conscious* Neuromuscular Rehab

Types of neuromuscular rehabilitation:
Co-activation: (simultaneous contraction of agonist and antagonist)

-Re-education of wrist "balance".
-Occurs as later onset reaction after stimulation of the SL ligament.
-Demand the use of eccentric, concentric and isometric exercises.

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Proprioception: *Conscious* Neuromuscular Rehab

Co-activation:
Similar to the balance plate used in ankle instability (Biomechanical ankle plate-form system-BAPS board) which have been shown to greatly increase the proprio-ception and co-activation pattern around the ankle joint.

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Proprioception: *Unconscious* Neuromuscular Rehab

Reactive muscle activation (RMA):

-Most important in wrist proprioception function.
-Aims at restoring the neuromuscular reflex patterns that exist in a normal joint.
-Uses *perturbation* exercises.

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Proprioception: *Unconscious* Neuromuscular Rehab

In patient with SL instability, sudden contraction of ECU may generate excessive torque at the MCJ thus increasing SL gap.

RMA* focus:
Enhancing muscles protecting SL joint (FCU and ECRL) while inhibating ECU.

→ Plyometric exercises using Dart throwing motion DTM

*RMA = Reactive muscle activation

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Proprioception: *Unconscious* Neuromuscular Rehab

Study of 8 healthy subject. Mean age 26 y.o. Electric stimulation of the SL ligament while EMG activity was recorded in the ECRB/L, ECU, FCR, and FCU with wrist in flexion, extension, UD and RD. The experiment was repeated following selective anesthesia of the posterior interosseous nerve (PIN).

Dramatic alteration of reflex patterns in flexion, RD and UD. 72% reduction in excitatory reactions.

Wrist proprioception through the scapholunate ligament in flexion, radial deviation, and ulnar deviation depends on an intact PIN function.

Hagert E, Persson JKE. Desensitizing the posterior interosseous nerve alters wrist proprioception reflexes. J Hand Surg 2010;35A:1059-1066.

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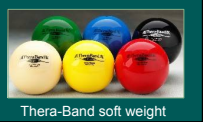
Reactive muscle activation (RMA):

Plyometrics "perturbation" exercises

Sammonspreston.com

OPTP B.O.I.N.G.

Artofmanliness.com



Thera-Band soft weight

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Reactive muscle activation (RMA):

Power ball

dynaflexpro.com

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Proprioception re-education: Other strategies

Visual influence
Cutaneous influence
Conscious appreciation of "self"

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Proprioception re-education: Other strategies

Visual influence

Mirror therapy:
-Shown to enhance both sensory and motor recovery after injury.
-Stimulates activity in somatosensory cortex.

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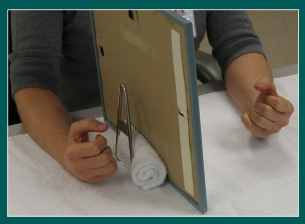
Visual influence | Mirror therapy



Dickstein R, Deutsch J. Motor imagery in physical therapy practice. Phys Ther. 2007; 87:942-53.

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Proprioception re-education: Other strategies

Cutaneous influence

Skin sensation of the hand has a powerful cortical representation and may act to suppress information from afferents within the wrist joint resulting in inhibition of an unconscious neuromuscular control.

It is hypothesized that cutaneous desensitization of the skin around the wrist would block cutaneous afferents, facilitate the afferent stimuli from articular mechanoreceptors, and thus, enhance a proper proprioception re-education.

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Cutaneous influence | Desensitization

Suggestions:
-Massage
-Desensitization bins
-Friction with air dried cloth
-Fluidotherapy

Sensory bins

Magic wand massager

Sammonspreston.com

Conservative management

Proprioception re-education: Other strategies

Conscious appreciation of "self"

Period of immobilization removes the influx of afferent information from the wrist joint itself and from the skin, muscle spindles, and the visual awareness of the wrist.

The total conscious appreciation of the patient's wrist is reduced.

Early conscious appreciation of proprioception will serve to stimulate the cortical area connected to sensorimotor joint control and possibly diminish the reorganizational changes observed in the cortex after nerve injury.

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Proprioception re-education: **Treatment plan**

Stages	Plan	Purpose	Techniques	Assessment
1	Basic rehab	Edema, pain control, promote motion	Basic hand therapy techniques	Visual analogue scale (VAS), ROM
2-3	Proprioception awareness, JPS.	Promote conscious jt. control, replicate jt. angle	Mirror therapy, blinded reproduction of jt. angle.	Accuracy of ROM (goniometer, exercise machine)
4	Kinesthesia	Ability to sense motion without audiovisual cues	Motion detection (exercise machine or passive motion)	Degree of jt. motion at which motion was sensed
5	Conscious NM rehab	Specific strengthening for jt. stability	Isometric, eccentric, isokinetic, co-activation training	Evaluation of specific muscles, wrist stability observation
6	Unconscious NM rehab	RMA	Powerball, plyometrics	Muscle activation pattern (EMG)

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