Neck Pain
ICF Based Clinical Practice Guideline

Combined Sections Meeting 2016
Anaheim, California, February 17-20, 2016

Speakers
(in order of appearance)

- Joseph Godges, DPT, MA, OCS
  - CPG Coordinator for Orthopaedic Section, APTA
  - Associate Professor, USC
- Peter Blanpied, PhD, PT, OCS, FAAOMPT
  - Neck Pain CPG Revision Team Lead
  - Professor, URI
- James Elliott, PhD, PT
  - Assistant Professor, Northwestern
  - Honorary Senior fellow, Queensland University
- Laurie Devaney, PT, MSc, ATC, OCS, FAAOMPT
  - Clinical Instructor, UCONN
  - PhD Candidate, Exercise Science, UCONN

Speakers
(in order of appearance)

- Cheryl Sparks, PhD, PT, OCS, FAAOMPT
  - Assistant Professor, Bradley University
  - Co-Director, Orthopaedic PT Residency Program, Bradley University
- Derek Clewley, PT, DPT, OCS, FAAOMPT
  - Assistant Professor, Duke
  - PhD Candidate, Rocky Mountain University
- Eric Robertson, PT, DPT, OCS, FAAOMPT
  - Clinical Assistant Professor, U Texas El Paso
  - Director, Kaiser Fellowship in Advances Orthopaedic PT

Members of Our Team
Unable to Be Here

- Anita Gross, PhD, PT
  - Associate Clinical Professor, McMaster University
- David Walton, PhD, PT
  - Assistant Professor, Western University

Disclosure

- Joe Godges: No relevant financial relationship exists
- Pete Blanpied: No relevant financial relationship exists
- Jim Elliott: No relevant financial relationship exists
- Laurie Devaney: No relevant financial relationship exists
- Cheryl Sparks: No relevant financial relationship exists
- Derek Clewley: No relevant financial relationship exists
- Eric Robertson: No relevant financial relationship exists

Session Learning Objectives

Upon Completion of this presentation, the attendee should be able to:

- Identify current status of the Neck Pain CPG Revision
  Briefly describe methods used for external peer review
- Briefly describe the development process Neck Pain CPG
  Identify key features 4 categories of Neck Pain
- Identify measures, in relation to the screening, diagnostic and classification process, prognosis and outcomes
- Identify evidence-based interventions, related to category
- Apply content of CPG to case studies

Schedule

- 5 minutes: Overview, Methods, and Current Status - Joseph Godges
- 10 minutes: Guideline development processes
  Neck pain subcategories – Peter Blanpied
- 20 minutes: Measures, related to screening, diagnostic / subcategories, prognosis and outcomes - James Elliott, Laurie Devaney
- 10 minutes: Question/Audience discussion period
- 30 minutes: Interventions, related to neck pain subcategories – Eric Robertson, Cheryl Sparks, Derek Clewley
- 10 minutes: Question/Audience Discussion Period
- 20 minutes: Case Presentations
- 15 minutes: Panel discussion soliciting feedback from audience – Godges / Blanpied / Elliott / Devaney / Sparks / Robertson / Clewley

Overview of Clinical Practice Guidelines

- Overview of the process
- Methods
- Status of the Neck Pain CPG Revision

Neck Pain CPG Revision

- Development Process
  - Training of the lead
  - Recruit / Gather team
    - Training
    - Managing conflict of interest
    - Identifying librarian assistance
  - Initial decisions
    - Interaction with ICON
    - Study selection
    - Levels of evidence
    - Staging

Neck Pain CPG Revision

- Development Process
  - Initial decisions (cont'd)
    - Study selection
    - Article storage / screening & assessment process
    - Data extraction
    - Levels of evidence
    - Staging
  - Writing decisions
    - Sequence similar to clinical encounter
    - Use new Guide language
    - Narrative and systematic-like review
    - 3-part synthesis

Neck Pain CPG Revision

- Neck Pain Subcategories – treatment-based[1]
  - Neck Pain with Mobility Deficits
  - Neck Pain with Movement Coordination Impairments
  - Neck Pain with Radiating Pain
  - Neck Pain with Headache
- Literature rarely aligns to these subcategories

Pathoanatomy

- Clinicians should rule out serious pathology in patients with neck pain, however a direct pathoanatomic cause of mechanical neck pain is rarely identifiable.

Neck Pain CPG Revision

- Risk Factors: New Onset Neck Pain
  - Moderate-high quality evidence
    - Female gender (Paksaichol2012,McLean 2010)
    - prior history of neck pain
  - Low-moderate quality evidence
    - older age
    - high job demands
    - ex-smoker
    - low support
    - prior history of low back pain

Neck Pain CPG Revision

- Screening for Serious Pathology
  - Arterial Insufficiency
    - 2012 IFOMPT Cervical Framework document[2]
  - Upper Cervical Ligament Competency
    - 2012 IFOMPT Cervical Framework document[2]
  - Fracture
    - Canadian C.Spine Rules, NEXUS
  - Medical / Visceral Issues
    - Refer to many texts on differential diagnosis for PTs

Neck Pain CPG Revision

- Screening
  - Imaging
    - Canadian Cervical Spine Rules, NEXUS, ACR
    - Advanced imaging often not necessary unless +neuro[3]
    - In Neck Pain with Radiating Pain
      - MRI in painful and traumatic myelopathy[4]
    - In Neck Pain w/Movement Coordination Impairment
      - Often no structural pathology[5]
      - Upper C.spine ligamentous disruptions[6]
      - Muscular degeneration[7]

Neck Pain CPG Revision

- Physical Examination Measures
  - Cervical AROM
  - Segmental Mobility Assessment
  - Spurling's Test
  - Distraction Test
  - UE Neurodynamic Testing
  - Valsalva Test
  - Shoulder Abduction Test
  - Cervical Flexion-Rotation Test
  - Pain Pressure Threshold

Neck Pain CPG Revision

- Prognosis
  - Neck Pain with Mobility Deficit
    - Age and prior history of MSK problems[8]
    - Clinical course 0-12 weeks; 12weeks to 1 year[9]
  - Neck Pain with Movement Coordination Impairment
    - <50% Complete Recovery within 1 year[10]
    - Possible helpful factors in prognosis[11]
    - Clinical course 0-12 weeks; 12weeks to 1 year[9]

Neck Pain CPG Revision

- Prognosis (cont'd)
  - Neck Pain with Radiating Pain
    - Cervical Myelopathy[12]
      - Stable Course
      - Elderly and conservative management - likely worsening
  - Neck Pain with Headache
    - No information identified
- Outcomes
  - Neck Disability Index recommended[13]

Neck Pain CPG Revision

Questions / Audience Discussion

Neck Pain CPG Revision

- Interventions – Neck Pain with Mobility Deficit
  - Literature Update[14-26]
    - Level II: Cerv manip
    - Level III: Cerv mob, Thorac manip
    - Level II: ROM +educ +advice
      Cerv+ST stretch&strengthen
      ST+UE strengthen&endurance
      DNF strengthen
    - Level III: Intermit, but not continuous traction
    - Level II: Dry needling, laser
    - Level II: NO BENEFIT for HP, IR, US and spray&stretch

Neck Pain CPG Revision

- Interventions – Neck Pain with Mobility Deficit
  - Confidence Statement
    - We have strong confidence based on high and mod level evidence that cerv manip, a variety of mobility and strengthen exercises, dry needling, and laser will benefit
    - We have mod confidence based on mod level evidence cerv mob, thoracic manip and intermittent traction will benefit
    - We have mod confidence based on mod level evidence that hot pack, infrared, ultrasound and spray and stretch will not benefit

Neck Pain CPG Revision

- Interventions – Neck Pain with Mobility Deficit
  - Recommendation
    - Clinicians should use cervical manipulation, mobility and strengthening exercises, dry needling, and laser for interventions in this subcategory
    - Clinicians should consider using cervical mobilization, thoracic manipulation and intermittent traction for interventions in this subcategory
    - Clinicians should consider NOT using hot pack, infrared, ultrasound and spray and stretch for interventions in this subcategory

Neck Pain CPG Revision

- Interventions – Neck Pain with Mov Coord Impair
  - Literature Update[11,17,27-31]
    - Level II: Cerv AROM +mob or manip +pt ed (acute/subacute)
    - Level III: Stretching & strengthening, not +AROM Laser (chronic stage only)
    - Level II: NO BENEFIT from collar use

Neck Pain CPG Revision

- Interventions – Neck Pain with Movement Coordination Impairment
  - Confidence Statement
    - We have strong confidence based on mod level evidence that cerv AROM combined with MT and pt ed when applied in the acute / subacute stage will benefit
    - We have mod confidence based on mod level evidence that cerv stretch and strengthen when applied in the chronic stage will benefit
    - We have mod confidence based on mod level evidence that collar use will not benefit

Neck Pain CPG Revision

- Interventions – Neck Pain with Movement Coordination Impairment
  - Recommendation
    - In the acute / subacute stage, clinicians should use cervical AROM combined with manual therapy and patient ed for interventions
    - In the chronic stage, clinicians should consider using stretching and strengthening exercises, but only if not using AROM exercises for interventions
    - Clinicians should not use collar wearing as an intervention

Neck Pain CPG Revision

- Interventions – Neck Pain with Radiating Pain
  - Literature Update[14,15,21,22,24,32,33]
    - Level II: Mobilization: No difference in segment treated
    - Level III: Mobilization + Exercise: No benefit compared over collar
    - Level III: Mobilization + Manipulation: No benefit over strengthening
    - Level III: Stretching and strengthening
    - Level III: Laser
    - Level III: Intermittent traction
    - Level III: TDN / acupuncture

Neck Pain CPG Revision

- Interventions – Neck Pain with Radiating Pain
  - Confidence Statement
    - We have weak confidence based on low level evidence that stretching and strengthening exercise, laser, intermittent traction, and dry needling will benefit

Neck Pain CPG Revision

- Interventions – Neck Pain with Radiating Pain
  - Recommendation
    - Recommendation carried forward from 2008: Clinicians should consider the use of upper quarter and nerve mobilization procedures to reduce pain and disability in patients with neck pain with radiating pain.
    - Clinicians may consider the use of cervical stretching and strengthening in patients with acute or subacute neck pain with radiating pain.
    - Clinicians may consider the use of mechanical intermittent cervical traction, combined with other interventions such as manual therapy and strengthening exercises, for reducing pain and disability in patients with neck pain with radiating pain.

Neck Pain CPG Revision

- Interventions – Neck Pain with Headache
  - Literature Update[10,14,34-39]
    - Level II: Manipulation high dose (short term)
    - Level III: Multiple sessions of cervical or CT manipulation
    - Level II: Manipulation + Mobilization
    - Level II: Manual therapy + Exercise
      - Compared to a control but no benefit adding manual therapy
    - Level II: Cervicoscapular and endurance exercise
    - Level III: Self SNAG

Neck Pain CPG Revision

- Interventions – Neck Pain with Headache
  - Confidence Statement
    - We have moderate confidence based on moderate level evidence that mobilization and manipulation will benefit
    - We have moderate confidence based on moderate level evidence that cervicoscapular strengthening and endurance exercise with pressure biofeedback will benefit
    - We have moderate confidence based on moderate level evidence that benefit from manual therapy or exercise, but both not needed

Neck Pain CPG Revision

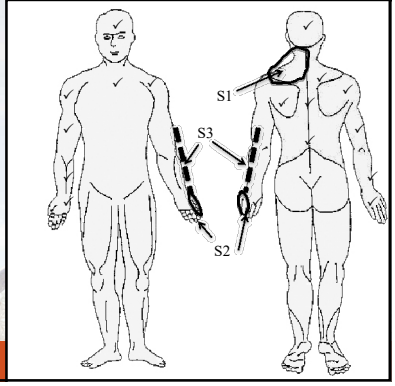
- Interventions – Neck Pain with Headache
  - Recommendation
    - In selecting treatments, clinicians should consider cervicoscapular strengthening and endurance exercise or manual therapy, but perhaps not both in the treatment of chronic neck pain with headache

Neck Pain CPG Revision

Questions / Audience Discussion

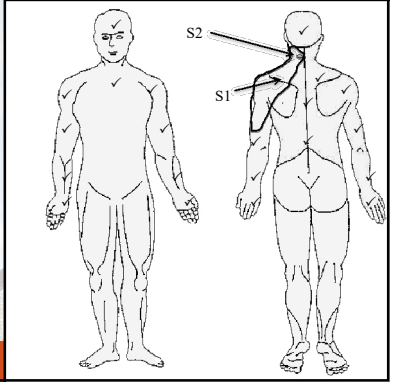
Case Study #1

- CS is a 32 y.o ♂ construction worker
  - Occas. shooting pain R arm
  - Gradual onset pain/numb R hand
  - Direct access



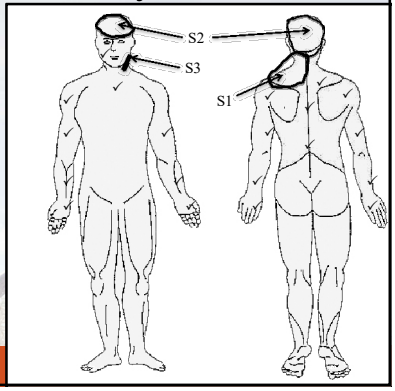
Case Study #2

- LD is a 50 y.o ♀
  - Medical Dx
    - Cervical OA
    - Type II DM
  - Smoker 1ppd
  - Imaging positive
    - C.spine DJD
    - C. Spine DDD
    - Central disk protrusion
      - C4-5 mild
      - C5-6 mod
      - C6-7 mod



Case Study #3

- HS is a 20 y.o ♀ 2 weeks s/p MVA (serious)
  - Medical Dx
    - Concussion
    - Neck Strain
    - Shoulder contusion
  - Imaging negative
    - C.spine
    - Shoulder
    - CT scan head



Neck Pain CPG Revision

Panel Discussion

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An ICF-Based Clinical Practice Guideline for Distal Radius Fracture
Work-to-date

Hand Rehabilitation and Orthopaedic Sections
of the American Physical Therapy Association

Presentation objectives

- Describe prognostic factors for recovery following DRF
- Describe pathoanatomy, imaging and surgeon's management following DRF
- Explain the evidence for examination procedures and outcome measurement tools following DRF based on ICF
- Use clinical reasoning to incorporate evidence-based interventions into physical therapy management following DRF

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Christos Karagiannopoulos, Joy MacDermid, Saurabh Mehta, Susan Michlovitz

Financial disclosure

Jerry Huang consultant for Arthrex, Acumed

Steps in developing the CPG

- Put together a team
- Develop outline
- Search databases for relevant literature
- Appraise literature
- Think, get feedback, consolidate
- Formulate recommendations
- Send out for review
- Revise and finalize

Christos Karagiannopoulos, PT, PhD

Assistant Professor, DeSales University
Doctor of PT Program, Center Valley, PA

Certified Hand Therapist (CHT)

Saurabh Mehta, PT, PhD

Assistant Professor, School of Physical Therapy
Clinical Assistant Professor, Department of Orthopedic Surgery, School of Medicine
Marshall University, Huntington, WV

Jerry Huang, MD

- Associate Professor & Program Director
  Dept. of Orthopaedics & Sports Medicine
  University of Washington Medical Center
- Associate Editor, *Journal of Hand Surgery*

Joy MacDermid, PT, PhD

- Dr. James Roth Research Chair in Musculoskeletal Measurement and Knowledge Foundation
- University of Western Ontario, London, Ontario
- Editor-in-Chief, *Journal of Hand Therapy*
- $$$$$$ grant funding DRF

Susan Michlovitz, PT, PhD

- Adj. Associate Professor, Columbia University Department of Rehabilitation & Regenerative Medicine, Program in PT
- Associate Editor, *Journal of Hand Therapy*
- Certified Hand Therapist (CHT)

Challenges in developing a CPG for DRF

- Lack of uniformity of surgeons categorizing patients for their management
  - Patients treated by cast or splint; treated by ORIF
- Patients without complications/ with complications
  - Many rehab studies on patients without complicated recovery
- Patients with comorbidities and life style habits that complicate fracture healing and recovery of motion, activities
- Surgery studies report surgery: therapy studies report therapy

Two very different cases

Non-displaced stable DRF treated in a cast= 42 yo female

- Uneventful recovery: 3 therapy visits
- Goal: return to work as a violinist

Displaced, unstable DRF treated with cast for 4 weeks, then surgery- 67 yo female

- Stiff fingers!!!!
- Pain catastrophizing
- Loss of forearm rotation
- "Many" therapy visits
- Goals: Drive, ADLs, iADL

Outline for this presentation

- Epidemiology/etiology
- Pathoanatomy
- Imaging and surgeon's management of fracture
- Predicting outcomes/prognosis
- PT Classification, outcomes measures and exam
- Therapist's Interventions
- Integrating evidence: Case examples
- Summarizing remarks

DRF
Epidemiology & Etiology

Christos Karagiannopoulos PT, PhD

Epidemiology

Most common UE fracture

- 18-44% all ER fractures
- Active functionally independent adults
- Low incidence 2nd & 3rd decade
- Sharp increase post 4th decade (♀)
- No change for men till 65
- DRF incidence ♀:
  - 40-65 years: 2.2 - 4.6/1000 per-years
  - 65-90 years: 6 - 12/1000 per-years
- DRF incidence males: 1.4 – 2.7 > 40 years

Cummings, 1989; Singer 1998; Thomson, 2004; O'Neil, 2001

Etiology

Both low- & high-energy injury mechanisms

High-energy trauma for young adults
- – Sports, occupational trauma

Low-energy for older aged groups
- – Fall on outstretched arm from standing
- – Decreased BMD

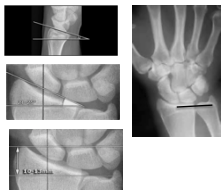
Chen & Jupiter, 2007; Handoll et al., 2006

Distal Radius Anatomy

- Foundation of the wrist – anatomic bridge hand-FA
- Metaphyseal region
  - – Thicker convex dorsal – Lister tubercle – fulcrum Ext tendons
  - – Curved palmar aspect – anterior articular flare
- Biconcave triangular articular surface
  - – Concave scaphoid & lunate fossa and ridge
  - – Apex: Rad styloid, base sigmoid notch
  - – Dorsal – volar ligamentous attachments
- Multiple joints involved
  - – Radio-carpal Joint
  - – Ulnocarpal - TFCC
  - – DRUJ

Normal Anatomy

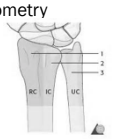
- Articular surface slopes in ulnar & palmar directions:
  - – Volar tilt angle (11˚)
  - – Radial inclination angle (23˚)
- Radius-ulna relationship:
  - – Radial height (12 mm)
  - – Ulnar variance (< 1mm)



Gartland & Werley, 1951; Pogue et.al., 1990

Biomechanics

- Axial compressive loads based on articular geometry
  - Ulnar-palmar inclination
  - Radial > Ulnar: 80/20%



- Distal radius part of the 3 columns:
  1. Lateral: scaphoid fossa – Osseous buttress
     Stability: Greater bony contact & RC ligaments
  2. Intermediate: lunate fossa- Primary load (46%)
     Greater compressive forces: Fx propagation
  3. Medial: UC joint -Axis for FA rotation

Rikli & Regazzoni, 1996

Pathoanatomy

- DRF:
  - Distal 10% of the radius (3-4 cm) (Augat, 1996)
  - Various types: extra- or intra-articular
    - Raia & Catalano, 2007; Chen & Jupiter, 2007

Fracture when external forces > maximum bone-yield capacity

  - Strongest independent factors for a DRF
    - Area BMD
    - Cortical & trabecular thickness / architecture
    - Estimated strain point for bone failure

Boutroy et al., 2008

Pathoanatomy

Strong correlation: (Augat, 1996)
- Load at Fx site – Distal radius bone morphology

Metaphyseal region is vulnerable to fracture (Cummings, 1985)
- 30-50% less cortical bone than diaphysis
- Mostly (50-70%) trabecular bone
- Trabecular bone total volume differences (Lutz, 2015)
- Volar > dorsal – compression region

Pathoanatomy

Based on the cortical and trabecular bone morphology
- 3D peripheral comp. CT on fresh cadavers (mean age 80 yo)
- Distal radius failure load-point
  - 1-7% of bone tissue strained beyond its yield strain capacity
  - 1.24 to 2.04 kN (1000 -2000 N) force

Pistoia et al., 2002

Pathomechanics

Fracture lines through weak trabecular region (Simic & Weiland 2003)
- Through/between the scaphoid and lunate fossa
  - Dorsal radius articular surface – intra-articular
  - Compressive forces – comminution

High-resolution 3D CT imaging (Ulrich et al., 1999)
- Various impact loads through carpus (mean 1000 N)
- Greatest tissue strain energy density: 10 mm region from articular surface

Patho-mechanics

Predictable bone strain sub-regions within distal radius (Ulrich et al., 1999)
- 4 distal areas: cancellous bone – near articular surface
- 4 proximal areas: cortical + cancellous bone

Sub-region bone strain depends on load distribution on carpal bones (L:S)
- Determined by hand position during fall
- Lunate vs. scaphoid overload
- Region specificity to fx

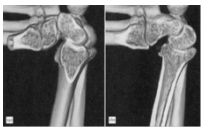
Ulrich et al., 1999

Fracture force direction

Chen & Jupiter, 2007; Pechlaner et.al., 2002

Bending moment – Hyper-extension (most common)
- Dorsal compression & angulation/Volar structures in tension
- Colle's fracture

Bending moment – Hyper-flexion
- Smith's fracture (Smith & Floyd, 1988)
  - Increased palmar tilt & pronation



Pathomechanics

Compressive moment – distal radius comminution

Shearing moment - palmar or radial translation
- Barton/reverse Barton (Barton , 1838; Thompson & Grant,1977)

Pathomechanics

Fracture leads to joint alignment and congruency alterations

Common Deformity

- Dorsal angulation – extension moment
  - >10° = loss of normal radial palmar tilt
  - Altered carpal alignment - mid carpal instability (Park 2002)
  - 45° = 65% shift of load to UC joint (short et al., 1987)
- Radial shortening - comminution
  - Loss of normal radial & palmar inclination angles (Warwick, 1993)
  - Rotation deformity (supinated fragment)
  - Dorsal angulation
  - Brachioradialis: proximal and dorsal pull (Sarmiento, 1965)

Common Deformity

Radial shortening – most common deformity (Cooney et al., 1980)
- Up to 5 mm: 20% grip strength up to 3 yrs (Villar et al., 1987)
- Positive ulnar variance – sig UCJ impaction
- Increased TFCC compression (Palmer, 1984; Adams, 1993)

Ulnar Variance

Radial shortening
- Load distribution changes:
- 80/20: Normal
- 60/40: Increased ulnar variance by 2.5 mm (Palmer, 1984)

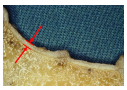
Common Deformity

Intra-articular step-off deformity

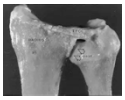
- Loss of RCJ congruency - abnormal force distribution
  - Average cartilage RCJ thickness <1mm (Pollock 2013)
    - >1mm may lead to OA
  - ≥ 2mm linked to developing long-term joint arthrosis (Field 1992)

Poor x-ray inter-rater agreement among surgeons:

- Inter-rater error ≥ 3 mm (Kreder, 1996)
- Inter-rater ICC 0.628 - 0.742 (Heo, 2012)



Common Deformity



- Ulnar styloid fracture (incidence 50-65%) (Sammer, 2009)
  - Prognostic value for DRUJ instability, prolong pain & function?
  - Based on location (tip vs. base), displacement & union levels
- Biomechanical model:
  - USF influences DRUJ stability during FA rotation (Mirarchi, 2008)
- Earlier research: (Mikic, 1995; May, 2002)
  - USF at base and > 2 mm → Increased risk for DRUJ instability
  - Increased L-T ulnar wrist pain response

Common Deformity

Current strong evidence: USF vs. no USF
Sammer, 2009; Zenke, 2009; Souer, 2009; Kim, 2010; Daneshvar, 2014

Trend for slower recovery of AROM (flexion, UD) and grip strength
No statistically sig differences: (up to 2 years)

- Function (i.e., DASH, MHQ, PRWE), ROM, pain & DRUJ instability
- Regardless location, displacement, size & union status
- Patients with ORIF & volar plate
- (+) ORIF effect on DRUJ stability
- No surg vs. non-surg data

USF is a not a good predictor of TFCC injury
Richards et al., 1997; Lindau et al., 2000

Surgeon Perspective: Classification, Imaging, and Decision-Making

Jerry I. Huang, MD
Assoc. Professor and Program Director
Dept of Orthopaedics and Sports Med
University of Washington Med Ctr

Orthopedic Surgeon Perspective

- Classification

➔ What am I cutting?

- Imaging

➔ What do I need to see to cut?

- Decisions

➔ What do I cut with?

Case: 25 yo Male FOOSH

Case

- Intra-articular DRFx
- Ulnar styloid fx
- Classification?
- More Imaging?
- Best Treatment?

Distal Radius Fracture Classification

- ICD-9 code: 813.42 (Distal radius fx)
- ICD-10 codes
  - S52.5 Fracture lower end of radius
  - 5th digit
    - 0 Unspecified
    - 1 Radial styloid
    - 3 Colles
    - 4 Smith
    - 5 Extra-articular
    - 6 Barton
    - 7 Other Intra-articular

Classification: ICD-10

- Other ICD-10 codes for associated health conditions/ injuries
  - S52.6 Fracture of lower end of ulna
    - 5th digit (0 unspecified, 1 ulnar styloid, 2 torus)
  - S63.0 Subluxation and dislocation of wrist
    - 5th digit (0 unspecified, 1 DRUJ, 2 radiocarpal, 3 midcarpal, 4 thumb CMC, 5 other CMC,…)
  - S63.3 Traumatic rupture of ligament of wrist

Fracture Classification Systems

Colles' Fracture	1814: earliest classification
Barton's Fracture	1838: Intra-articular shear w/ dislocation
Gartland & Werley	1951: Extra-articular vs. Intra-articular
Older et al	1965: Severity dorsal angulation & shortening
Frykman	1967: Intra-articular & distal ulna Fx patterns
Melone	1984: Intra-articular components
McMurtry & Jupiter	1991: Intra-articular fragment size
Muller/ AO-ASIF	1991: Extra, Partial, Intra-articular; Comminution
Fernandez	1993: Injury mechanism (5 types)

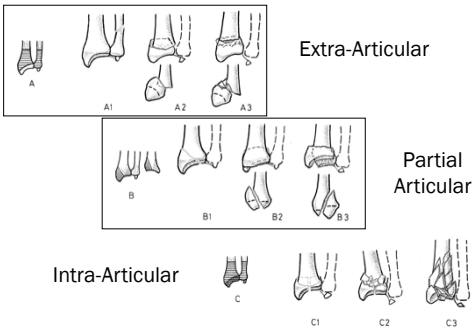
Classification Systems

- Value to surgical decision making?
- Predict prognosis and functional recovery?
- Guide rehabilitation decisions?

Best Classification-Solgaard 1985

- Comparison 5 Classifications
  - Nissen 1939
  - Gartland & Werley 1951
  - Lidstrom 1959
  - Older 1965
  - Frykman 1967
- Older classification superior: amount of displacement and shortening
- Quality of REDUCTION is KEY

AO Classification (Most Common)



Extra-Articular

Partial Articular

Intra-Articular

AO Classification

- Kreder et al. JBJS Br 1996 looked at Intra- and Inter-rater reliability?
  - Good for A, B, and C
  - Poor for subtypes for comminution
- Good as Research Tool

Best Classification / Paradigm

- International Distal Radius Fracture Study Group and IFSSH Board of Directors (update 2006)
  - *No consensus on best classification* ➔ *unanimous decision: generic in nature*
  - Location (extra vs. intra), Configuration simple vs. comminuted)
  - Displacement
  - Ulnar Styloid and DRUJ Integrity
  - Stability ➔ Lafontaine
  - Associated Injuries

Fernandez-Jupiter Classification

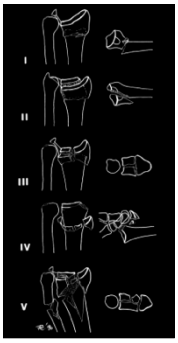
I Bending metaphysis

II Shearing joint

III Compression joint

IV Avulsion radiocarpal

V Combined mechanism (high energy)



Fernandez-Jupiter Classification

I Bending metaphysis ➔ **Neutralization**

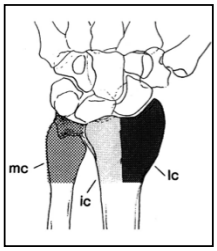
II Shearing joint (Barton)➔ **Buttress**

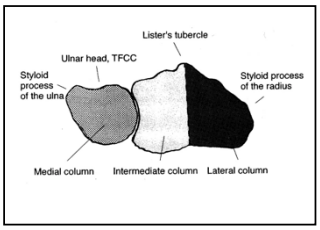
III Compression joint ➔ **Articular congruity**

IV Avulsion radiocarpal ➔ **Stability joint**

V Combined mechanism ➔ **High energy**

Rikli and Regazzoni 3-Column

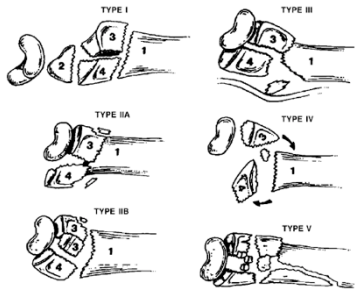




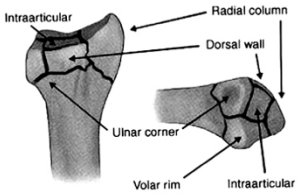
3 Column Theory

- Lateral column
  - Osseous buttress + capsular attachment
- Intermediate column
  - Load transmission
- Medial column
  - Axis forearm rotation

Melone Classification



Fragment Specific- Medoff



Imaging Study

- Plain Radiographs
  - PA, Oblique, Lateral
  - Post-Reduction or Traction Views
- CT Scans
- MRI for associated soft tissue injury

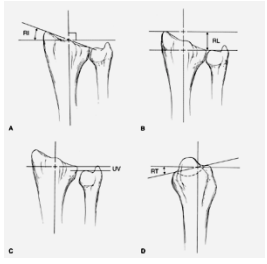
Radiographic Parameters

Radial inclination
- 23°

Volar tilt
- 11°

Radial length
- 12 mm

Ulnar variance



Tear Drop Angle

Normal: 70°

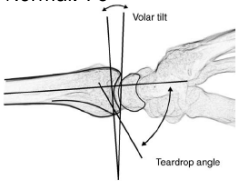
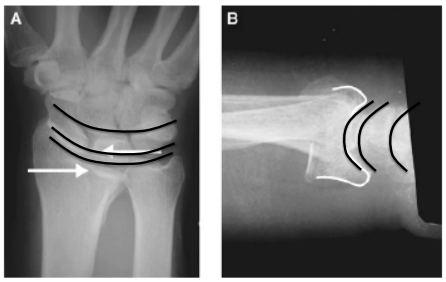


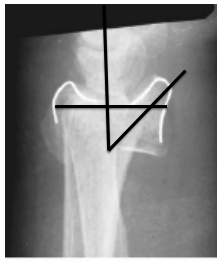
Fig. 10. Measurement of volar tilt and teardrop angle.

Concentricity



Restoring Parameters

- Loss of concentricity
- Increased A-P distance
- Decreased tear drop angle lunate facet



CT Scan

- Die-punch fractures
- Volar lip fractures
- Lunate facet and sigmoid notch
- Operative decision-making and approach

MRI

- Incidence of intercarpal ligament injury as high as 69%
- Scapholunate ligament 16-40%
- Predictors
  - Extension into lunate facet
  - More than 2 mm ulnar positive variance

MRI

- Standard MRI vs. MR Arthrogram (Scheck RJ et al JMRI 1999)
  - Sensitivity/ specificity/ accuracy for full thickness defects in intercarpal ligaments
    0.81/0.75/0.77 vs. 0.97/0.96/0.96
- 3T MRI (Magee T AJR 2009)
  - Sensitivity 86% TFCC, 89% SL injury
  - 100% specificity; No false positives

Treatment Options

- Conservative management
  - Immobilization for 4-6 weeks
  - Long arm splint x 2 weeks? vs. Short arm?
  - Start ROM exercises with Therapy at 6 weeks
- Surgical fixation
  - Fracture characteristics
  - Patient characteristics

Radiographic Criteria of Instability (Lafontaine)

1. Dorsal (or palmar) angulation > 20°
2. Displacement > than 2/3 width of shaft
3. Metaphyseal comminution (> 1/3 width)
4. Shortening (initial) > 5mm
5. Intra-articular component
6. Distal ulna fracture
7. Osteoporosis (age > 60)

Surgical Options

- Closed reduction perc. pinning (CRPP)
- External fixation
- Open reduction internal fixation (ORIF)
  - Volar plate
  - Dorsal plate
  - Fragment specific plate
  - Nail plate
- Spanning dorsal bridge plate
- Bone cement

Best Fixation

Many Ways

Clinical Evidence

- McQueen et al JBJS Br 1996
  - Randomized, prospective study
  - Cast immobilization vs. ORIF vs. External Fixation
  - NO difference in functional outcome at 6 weeks, 3 months, 6 months, 1 year
  - Main influence: **Carpal Malalignment**

Clinical Evidence

- Kreder et al. JBJS Br 2005
  - Randomized, prospective study
  - Indirect percutaneous reduction with external fixator vs. ORIF
  - NO difference in radiographic parameters or ROM if **Articular Stepoff and Gap Reduced**
  - Percutaneous group more rapid return of function and better functional outcome

Clinical Evidence

- Wei DH et al JBJS 2009
  - Randomized, prospective study
  - External fixator vs. locked volar plate vs. radial column plate
  - Volar plate better patient reported outcomes at 3 months
  - No difference in outcomes at 6 months and 1 year (similar to normal population)

Predictors of Functional Outcome

- Radial height/ ulnar variance (2 mm)
- Volar tilt
- Articular stepoff (2 mm)
- Carpal alignment

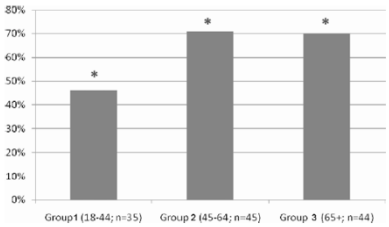
1. *Batra S and Gupta A Injury 2002*
2. *Ng CY and MCQueen MM JBJS Br 2011*
3. *Dario P et al Injury 2014*

Ulnar Styloid

- No difference in functional outcome
  - Tip vs. Base
  - Displacement > 2mm
  - Nonunion
- Assess DRUJ stability post-fixation of distal radius

1. *Kim JK et al. JBJS 2010*
2. *Souer JS et al. JBJS 2009*
3. *Buijze et al J Hand Surg 2010*

Effect of Patient Age on Secondary Redisplacement



Makhni et al. J Hand Surg 2008

Functional Outcome Pts > 70

TABLE 5. Mean Radiologic Measurements (±SD) for the 2 Treatment Groups

	Intra-Articular Fracture			Extra-Articular Fracture		
	ORIF	Cast	*P*	ORIF	Cast	*P*
Dorsal tilt (degrees)						
Initial prereduction	−24.2 ± 17.7	−33.3 ± 15.5	0.13	−20.0 ± 25.1	−29.8 ± 14.4	0.22
Postoperative/reduction	9.0 ± 26.1	−14.3 ± 9.5	0.0001	1.8 ± 7.6	−6.8 ± 11.2	0.01
Six weeks	−1.6 ± 3.7	−26.9 ± 8.9	0.0001	0.8 ± 7.6	−21.3 ± 7.0	0.0001
Twelve weeks	−2.4 ± 5.0	−26.3 ± 13.1	0.0001	3.4 ± 8.1	−22.1 ± 13.1	0.0001
Final follow-up	−1.4 ± 3.8	−23.9 ± 16.4	0.0001	1.3 ± 9.2	−24.9 ± 7.8	0.0001
Radial inclination (degrees)						
Initial prereduction	10.3 ± 4.6	18.5 ± 3.9	0.0001	14.3 ± 8.4	20.0 ± 4.1	0.03
Postoperative/reduction	22.9 ± 4.6	22.0 ± 2.5	0.46	22.8 ± 3.7	23.3 ± 2.9	0.64
Six weeks	23.8 ± 4.1	19.7 ± 2.2	0.0001	22.9 ± 3.4	19.7 ± 3.6	0.01
Twelve weeks	24.0 ± 5.2	19.9 ± 2.9	0.01	23.0 ± 4.0	19.6 ± 3.9	0.03
Final follow-up	24.3 ± 4.2	18.3 ± 9.3	0.04	23.0 ± 3.4	20.1 ± 3.6	0.04
Ulnar variance (degrees)						
Initial prereduction	4.7 ± 2.5	4.0 ± 3.6	0.54	4.2 ± 3.3	2.6 ± 2.3	0.13
Postoperative/reduction	0.4 ± 1.9	1.0 ± 2.0	0.37	1.0 ± 1.8	0.5 ± 1.4	0.45
Six weeks	1.9 ± 2.4	3.6 ± 2.7	0.08	1.1 ± 2.1	3.3 ± 2.5	0.01
Twelve weeks	1.3 ± 1.6	4.1 ± 3.1	0.02	1.0 ± 1.4	3.7 ± 2.4	0.0005
Final follow-up	1.7 ± 1.5	4.1 ± 3.0	0.0001	1.4 ± 2.3	3.7 ± 2.3	0.0001

Arora et al. J Orthop Trauma 2008

Functional Outcome Pts > 70

TABLE 3. Mean Functional Outcome Measures (±SD) and Percentage of the Normal Side (%) at Final Follow-up for Both Groups

	ORIF Group	CAST Group	*P*
Extension, degrees (%)	57.0 ± 11.6 (87.6)	59.8 ± 7.0 (95.0)	0.23
Flexion, degrees (%)	44.6 ± 10.4 (79.2)	49.6 ± 9.8 (88.2)	0.06
Pronation, degrees (%)	82.2 ± 8.9 (98.4)	81.4 ± 8.6 (97.7)	0.74
Supination, degrees (%)	83.0 ± 9.9 (97.9)	82.5 ± 6.8 (98.4)	0.83
Radial deviation, degrees (%)	20.6 ± 8.6 (94.9)	21.2 ± 8.4 (95.2)	0.68
Ulnar deviation, degrees (%)	38.0 ± 9.4 (97.6)	36.4 ± 9.2 (96.9)	0.72
Grip strength, kp (%)	19.4 ± 6.0 (75.3)	21.1 ± 7.0 (91.8)	0.39

Arora et al. J Orthop Trauma 2008

Functional Outcome Pts > 70

TABLE 4. Mean (Interquartile Range) DASH and PRWE Scores, Green and O'Brien Score, and Pain Level (Mean ± SD) for Both Groups at Final Follow-up

	ORIF Group	CAST Group	*P*
DASH (points)	11.1 (0–17.4)	11.6 (0–18.1)	0.90
PRWE (points)	9.3 (0–12.6)	16.9 (0–16.3)	0.21
Green and O'Brien			
Excellent	27	41	
Good	12	11	0.19
Fair	8	4	
Poor	6	5	
Pain (points)	1.7 ± 1.4	0.7 ± 1.4	0.03

Arora et al. J Orthop Trauma 2008

Catastrophic Thinking Is Associated With Finger Stiffness After Distal Radius Fracture Surgery

Teun Teunis, MD, Arjan G. J. Bot, MD, PhD,† Emily R. Thornton, BSc,* and David Ring, MD, PhD**

	Measured Variables			
Author	Demographics	Injury-Related Variables	Psychologic Variables	Outcome Summary
Jellad et al[7]	Age, sex, medical history, profession, education, socioeconomic status, and dominant hand	Trauma mechanism, radial translation, volar inclination, epiphyseal shortening, radioulnar index, sagittal inclination	Hospital anxiety and depression scale	Female sex and low/medium-energy trauma were associated with "complex regional pain syndrome"
Dilek et al, 2010[19]	Age, sex, education, smoking, marital status, and psychiatric and systemic diseases	Not evaluated	Anxiety Sensitivity Index, Toronto Alexithymia Scale-20, State-Trait Anxiety Inventory I and II, and the Beck Depression Inventory	Higher anxiety on State-Trait Anxiety Inventory II was associated with "complex regional pain syndrome"
Pechlaner and Zyluk, 2003[20]	Not evaluated	Not evaluated	Eysenck Personality Questionnaire, Adjectives Checklist (personality traits), Beck Depression Inventory/Younger Geriatric Depression Scale	No predictor of "complex regional pain syndrome"
Dijkema et al, 2003[18]	Age, sex, life events, (non) dominant side, and psychiatric history	Number of repositions	Social Readjustment Rating Scale and Symptom Checklist-90	No predictor of "complex regional pain syndrome"
Field and Gardner, 1997[21]	Not evaluated	Not evaluated	General Health Questionnaire-30	No predictor of "Algodystrophy"
Field et al, 1994[16]	Not evaluated	Cast tightness	Not evaluated	Tighter cast at 1, 2, and 3 wk was associated with "Algodystrophy"
Bickerstaff et al, 1994[9]	Age, sex, (non)dominant side, and time in cast	Frykman classification and number of reductions	Not evaluated	"Algodystrophy" was more common in Frykman type VIII fractures and less common in type I fractures. It was also more common in reduced fractures than unreduced fractures
Atkins et al, 1996[10]	Age, sex, (non)dominant side, and time in cast	Frykman classification, number of reductions, quality of the reduction, final position, and median nerve compression	Not evaluated	No predictor of "Algodystrophy"
Pollack et al, 1989[17]	Not evaluated	Not evaluated	Freiburger Persönlichkeitsinventar (personality test) and Angstbewältigungsbogen (anxiety questionnaire)	Identified type A and B "Sudeck personality"

Summary

- Classification➔ not helpful
  - Articular fragments
  - Displacement, shortening
  - Ulnar styloid: DRUJ stability
- Surgical decision making
  - Patient age/ activity level (physiologic age)
  - Reduction more important than implant
  - Volar plate ➔ earlier ROM; same outcome

Predicting Outcomes after DRF

Saurabh Mehta, PT, PhD

Clinical Vignette: Sallie Green

52 yo female sustained low energy left DRF on 12-27-15
PMH: HT controlled with meds
Patient-Rated Wrist Evaluation

- Pain 37/50
- Function 34/50

High school teacher
R handed
Delayed fracture healing as per xray

Clinical Vignette: Jack Childs

74 yo male fell from ladder 01-04-2016
High energy comminuted R DRF
H/o hypertension, type 2 diabetes
2 recent fall-related fracture

- R hip 05-2014; L shoulder 04-2015)

Significant hand stiffness of right hand
DASH score 73/100, Pain rating of 8/10.

Retired coal miner
R hand dominant.
Malunion of fracture.

Will discuss

Literature search

Inclusion/exclusion criteria

Review of studies

Putting the results into perspective for each of the prognostic factors

Summary of results

Literature Search: Prognosis

Injury	Prognosis	Outcomes
distal radius fracture wrist fracture distal forearm fracture	Predic* Progno*	strength OR motion OR range of motion OR endurance, dexterity OR function OR proprioception OR sensibility OR sensation OR touch threshold OR kinesthesia OR vibration OR cold intolerance OR 2 point discrimination, self-report OR questionnaire OR patient-reported OR outcome measure

Independent citations – 647

Removed after title review – 605 (42 remaining for abstract review)

Removed after abstract review – 20 (22 full text review)

Quality rating: 17 studies with good quality rating (>70%); 5 studies with fair quality (40-70%)

Evidence

Different Known Predictors
Affect on Outcomes after DRF

Predictor? Age

Short /medium term (to 6 mo post DRF)

Age not associated with recovery in self-rated function

Chung et al, 2007; MacDermid, et al 2002

Long term (up to 16 mo post DRF

Age: significant association with patients >65 yo

- Report poor recovery in self-rated function @1 yr post DRF

  Egol, et al, 2014; Chung et al2007; Moore & Leonardi-Bee, 2008; Roh et al., 2014
- Reduced grip strength

  Cowie, et al, 2015; Roh et al., 2014)

Predictor? Age

Over a long term (to 12 mo after injury) –

Some studies refute claim that age is a predictor of functional disability 1 year after DRF (Grewal, et al, 2007; Grewal & MacDermid, 2007)

Predictor? Gender/Sex

Short/ medium term (up to 6 mo post DRF) –

Sex was not associated with pain or functional outcomes (Chung, Kotsis, & Kim, 2007; MacDermid, Donner, Richards, & Roth, 2002)

Long term (up to 12 mos post DRF) –

Sex was not associated with pain or functional outcomes 1 year after DRF (Chung, et al , 2007; Grewal, et al, 2007; Mehta et al, 2015; Moore & Leonardi-Bee, 2008; Soue, et al 2008)

- ✓Females especially middle-aged at high risk of developing CRPS after DRF (Roh et al., 2014; Dyer et al, 2008)

Predictors: Socioeconomic Status/Injury Compensation

Short or medium term (up to 6 mo post DRF) –

- ✓ Income level did not predict functional recovery at 3 months (Chung et al, 2007; MacDermid, Donner, Richards, & Roth, 2002)
- ✓ Injury compensation, ongoing legal proceedings for work-related DRF strongly associated with poor functional status 6 mos and (MacDermid et al, 2002) & 1 year (Grewal et al, 2007)
- ✓ Claimants who have higher work demands and who report high functional disability DASH scores ≥70/100 at baseline likely to have significant loss of work time during recovery

Predictors? Injury-related Variables

The following injury-related factors, irrespective of short- or long-term assessment period significantly associated with risk of poor pain & functional outcomes

High energy fracture (Roh et al., 2014; Cowie et al, 2015)

Pre-reduction or injury ulnar+ variance or radial shortening (MacDermid, et al 2002) (Egol et al, 2014)

- ✓ Greater severity of injury, e.g. comminution (Roh et al., 2014; Wakefield & McQueen, 2000)
- ✓ Mal-union (Grewal & MacDermid, 2007; Wakefield & McQueen, 2000)

Predictors? Other

- ✓ Higher the **education**, better the functional outcomes (MacDermid, et al, 2002; (Paksima et al, 2014)
- ✓ Lack of emotional or informational support results in poor pain and functional outcomes at 1 year (Symonette et al l, 2013)
- ✓ Pain catastrophization –Baseline score of ≥35/50 on PRWHE pain scale 8.5 x more likely to report chronic ongoing pain at 1 year (Mehta et al, 2015)

Summary

Cautions on recovery

Patients receiving injury compensation

High energy injury

Greater severity of injury, e.g. other associated injuries, comminuted fracture

Mal-union

Age (inconsistent evidence)

Score of ≥35/50 on PRWE pain scale at baseline

Summary

Also…

Lack of emotional or informational support

High school education or less

Lower income level

Middle-aged female gender (risk for CRPS and associated pain and disability NOT non-CRPS pain or disability)

Let's Revisit the Clinical Vignettes

Clinical Vignette: Sallie Greene

52 yo female sustained low energy left DRF on 12-27-15
PMH: HT controlled with meds
Patient-Rated Wrist Evaluation

- Pain 37/50
- Function 34/50.

High school teacher
R handed
Delayed fracture healing as per xray

Clinical Vignette: Jack Childs

74 yo male fell from ladder 01-04-2016
High energy comminuted R DRF
H/o hypertension, type 2 diabetes
2 recent fall-related fractures
- R hip 05-2014; L shoulder 04-2015)

Significant hand stiffness of right hand
DASH score 73/100, Pain rating of 8/10.

Retired coal miner
R hand dominant.
Malunion of fracture.

Thoughts for discussion

- Effects of surgeon's and therapist's care on outcome in the face of predictors
- What factors are modifiable, what are not?

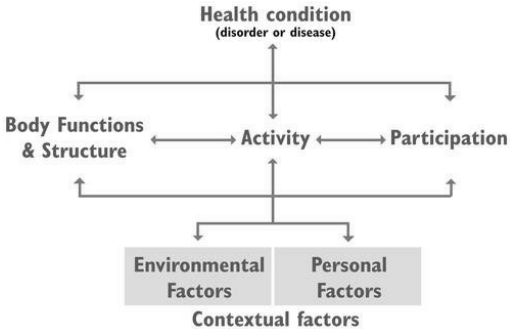
Classification systems

- Radiographic
- Functional Joy MacDermid, PT, PhD

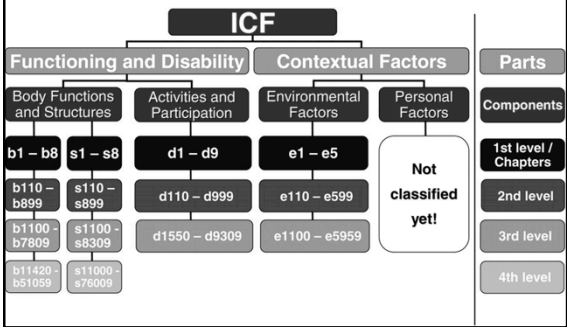
Issues

Radiographic
– Does not relate to rehab needs or functional outcome
+ Can be used to determine motion blocks or loss of available range

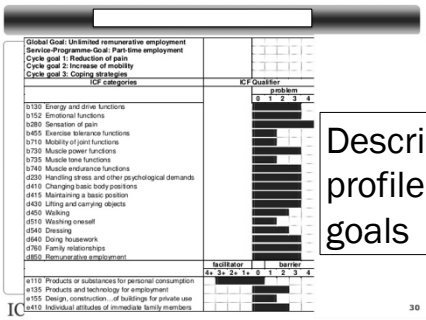
ICF
+ Very useful for detailed description
+ May be needed for billing
– Does not given essence of key differences in fracture rehab approach



ICF Classification



Descriptive, might be useful



Descriptive profile, set goals

A classification system should:

- **Separate people into distinct and meaningful groups**
- Classify all
- Be reliable
- Predict treatment needs ± outcomes
- Be easily communicated and adopted by others

PROPOSED CLASSIFICATION

1. Simple fracture (minor associated tissue injury, pain or psychosocial factors)
   a. ± malalignment
   b. ± fragility fracture
2. Fracture with physical impairments; with moderate to severe associated wrist injuries or impairments
   a. ± malalignment
   b. ± fragility fracture

3. Fracture with psychosocial barriers, associated with high pain and/or psychosocial risk factors
   a. ± malalignment
   b. ± fragility fracture;
4. Fracture with physical and psychosocial barriers; associated with moderate to severe physical impairments and high pain and/or psychosocial risk factors
   a. ± malalignment
   b. ± fragility fracture

Proposed classification: 1. Simple Fracture

- Fracture is not complicated by additional physical or psychosocial problems
- minor associated tissue injury
  – Minimal swelling
  – Fingers moving well
  – Low pain

Proposed Classification- Qualifiers

a. ± malalignment
  – May affect available ROM and motion goals
    - A 5-mm ulnar translation deformity results in a mean 23% loss of pronation range of motion.
    - Radial shortening of 10 mm reduces forearm pronation by 47% and supination by 29%
    - .(Bronstein, 1997; Fraser et al 2009)
  – Joint deformity
  – Impact on function controversial
    - Depend on demands/expectations

Proposed Classification-Qualifier-Fragility Fracture

- fractures resulting from a fall from a standing height or less, or presenting in the absence of obvious trauma.
- Need to consider bone health and fracture prevention
  - BMD-
  - Advice, intervention or referral for balance, fall prevention
  - Weight-bearing exercise (Tai-chi, walking)

Proposed Classification:
2. DRF with Physical Impairment

Moderate to severe associated wrist injuries or impairments

- Ligament injury
- Nerve injury
- Swelling
- Finger stiffness
- Abnormal movement

Proposed Classification
3. Fracture with psychosocial barriers

high pain

≥ 35/50 PRWE 2-10 days (Mehta et al, 2015)

and/or psychosocial risk factors

- Pain catastrophizing
- Low self-efficacy
- Depression
- Anxiety
- Poor coping

Proposed Classification
4. Fracture with physical and psychosocial barriers

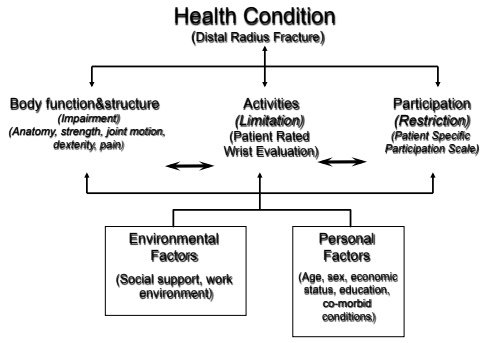
- BOTH moderate to severe physical impairments and high pain and/or psychosocial risk factors
- Physical impairments act as an ongoing stressor and interact with psychosocial barriers

****Additive or multiplicative effects*

Challenges

- No accepted functional classification system
- May depend on reason for classifying
- Guideline should incorporate a simple systems and be ICF based

ICF and Outcome Measures



- 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.....

- 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 door knob 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

Multiple SR address outcome measures
PRWE, all PRO, all measures


Injury
Volume 42, Issue 3, March 2011, Pages 253–258
Assessing Patient Outcomes

Measuring wrist and hand function: Common scales and checklists

A. Hoang-Kim[A], F. Pegreffi[B], A. Moroni[A], A. Ladd[J]

[RESEARCH REPORT]

SAURABH P. MEHTA, PT, PhD[1,2] • JOY C. MACDERMID, PT, PhD[3,4] • JULIE RICHARDSON, PT, PhD[3]
NORMA J. MACINTYRE, PT, PhD[3] • RUBY GREWAL, MD, MSc, FRCSC[4,5]

A Systematic Review of the Measurement Properties of the Patient-Rated Wrist Evaluation

- Reliability estimates range 0.81-0.90
  - 50% of the study ICC ≥0.90
- MDC_{90} ranges from 8-19; usually 10-12
- Responsiveness- large effects
  - Meets or exceeds DASH

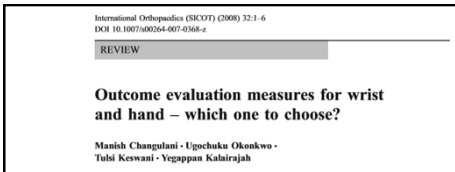

Arch Orthop Trauma Surg (2014) 134:197–205
DOI 10.1007/s00402-013-1767-9

TRAUMA SURGERY

Recommendation for measuring clinical outcome in distal radius fractures: a core set of domains for standardized reporting in clinical practice and research

Jörg Goldhahn · Dorcas Beaton · Amy Ladd · Joy Macdermid · Amy Hoang-Kim

- Pain
  - PRWE pain subscale or VAS
- Function PRWE
  - QuickDASH
- Complications
- Participation


International Orthopaedics (SICOT) (2008) 32:1–6
DOI 10.1007/s00264-007-0368-z

REVIEW

Outcome evaluation measures for wrist and hand – which one to choose?

Manish Changulani · Ugochuku Okonkwo · Tulsi Keswani · Yegappan Kalairajah

- Our study provides very useful evidence to suggest that the PRWE score is the most responsive instrument for evaluating the outcome in patients with distal radius fractures,
- while the DASH score is the best instrument for evaluating patients with disorders involving multiple joints of the upper limb.

Other Options

- Same constructs as PRWE
- QuickDASH/DASH
  - Some studies in DRF
- Michigan Hand Questionnaire
  - Less data
  - Length and scoring complexity is a barrier

Patient Specific Functional Scale

The Patient-Specific Functional Scale

This useful questionnaire can be used to quantify activity limitation and measure functional outcome for patients with any orthopaedic condition.

Clinician to read and fill in before: Complete at the end of the history and prior to physical examination.

Initial Assessment:

I am going to ask you to identify up to three important activities that you are unable to do or are having difficulty with as a result of your _____ problem. Today, are there any activities that you are unable to do or having difficulty with because of your _____ problem? (Clinician: show scale to patient and have the patient rate each activity).

Follow-up Assessments:

When I assessed you on (state previous assessment date), you told me that you had difficulty with (read all activities from list at a time). Today, do you still have difficulty with: (read and have patient score each item in the list)?

Patient-specific activity scoring scheme (Point to one number):

0 1 2 3 4 5 6 7 8 9 10

Unable to perform activity — Able to perform activity at the same level as before injury or problem

(Date and Score)

Activity	Initial					
1.						
2.						
3.						
4.						
5.						
Additional						
Additional						

Total score = sum of the activity scores/number of activities
Minimum detectable change (90%CI) for average score = 2 points
Minimum detectable change (90%CI) for single activity score = 3 points

An ICF-Based Clinical Practice Guideline for Distal Radius Fracture 2/19/2016

Distal Radius Fracture: Therapist's Examination

Christos Karagiannopoulos PT PhD
Susan Michlovitz PT PhD

Examination discussion

- Range of motion
- Edema
- Grip strength
- Sensory motor control
- Load-bearing e.g. push off
- Sensibility
- Provocative maneuver
- Dexterity and hand tasks

Wrist ROM Mobility of joint functions (ICF code b710)

Active ROM preferred

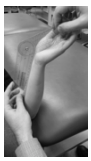
Clinically meaningful – represents functional capacity

Passive ROM

Musculo-tedinous vs. capsulo-ligamentous tissue

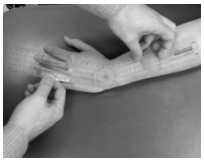
GONIOMETRIC MEASURES

Reliability
LaStayo & Wheeler, 1994



Wrist ROM Mobility of joint functions (ICF code b710)

Ulnar and radial deviation



	Intra-tester reliability	Inter-tester Reliability
Flex	ICC= 0.92	ICC= 0.93
Ext	ICC= 0.84	ICC= 0.84
RD	ICC= 0.90	ICC= 0.86
UD	ICC= 0.92	ICC= 0.78

Horgen, 1990

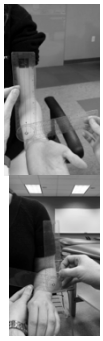
Responsiveness
ES=0.67, SRM=0.84

MacDermid et al., 2000

Forearm Rotation
Distal forearm approach

Mobility of joint functions (ICF code b710)

Moving arm across dorsal/volar distal forearm



Test Type	Motion	Intra-tester reliability	Intra-tester MDC value	Inter-tester Reliability	Inter-tester MDC value
Distal Forearm	Sup	ICC = 0.97	8°	ICC = 0.86	11°
	Pron	ICC = 0.97	8°	ICC = 0.93	10°

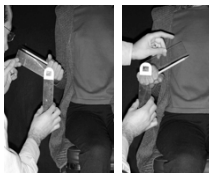
Armstrong et al., 1998

Forearm Rotation
Hand-held pencil (functional) approach

Mobility of joint functions (ICF code b710)

Requires ability to make a full fist to hold the pencil

	Supination	Pronation
Intra (ICC)	.98	.95 – .97
Inter (ICC)	.96	.95



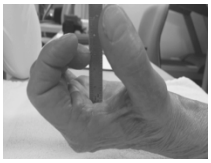
Karagiannopoulos et al., 2001

Digital ROM: Pulp-to-palm distance

Mobility of joint functions (ICF code b710)

Nail-skin junction to DPC

Distance in cm



Repeatability Coefficient	
Intra-rater	Inter-rater
5-6 mm	7-9 mm

Ellis and Bruton, 2002

Criterion Validity
r = - 0.51 (goniometry)

MacDermid 2001

Digital ROM

Mobility of joint functions (ICF code b710)

Total active digital motion

Better predictive value

Sig association to DASH

MacDermid JC. JHS, 2001

Joint	Intra-tester reliability	Inter-tester Reliability
MCP	ICC = 0.64-0.93	ICC = 0.67
PIP	ICC = 0.68-0.94	ICC = 0.67
DIP	ICC = 0.78-0.99	ICC = 0.85

MCP Joint	0/90°	90°
PIP Joint	10/70°	60°
DIP Joint	0/50°	50°
TAM		200

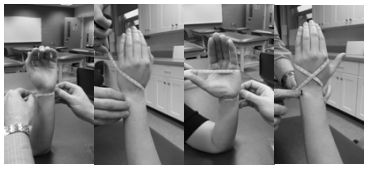
Lewis et al., AJOT, 2010

Wrist/Hand Edema Effusion of joint (ICF code M25.4)

Figure-of-eight method

Intra-tester Reliability	Inter-tester Reliability
ICC = 0.99	ICC = 0.99

Leard et al., JOSPT, 2004



Digital Edema: Circumferential measure

Effusion of joint (ICF code M25.4)

Select anatomical points

Intra-tester reliability	Inter-tester Reliability	MDC value
ICC = 0.95 – 0.99	ICC = 0.96 – 0.99	2 mm

Jansen et al., 2010

Grip Dynamometry

Power of isolated muscles and muscle groups function (ICF b7300)

Maximum grip

Standardized instructions

Intra-tester reliability	Inter-tester Reliability	Responsiveness	MDC value
r = 0.99	r = 0.88 – 0.92	ES=0.84, SRM=1.52	2.73 – 4.68 kg

Mathiowetz et al., 1984; Bertrand et al.,2015; MacDermid et al., 2002

Dynamometry: Load bearing/pushing

Pushing (ICF code d4451)

- Administered when UE weight-bearing permitted

Level of evidence 1b

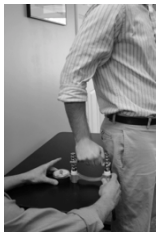


Table 2
Inter-rater reliability of the push-off test

POT-1 vs POT-2	ICC	95% confidence interval
Affected extremity	0.97	0.93–0.99
Unaffected extremity	0.85	0.68–0.94

Intra-rater reliability of the Push-off test

Measure	ICC	95% confidence interval
Rater – 1 Affected	0.95	0.90–0.98
Rater – 1 Unaffected	0.92	0.84–0.96
Rater – 2 Affected	0.97	0.94–0.99
Rater – 2 Unaffected	0.93	0.86–0.97

Vincent JI, et al JHT 2014 Correlation with DASH .43

Sensori-Motor Control

Proprioceptive function (ICF b260)

Active Wrist JPS Test

- Conscious proprioception
- Simple goniometric method

Score = Reference angle – Reproduced Angle

Intra-tester reliability	Responsiveness	MDC value	MCID Value
ICC = 0.85	SRM = 1.57 ES = 1.53 (8 wks) SRM = 2.14 ES = 2.36 (12 wks)	4° (8 wks) 5° (12 wks)	5° (8 wks) 7° (12 wks)

Karagiannopoulos et al., 2014

Sensibility Screen: Ten-Test

Light moving touch (ICF b265 Touch function)

- Quick detection of areas with altered sensation
- Simultaneous moving light-touch
- Along equivalent skin dermatomes
- Verbal scale: 1(absent) -10 (normal)
- Tested in Peds & CTS

Strauch et al., 1997, Durrant, 2014

Intra-rater	Inter-rater	Concurrent Validity (S-W Monofilaments)	MDC
ICC = 0.91	ICC = 0.61-0.90	Spearman's r = -0.71	1.57-2.15

Predictive values to CTS: Faught & McKee 2002

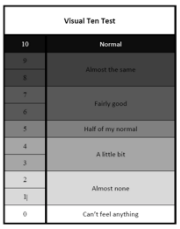
Specificity	Sensitivity
48 %	80%

Sensibility Screen

Light moving touch (ICF b265 Touch function)

Visual Version Ten-Test

- Strongly correlates to the original version
- Spearman's rank correlation coefficient (*r*= 0.74 – 0.90)



Durrant N. The reliability and validity of the ten test and exploring a new visual version. [Thesis] McMaster University, 2014

Provocative tests: median nerve/CTS

Touch function (ICF b265)

Purpose post DRF: screen for complication

Test	Sensitivity	Specificity
Phalen*	68%	73%
Carpal compression	64%	83%
Tinel	50%	77%

* Post DRF may not be able to position wrist for the test!

MacDermid and Wessel, Systematic Review JHT 2004

Dexterity and Hand Tasks
ICF d444 Fine hand use

Pegboard tests:
- Functional Dexterity Test
- Nine-hole peg test
- Purdue Pegboard Test

- Limited research on DRF

Dexterity and Hand tasks
d444 Fine hand use

Jebsen-Taylor Hand Function Test

Poor validity & responsiveness when applied to surgically-treated hand patients, including those with DRFs at 1 yr post (n=46).

JTT* cannot reliably predict positive patient-reported outcome as assessed by the MHQ.

*Measures different aspects of recovery?

Sears and Chung 2010

Moving along to Therapy Interventions

Therapy Interventions Following Distal Radius Fracture

Christos Karagiannopoulos PT, PhD

Susan Michlovitz PT, PhD

Intervention Types

1. Patient education and counseling - HEP
2. Manual therapy & Joint mobilization
3. Therapeutic exercise and activities
4. Neuromuscular re-education & strengthening
5. Modalities for pain and edema control
6. Splints and custom orthoses

Current Evidence ?

Handoll & Elliott, 2015
Systematic Review

"The available evidence from RCTs is insufficient to establish the relative effectiveness of the various interventions used in the rehabilitation of adults with fractures of the distal radius. Further randomized trials are warranted"

- Small studies
- Poor design for reliable findings
- Not reporting on patient reported outcome measures
- Not long-term follow ups

Appraising the Evidence?

- Handoll & Elliott, 2015
  - Inclusion of only higher quality RCT
  - Excluded diagnostic/prognostic or other SRs
  - Inclusion criteria:
    - Populations with lower comorbidities post DRF
    - No vulnerable populations (older, unstable Fx)
      - Questionable clinical meaningfulness
      - Low demand for PT referral
    - No strengthening / Neuro- Re-Ed
    - No orthosis

Patient Education

- Adherence
- Advice
- Home exercise programs

SCIENTIFIC/CLINICAL ARTICLES

The Relationship between Adherence to Hand Therapy and Short-term Outcome after Distal Radius Fracture

JHT 2005

Anthony Lyngcoln, PT (Hons)
Peninsula Private Hospital
Frankston, Australia

Nicholas Taylor, PT, PhD
Tania Pizzari, PT, PhD
Musculoskeletal Research Centre
School of Physiotherapy
La Trobe University
Victoria, Australia

Kris Baskus, PT
Box Hill Hospital
Box Hill, Australia

ABSTRACT: This study aimed to examine the relationship between adherence to hand therapy and short-term outcome after fracture of the distal radius. Attendance at hand therapy appointments, therapist-rated adherence during appointments, and home-exercise diaries were used to monitor adherence in 15 people undertaking rehabilitation after a wrist fracture. Outcome measures were change in impairment (wrist extension, grip strength, and pain rating) and change in activity (modified Levine questionnaire, Jebsen Test of Hand Function) from initial assessment (after cast removal) to follow-up (six weeks later). Multiple regression analysis found over 50% of variance in wrist extension change, Levine questionnaire change, and change on the simulated feeding item of the Jebsen Test of Hand Function to be predicted by adherence. Home exercise adherence was the most important predictor of the adherence measures. These results highlight the importance of adherence to home exercises prescribed by a hand therapist after fracture of the distal radius.

Home exercise prescribed by therapist: adherence important

Patient education: Advice

Bruder et al. October, 2015
(presented at Australian Physiotherapy Association Conference)
Does a program of exercise and advice improve activity compared to advice alone following DRF?
Prospective RTC (two groups)
In-clinic supervised + advice 6 weeks
Advice – 3 PT consultations over 6 weeks
this group NOT instructed in exercises

No difference between groups
in outcomes- both improved-large ES

HEP vs. Supervised in-clinic PT

- Moderate evidence that HEP can result in similar outcomes in patients without complications following DRF
  - Valdes et al Systematic Review JHT 2014 included 7 studies

What about patients who have complicating factors that alter recovery?
OA, CTS, wrist ligament injury, finger stiffness

HEP vs. Supervised in-clinic PT

RCT over 1 year 50 patients DRF with volar plate fixation
In-clinic treatment group: BIW 2 weeks 6 weeks +HEP
Supervised HEP group (therapist instructed): written/photo HEP instructions by therapist compared to supervised in-clinic PT
- 4 patients with complications switched to in clinic program at 4 weeks
- Many patients had co-morbidities
- Assessments were performed at 2, 4, 8, 12 weeks for secondary outcomes and at 6 months for the primary outcome for both groups.

Both groups had improvement in PRWHE, grip, ROM but no difference between groups

Valdes et al RCT JHS 2015 (Level 2)

Therapeutic Exercise

What are the most frequently used therapy interventions post DRF?

1. Therapeutic exercises
2. Patient education
3. Passive mobilization
4. Therapeutic massage

ELSEVIER — Physiotherapy

Physiotherapy intervention practice patterns used in rehabilitation after distal radial fracture

Andrea M. Bruder, Nicholas F. Taylor, Karen J. Dodd, Nora Shields

Benefit of Therapeutic Exercise?

Therapeutic exercise in physiotherapy practice is beneficial: a summary of systematic reviews 2002–2005

Nicholas F Taylor, Karen J Dodd, Nora Shields and Andrea Bruder

La Trobe University, Australia

Is Therapeutic Exercise Beneficial post DRF?

- Good evidence to support the role of therapeutic exercise & patient advice post UE fractures (DRF included)
  - Heterogeneity of types and durations
  - Effective to reduce pain & improve function

Exercise reduces impairment and improves activity in people after some upper limb fractures: a systematic review

Andrea Bruder, Nicholas F Taylor, Karen J Dodd and Nora Shields

Therapy Practice Patterns Post DRF

242 clinicians (PT, OT, CHT) surveyed at a course

- During immobilization phase:
  - > 75% used ROM, edema control techniques
- During post-immobilization phase:
  - > 90% used ROM exercises, heat/cold modalities

Distal Radius Fractures: Therapy Practice Patterns

Susan L. Michlovitz, PT, PhD, CHT; Paul C. LaStayo, PT, PhD, CHT; Sharon Alzner, MPT; Elizabeth Watson, MPT

Interventions to improve ROM?

- Following UE MS trauma: including wrist fractures
- Moderate to low quality of evidence (levels II-IV) to support:
  - Supervised therapeutic exercises
  - Joint mobilization
  - Splinting
  - No studies on physical agents

Therapy Interventions for Improving Joint Range of Motion: A Systematic Review

Susan L. Michlovitz, PT, PhD, CHT; Bette Ann Harris, DPT, MS; Mary P. Watkins, DPT, MS

Is early mobilization more effective?

- Controversial
- Early AROM leads to quicker return to functional ROM (Valdez, 2009)
  - Weak evidence: Small sample-retrospective analysis
- Stronger evidence emergence: RCT Level I
- No differences in ROM & functional outcomes (DASH)
  - Start 2wks vs. 6 wks post ORIF
  - 3 and 6 months
  - Not categorization between complicated & non-complicated cases

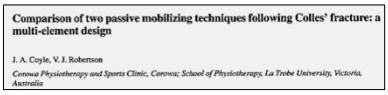
Wrist Mobilization Following Volar Plate Fixation of Fractures of the Distal Part of the Radius

By Santiago A. Lozano-Calderón, MD, Sebastiaan Souer, MD, Chaitanya Mudgal, MD

Lozano-Calderon et al., 2008

Joint Mobilization

- Limited evidence
- Lack of high quality RCTs following DRF
  - Preliminary weak evidence:
    - Efficacy of Maitland A-P Oscillation III & Kaltenborn sustained glide III
      - Increased wrist extension AROM
    - No control, small sample (n = 8)
    - No functional outcomes
    - Uncomplicated patients - stable DRF post immobilization

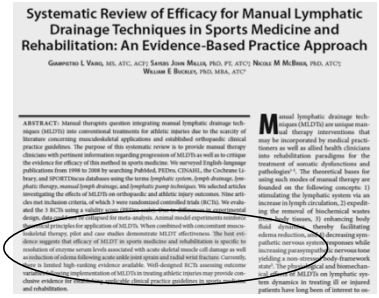

Comparison of two passive mobilizing techniques following Colles' fracture: a multi-element design

J. A. Coyle, V. J. Robertson

Cerowa Physiotherapy and Sports Clinic, Cerowa; School of Physiotherapy, La Trobe University, Victoria, Australia

Manual Therapy. 1998; 3 (1): 34-41

Is Therapeutic Massage Effective?


Systematic Review of Efficacy for Manual Lymphatic Drainage Techniques in Sports Medicine and Rehabilitation: An Evidence-Based Practice Approach

ABSTRACT: Manual therapists question integrating manual lymphatic drainage techniques (MLDTs) into conventional treatments for athletic injuries due to the scarcity of literature concerning musculoskeletal applications and established orthopaedic clinical practice guidelines. The purpose of this systematic review is to provide manual therapy clinicians with pertinent information regarding progression of MLDTs as well as to critique the evidence for efficacy of this method in sports medicine. We surveyed English-language publications from 1998 to 2008 by searching PubMed, PEDro, CINAHL, the Cochrane Library, and SPORTDiscus databases using the terms *lymphatic system*, *lymph drainage*, *lymphatic therapy*, *manual lymph drainage*, and *lymphatic pump* techniques. We selected articles investigating the effects of MLDTs on orthopaedic and athletic injury outcomes. Nine articles met inclusion criteria, of which 3 were randomized controlled trials (RCTs). We evaluated the 3 RCTs using a [illegible] scale. Due to differences in experimental design, data could not be collapsed for meta-analysis. Animal model experiments reinforce theoretical principles for application of MLDTs. When combined with concomitant musculoskeletal therapy, pilot and case studies demonstrate MLDT effectiveness. The best evidence suggests that efficacy of MLDT in sports medicine and rehabilitation is specific to resolution of enzyme serum levels associated with acute skeletal muscle cell damage as well as reduction of edema following acute ankle joint sprain and radial wrist fracture. Currently, there is limited high-ranking evidence available. Well-designed RCTs assessing outcome variables following implementation of MLDTs in treating athletic injuries may provide conclusive evidence for [illegible] clinical practice guidelines in sports medicine and rehabilitation.

Manual lymphatic drainage techniques (MLDTs) are unique manual therapy interventions that may be incorporated by medical practitioners as well as allied health clinicians into rehabilitation paradigms for the treatment of somatic dysfunctions and pathologies[1–6]. The theoretical bases for using such modes of manual therapy are founded on the following concepts. 1) stimulating the lymphatic system via an increase in lymph circulation, 2) expediting the removal of biochemical wastes from body tissues, 3) enhancing body fluid dynamics, thereby facilitating edema reduction, and 4) decreasing sympathetic nervous system responses while increasing parasympathetic nervous tone yielding a non-stressed body framework state[7]. The physiological and biomechanical effects of MLDTs on lymphatic system dynamics in treating ill or injured patients have long been of interest to on-

THE JOURNAL OF MANUAL & MANIPULATIVE THERAPY, 17(3), 2009

Manual Lymphatic Drainage

Limited current evidence

- Lack of high quality RCTs following DRF
- Weak preliminary evidence:
  - Small RCTs
  - Significant edema reduction
  - First 3 wks post tx
    - Cast immobilization & Ext Fix
  - No other physical impairments
  - No functional outcomes


Hand Therapy

A prospective randomized controlled trial of manual lymph drainage (mld) for the reduction of hand oedema after distal radius fracture

Kathrin Harén, MSc

Department of Occupational Therapy, Sundsvall County Hospital, Sweden

Address for correspondence: Kathrin Harén, Occupational Therapist, MSC, Department of Occupational Therapy, Sundsvall County Hospital, Sweden, Tel:

Mikael Wiberg, MD, PhD


Scand J Plast Reconstr Hand Surg 34: 367–372, 2000

EFFECT OF MANUAL LYMPH DRAINAGE AS DESCRIBED BY VODDER ON OEDEMA OF THE HAND AFTER FRACTURE OF THE DISTAL RADIUS: A PROSPECTIVE CLINICAL STUDY

Kathrin Harén,[1] Clas Backman[2] and Mikael Wiberg[2]

Strengthening

- Lack of studies addressing the role of progressive resistance training methods following DRF
- Current evidence based on basic science of muscle adaptation to strength training
- Evidence applied from other joints or conditions


RESEARCH REPORT

A Progressive 5-Week Exercise Therapy Program Leads to Significant Improvement in Knee Function Early After Anterior Cruciate Ligament Injury


American Journal of Physical Medicine & Rehabilitation

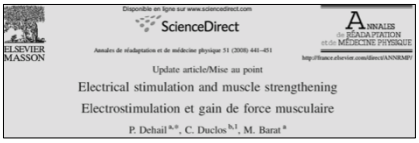
High Intensity Strength Training Improves Strength and Functional Performance After Stroke

Weiss, Angela MSPT; Suzuki, Toshimi MS; Bean, Jonathan MD; Fielding, Roger A. PhD

level 2b.
J Orthop Sports Phys Ther 2010;40(11): 705-721.

NMES Strengthening

- Therapeutic application of NMES is still much debated
  - Low evidence level for its efficacy
  - Lack of well designed RCTs
  - Review of literature:
    - No superiority over traditional muscle strengthening


Disponible en ligne sur www.sciencedirect.com

ScienceDirect

ELSEVIER MASSON

Annales de réadaptation et de médecine physique 51 (2008) 441–451

Update article/Mise au point

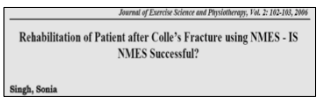
Electrical stimulation and muscle strengthening

Electrostimulation et gain de force musculaire

P. Dehail [a,*], C. Duclos [b,1], M. Barat [a]

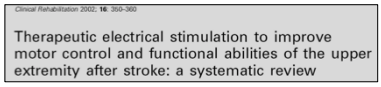
NMES Strengthening

- Some evidence suggesting (+) effect to NM control post stroke
- No association to function
- Lack of quality research post DRF
  - 1 case study
  - Positive effect on ROM


Journal of Exercise Science and Physiotherapy, Vol. 2: 102-103, 2006

Rehabilitation of Patient after Colle's Fracture using NMES - IS NMES Successful?

Singh, Sonia


Clinical Rehabilitation 2002; **16**: 360–360

Therapeutic electrical stimulation to improve motor control and functional abilities of the upper extremity after stroke: a systematic review

Strengthening

Promising evidence for contralateral side strengthening

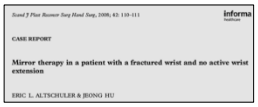
- Cross muscle training:
  - Training homologous muscles at unrestrained limb
  - Proportional strength gains at the immobilized limb
  - Attributed to neural adaptation within the CNS
  - Exact mechanism still unknown
- Clinical application:
  - During post-fracture protective phase

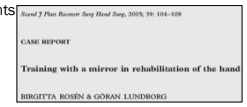

Available online at www.sciencedirect.com
SciVerse ScienceDirect
Journal of Science and Medicine in Sport
Review
Cross education and immobilisation: Mechanisms and implications for injury rehabilitation
Ashlee M. Hendy*, Michael Spittle*, Dawson J. Kidgell

Proprioception & SM Control

Limited evidence - lack of RTCs

- Weak preliminary evidence for mirror therapy
  - Small pilot studies & case reports
  - Central neural adaptation –cross training effect
  - Improve conscious proprioception
  - Pain control, AROM
  - Early rehabilitation phase
- Proposed methods based on basic science knowledge
- Rehabilitation paradigms from other joints
  - Shoulder, knee, ankle

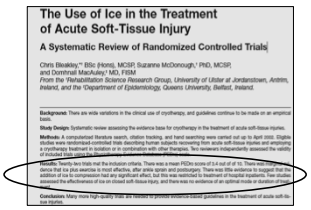

CASE REPORT
Mirror therapy in a patient with a fractured wrist and no active wrist extension
ERIC L. ALTSCHULER & JEONG HU


CASE REPORT
Training with a mirror in rehabilitation of the hand
BIRGITTA ROSÉN & GÖRAN LUNDBORG

Modalities - Cryotherapy

- Equivocal evidence based on basic science knowledge on soft-tissue injury
  - Insufficient evidence of gains in clinical outcome
  - Mostly post acute human ankle sprains
  - Animal studies
  - Low methodological quality
  - No functional outcomes
  - Outcome heterogeneity

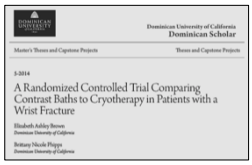
Is ice right? Does cryotherapy improve outcome for acute soft tissue injury?
N C Collins
Emerg Med J. 2008; 25: 65-68

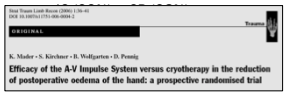

The Use of Ice in the Treatment of Acute Soft-Tissue Injury
A Systematic Review of Randomized Controlled Trials

Am J Sports Med. 2004; 32: 251-261

Modalities - Cryotherapy

- Limited evidence for cryotherapy on post DRF treatment paradigms
  - Low methodological quality RCTs
  - Small sample
- Cold pack vs. Contrast baths
  - ST: 4 weeks post (Surg & NSurg)
  - Edema, pain, function
  - Equal improvement for both
- Cold pack vs. Intermittent comp.
  - Post Ext-Fix unstable DRF
  - Hand edema 7th post op day


Dominican University of California
Dominican Scholar
A Randomized Controlled Trial Comparing Contrast Baths to Cryotherapy in Patients with a Wrist Fracture


ORIGINAL
Trauma
K. Mader · S. Kirchner · B. Wolfgarten · D. Pennig
Efficacy of the A-V Impulse System versus cryotherapy in the reduction of postoperative oedema of the hand: a prospective randomised trial

Modalities: Heat

- Lack of research post DRF treatment
- Promising evidence from clinical application to general wrist MS injury
- Prospective single-blind multicenter RCT (N = 93)
  - Low-level heat wraps, placebo, oral med
  - ST (3-day)effect on wrist pain, grip, ROM, PRWE
  - Dxs: S/S, CTS, OA, Itis,


Continuous Low-Level Heat Wrap Therapy Is Effective for Treating Wrist Pain
Susan Michlovitz, PhD, PT, Lavyn Hun, MD, MS, Geetha N. Erasala, MS, David A. Hengehold, MS, Kurt W. Weingand, DVM, PhD

Michlovitz et al., 2004

Orthoses

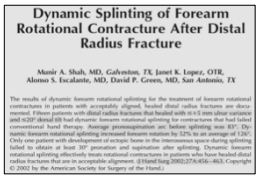
- **Does static progressive splinting restore wrist/FA ROM post DRF?**
  - Limited evidence: low methodological quality experimental study
  - Case series study
  - JAS FA brace study:
    - Small sample
    - 18 DRFs/38 patients
    - Only stable DRFs
    - No functional assessment
    - No control


Static Progressive Splinting for Restoration of Rotational Motion of the Forearm
Mike S. McGrath, MD
Sid D. Ulrich, MD
Peter M. Bonutti, MD
David R. Marker, BS
Henning K. Johansen, BS
Michael A. Mont, MD

Static progressive splinting to improve wrist stiffness after distal radius fracture: A prospective, case series study
Ann M Lucado, PT[1] and Zhongyu Li, MD, PhD[2]
Physiotherapy Theory and Practice, 25(4), 2009

Orthoses

- Does dynamic splinting restores wrist/FA ROM post DRF?
  - Limited evidence: Low methodological study quality
  - Custom outrigger study
    - 18 DRFs acceptably aligned 56 months post tx (conservative and surg)
    - 6hrs/day for 11 weeks
    - No control, no functional assessment


Dynamic Splinting of Forearm Rotational Contracture After Distal Radius Fracture

Munir A. Shah, MD, Galveston, TX, Janet K. Lopez, OTR, Alonso S. Escalante, MD, David P. Green, MD, San Antonio, TX

Preliminary evidence & Recommendations

C*	Patient education*	Weak evidence to support advice and instructions on adherence to therapy
B	HEP vs supervised in clinic PT	Moderate evidence for uncomplicated cases shows no difference between HEP or supervised in-clinic therapy
C	Therapeutic Exercise	Weak evidence to support specific exercise protocols
C	Manual Therapy & Joint Mobilization	Weak evidence to support specific manual methods
E	Strengthening	Only theoretical or foundational evidence
C	Proprioceptive & NM Training	Weak evidence to support specific training paradigms
C	Thermal agents	Weak evidence to support use of cold or heat modalities
C	Orthosis use	Weak evidence to support static or dynamic splinting

Patient education* ? moderate

Distal Radius CPG Case Discussions

Jerry I. Huang, MD
Assoc. Professor and Program Director
Dept of Orthopaedics and Sports Med
University of Washington Med Ctr

Case: 25 yo Personal Trainer FOOSH: Extra-Articular DRFx

Intra-Op ORIF Volar Plate; DRUJ Stable

6 Weeks Post-Op Wrist Flexion 60; Extension 65

Hand Therapy Options for the personal trainer

(Proposed Classification: Category 1)

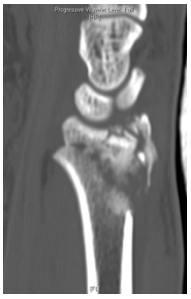
A. Active ROM only
B. Passive + Active ROM
C. Strengthening Program
D. Static progression splinting
E. Home exercise program (HEP)

UWHAND

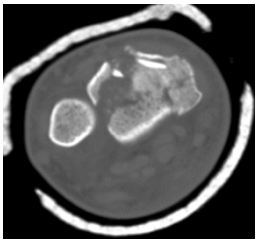
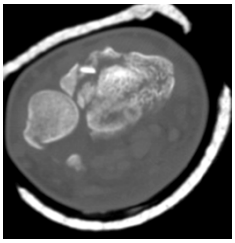
Case: 35 yo Male Fall Off Roof


35 yo Male Fall Off Roof

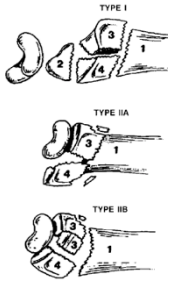

CT Scan➔ Define Fragments

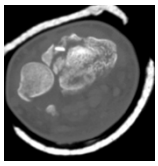
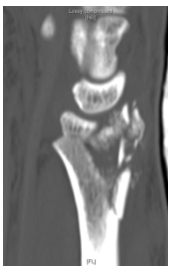



CT Scan➔ Define Fragments Volar Ulnar, Dorsal Ulnar,…..

Melone Fragments



Intra-Op


Intra-Op
Role for Therapy?
(Proposed Classification: Category 2)


3 Months Post-Op


Case: Grad Student

- 24 y/o RHD grad student fall onto right wrist rock climbing 5 wks ago
- Short arm cast for 5 weeks for right distal radius fracture
- Referred to therapy for concerns of forearm and wrist stiffness

Case: Therapy Mystery

- On exam➔ mild swelling with prominent distal ulna dorsally
- Wrist Flexion 45 and Extension 70
- Forearm Pronation 70, Supination 20
- Referred to therapy for ROM

Therapy Options

No improvement supination 3 weeks

A. Active ROM only
B. Active and passive ROM
C. Dynasplint™ for forearm supination
D. Static progressive splinting
E. Stop therapy, refer to surgeon

Case: 8 Weeks Non-Op
Proposed Classification: (Category 2)

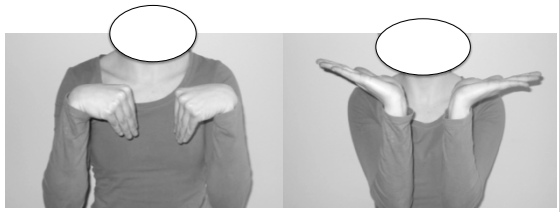

Therapy Options

No improvement supination 3 weeks

A. Active ROM only
B. Active and passive ROM
C. Dynasplint™ for forearm supination
D. Static progression splinting
E. Stop therapy, refer to surgeon

ORIF w/ Volar Plate

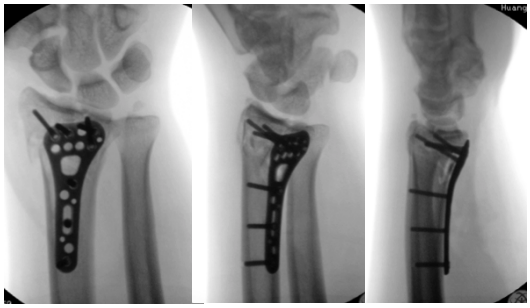

6 Weeks Post-Op



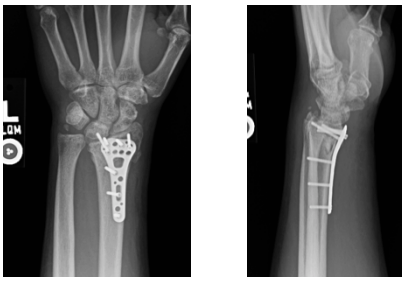
6 Weeks Post-Op


54 y/o male s/p FOOSH


Intra-Op



Lost to F/U….3 Months Later... Went Back to Construction Work



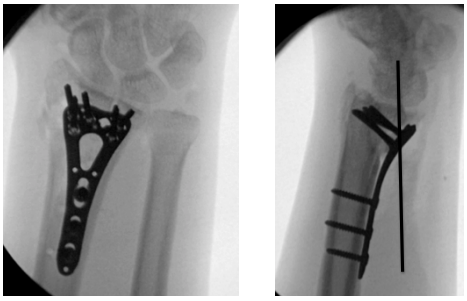
Case: Construction Worker

- Full-time work at 1 month post-op
- "Tried" avoiding heavy lifting
- Severe pain 7/10
- Wrist flexion 35; Extension 45
- Forearm Pronation 80; Supination 50

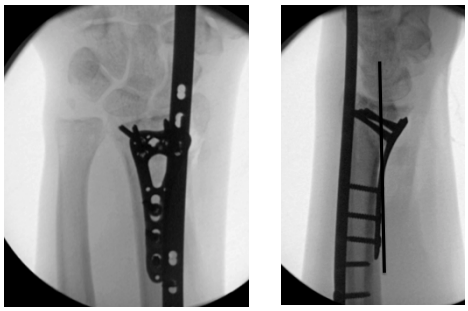
2/16/2016 presentation

Property of MacDermid, Huang, Karagiannopoulos,

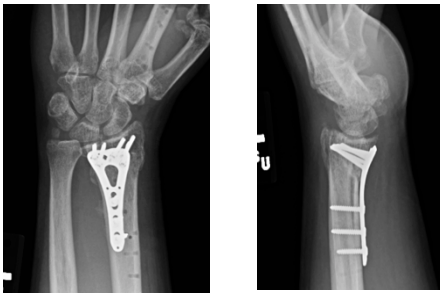
Carpal Malalignment



Revision ORIF



3 Months Later



Case: Construction Worker

- 4 Months Post-Revision ORIF
- Pain 1/10 at rest ➔ 5/10 w/ activities
- Wrist Flexion 35; Extension 55
- Pronation 80; Supination 80
- Released to full work

UWHAND

DRF Case with Complication

49 yo LHD ♂ business executive
Injured while biking
✓ Landed at L side and fx his L distal radius
Fracture characteristics:
✓ Min-displaced & stable
✓ Maintained satisfactory ulnar variance
Treatment: 6 weeks cast immobilization
✓ Referral to PT for AROM only.

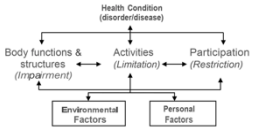
Christos Karagiannopoulos, PT, PhD, ATC, CHT

DRF Case with Complication

49 yo LHD ♂ business executive who sustained a stable/non-displaced L DRF while biking. Tx with 6 wks cast immobilization and referred to PT for AROM.

Physical Impairments @ IE:
Edema Figure-8: +3 cm
Decreased AROM:
- Ext 25°, Flex 20°, sup 45°
- Dig flex: 3 cm DPC
- Pain 3-5/10 with activity
- Hand numbness: Th, II, III tips
  - Ten-Test 7-8/10
  - (+) CT compression, Tinels
- Quick DASH: 65%

ICF: Interaction of Concepts



DRF Case with Complication

49 yo LHD ♂ business executive who sustained a stable/non-displaced L DRF while biking. Treated with 6 wks cast immobilization and referred to PT for AROM only.

Physical Impairments @ IE:
Edema Figure-8: +3 cm
Decreased AROM:
- Ext 25°, Flex 20°, sup 45°
- Dig flex: 3 cm DPC
- Pain 3-5/10 with activity
- Hand numbness: Th, II, III tips
  - Ten-Test 7-8/10
  - (+) CT compression, Tinels
- Quick DASH: 65%

Activity Limitations:
Driving long distance for work
Typing & carrying briefcase
Holding utensils & tools
Buttoning shirt
Opening bottles
Turning door knobs
Gym lifting & Riding bike

DRF Case with Complication

49 yo LHD ♂ business executive who sustained a stable/non-displaced L DRF while biking. Treated with 6 wks cast immobilization and referred to PT for AROM only.

Activity Limitations:
Driving long distance for work
Typing and carrying briefcase
Holding utensils & tools
Buttoning shirt
Opening bottles
Turning door knobs
Gym lifting & Riding bike

Participation:
Work activity
Housekeeping
Recreation

DRF Case with Complication

49 yo LHD ♂ business executive who sustained a stable/non-displaced L DRF while biking. Treated with 6 wks cast immobilization and referred to PT for AROM only.

Activity Limitations:
Long distance driving
Typing & carrying briefcase
Holding utensils & tools
Buttoning shirt
Opening bottles
Turning door knobs
Riding bike

Participation:
Work activity
Housekeeping
Recreation

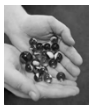
Personal Factors:
Long hours work typing
Pre-existed mild hand P/N occasionally
No h/o smoking or diabetes or L arm trauma

Treatment: wk 6-10

Edema control
- Night glove
- Hand pumps (every 1-2 hours)
- Manual retrograde massage

Wrist AROM all planes
- Open & closed chain

Tendon glides
Intrinsic stretching
Functional dexterity/sensibility
HEP (written instructions)


Treatment wk 8

Light resistance added:
- Added light therapeutic putty
- Light wrist isometrics
- wrist PREs: light wt: 2 lbs – pain free
- Postural re-education: T band rows



Progress @ 10 wks

- Pain 0-2/10 with activity
- AROM WFL all planes (Flex 58, Ext 68, Sup 90)
- Full Hand AROM to DPC
- Edema + 0.5 cm figure-8
- Grip strength: 75%, 3-jaw pinch 65%
- **Constant numbness no change**
  - Ten-Test 7-8/10: Th, II,III tips
  - (+) CTS clinical testing
- **Quick DASH: 25%**
  - Return to full work: still trouble with fine motor

Communication with physician:
- Cont. supervised PT - Wait+ see approach
- Activity mod & night splint

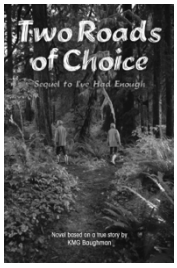
Progress @ 12 wks

No sig change:
- ➢ Grip/pinch strength
- ➢ Function/numbness:
  - (+) CTS testing

⇨ DC PT → Ortho Consult

Clinical Case Key Points:
- ➢CTS is common complication
- ➢Screened and ID in therapy
- ➢Delayed functional recovery
  - ➢Even for less complex DRF
- ➢Require further ortho treatment

A Tale of two guidelines…..
APTA and AAOS



An ICF-Based Clinical Practice Guideline for Carpal Tunnel Syndrome

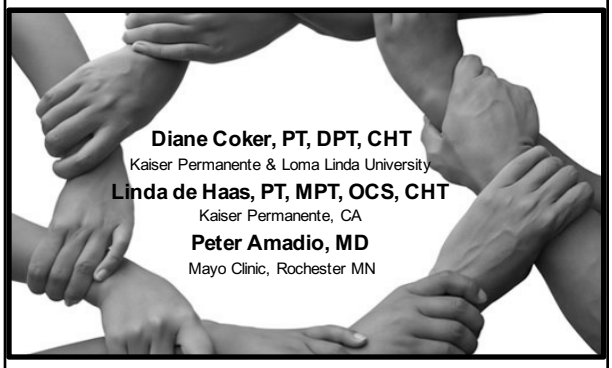
Combined Sections Meeting 2016
Anaheim, California, February 17-20, 2016

Disclosure

Carla Cleary, PT, DPT, CHT
St. Dominic Outpatient Rehab & Hand Management. Jackson, MS
Marsha Lawrence, PT, CHT
Practice Division Director, ASHT
Caroline W. Stegink Jansen, PT, PhD, CHT
UTMB, Dept of Orthopaedic Surgery and Rehabilitation. Galveston, TX
Mia Erickson, PT, EdD, CHT, ATC
West Virginia University, SOM, Division of Physical Therapy

The authors have nothing to disclose.

Additional Members of CPG Team



Diane Coker, PT, DPT, CHT
Kaiser Permanente & Loma Linda University
Linda de Haas, PT, MPT, OCS, CHT
Kaiser Permanente, CA
Peter Amadio, MD
Mayo Clinic, Rochester MN

Session Learning Objectives
Provide and Apply Practice Guideline for Carpal Tunnel Syndrome

1. Describe the pathophysiology found in CTS.
2. Identify the most likely risk factors for the development of CTS in patient cases.
3. Weigh the evidence for examination procedures and outcome measurement tools for CTS based on current medical literature.
4. Provide clinical reasoning to incorporate evidence-based treatment interventions into physical therapy treatment of CTS

Introduction

Guide to Physical Therapy Practice APTA

This Clinical Practice Guideline is a collaboration between the Hand Rehabilitation Section & the Orthopedic Section.

Introduction: Purpose of ICF CPGs

- Guide PT practice, including diagnosis, prognosis, intervention, and assessment of outcome.
- Classify conditions using the WHO's terminology related to impairments of body function and body structure, activity limitations, and participation restrictions.
- Describe the current "state of the evidence" and identify gaps.
- Determine appropriate outcome measures to assess changes resulting from PT interventions.
- Identify evidence supported interventions reducing or preventing symptoms or progression of the disease or condition.
- Provide a description to policy makers, using internationally accepted terminology, of the practice of PT
- Create a reference document for clinicians, educators, and students on best practice in physical therapy.

Introduction

Methods

1. Similar to previous Orthopedic CPGs
   1. Systematic search for concepts associated with carpal tunnel syndrome published since 1966.
      - ✓ Medline
      - ✓ CINAHL
      - ✓ Cochrane Database
      - ✓ References from articles found above
      - ✓ Excluded articles written in language other than English
   2. Each article reviewed by at least 2 reviewers
      - ✓ Assigned a level of evidence
      - ✓ Evaluated quality using critical appraisal tools developed by Joy MacDermid 2011 (macderj@mcmaster.ca)

ONLINE APPENDIX F

LEVELS OF EVIDENCE TABLE*

Level	Intervention/ Prevention	Pathoanatomic/Risk/ Clinical Course/Prognosis/ Differential Diagnosis	Diagnosis/Diagnostic Accuracy	Prevalence of Condition/Disorder	Exam/Outcomes
I	Systematic review of high-quality RCTs High-quality RCT†	Systematic review of prospective cohort studies High-quality prospective cohort study†	Systematic review of high-quality diagnostic studies High-quality diagnostic study‡ with validation	Systematic review, high-quality cross-sectional studies High-quality cross-sectional study‖¶	Systematic review of prospective cohort studies High-quality prospective cohort study
II	Systematic review of high-quality cohort studies High-quality cohort study† Outcomes study or ecological study Lower-quality RCT¶	Systematic review of retrospective cohort study Lower-quality prospective cohort study High-quality retrospective cohort study Consecutive cohort Outcomes study or ecological study	Systematic review of exploratory diagnostic studies or consecutive cohort studies High-quality exploratory diagnostic studies Consecutive retrospective cohort	Systematic review of studies that allows relevant estimate Lower-quality cross-sectional study	Systematic review of lower-quality prospective cohort studies Lower-quality prospective cohort study
III	Systematic reviews of case-control studies High-quality case-control study Lower-quality cohort study	Lower-quality retrospective cohort study High-quality cross-sectional study Case-control study	Lower-quality exploratory diagnostic studies Nonconsecutive retrospective cohort	Local nonrandom study	High-quality cross-sectional study
IV	Case series	Case series	Case-control study		Lower-quality cross-sectional study
V	Expert opinion	Expert opinion	Expert opinion	Expert opinion	Expert opinion

Abbreviation: RCT, randomized clinical trial.
Adapted from Phillips et al[2] (http://www.cebm.net/index.aspx?o=1025). See also* **APPENDIX G.
†High quality includes RCTs with greater than 80% follow-up, blinding, and appropriate randomization procedures.
‡High-quality cohort study includes greater than 80% follow-up.
§High-quality diagnostic study includes consistently applied reference standard and blinding.
‖High-quality prevalence study is a cross-sectional study that uses a local and current random sample or censuses.
¶Weaker diagnostic criteria and reference standards, improper randomization, no blinding, and less than 80% follow-up may add bias and threats to validity.

McPoil 2008; Martin 2014 Heel Pain—Plantar Fasciitis CPG

Simplified Version of Levels of Evidence

I	Evidence obtained from high-quality diagnostic studies, prospective studies, or randomized controlled trials
II	Evidence obtained from lesser-quality diagnostic studies, prospective studies, or randomized controlled trials (eg, weaker diagnostic criteria and reference standards, improper randomization, no blinding, less than 80% follow-up)
III	Case-control studies or retrospective studies
IV	Case series
V	Expert opinion

Martin 2014 Heel Pain—Plantar Fasciitis CPG

Introduction: Methods

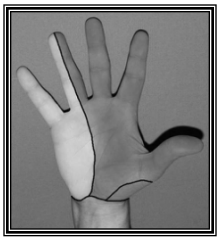
3. Recommendation developed upon review of the literature
4. Assigned a grade based on the strength of evidence supporting the recommendation

GRADES OF RECOMMENDATION BASED ON	STRENGTH OF EVIDENCE
A Strong evidence	A preponderance of level I and/or level II studies support the recommendation. This must include at least 1 level I study
B Moderate evidence	A single high-quality randomized controlled trial or a preponderance of level II studies support the recommendation
C Weak evidence	A single level II study or a preponderance of level III and IV studies, including statements of consensus by content experts, support the recommendation
D Conflicting evidence	Higher-quality studies conducted on this topic disagree with respect to their conclusions. The recommendation is based on these conflicting studies
E Theoretical/ foundational evidence	A preponderance of evidence from animal or cadaver studies, from conceptual models/ principles, or from basic science/bench research supports this conclusion
F Expert opinion	Best practice based on the clinical experience of the guidelines-development team

Introduction: Overview of the Syndrome

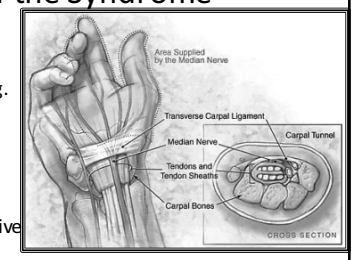
Symptoms of CTS

- Numbness, tingling, pins & needles in median nerve distribution (many times whole hand)
- Pain in median nerve distribution, wrist area (palm side), occasionally up to shoulder
- Symptoms usually worse at night and disturb sleep
- Frequently drop or difficulty picking up small objects



Introduction: Overview of the Syndrome

- Anatomy Review
- Tunnel formed by:
  - ❖Transverse Carpal Lig.
  - ❖Carpal bones
- Contents of tunnel:
  - ❖Median nerve
  - ❖9 Flexor tendons
  - ❖Subsynovial connective tissue (SSCT)
  - ❖Visceral synovial layer-provides gliding surface between tendons



SSCT: multiple layers of collagen that surround the flexor tendons & connects to synovial layer

Introduction: Overview of the Syndrome

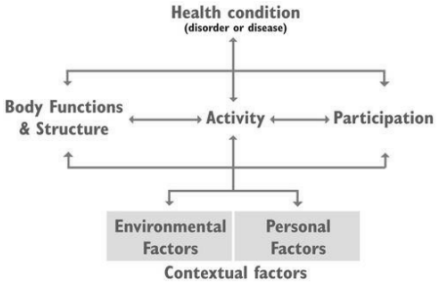
- Pathophysiology
- Tight compartment---anything taking up space will produce pressure & choke blood supply to the nerve
  - ❖Enlarged bone—OA
  - ❖Swelling
  - ❖Fibrosis & thickening of the synovium & SSCT
    - ➢ 90% synovium from pts with idiopathic CTS demonstrated edema & fibrosis
    - ➢ In vivo & in vitro evidence that tendon shearing forces (repetitive motion?) create microtears in the small fibrils found between successive layers of the SSCT, tendon and synovial layer
    - ➢ Theory that this leads to fibrosis

Henderson et al; 2011
Ghasemi-rad et al; 2014

Introduction: Overview World Health Organization Classification ICD Codes Associated with CTS

- ICD-9 code is **354.0**
- ICD-10 codes: **G56.0:** carpal tunnel syndrome
  - **G56.00:** unspecified upper limb
  - **G56.01:** right upper limb
  - **G56.02:** left upper limb.

Introduction: Overview World Health Organization Classification ICF Model of Health



Introduction: Overview World Health Organization Classification ICF Codes Associated with CTS

ICF Labels: Body Function

- b134: sleep
- b260: Proprioceptive
- b265: Touch
- b270: sensory related to temperature and other stimuli
- b279: additional sensory functions, other specified & unspecified (Carla's i.e.: stereognosis)
- b280: sensation of pain
- b730: muscle power
- b750: motor reflex
- b760: control of voluntary movements
- b780: sensations related to muscles & movement
- b:810 protective functions of the skin
- b840 sensation related to skin

Introduction World Health Organization Classification ICF Labels: Body Structure

- The body structure codes associated with carpal tunnel syndrome are:
  - s198: structure of the nervous system, other specified
  - s7302: structure of hand.
    - s73022: muscles of the hand

Introduction: WHO: ICF Labels: Activities & Participation

(Learning, Gen'l Tasks, Communication, Mobility)

- d120: other purposeful sensing
- d170: writing
- d230: carrying out daily routine
- d360: using communication devices and techniques
- d430: lifting & carrying objects
- d440: fine hand use
- d445: hand and arm use
- d449 : carrying, moving & handling objects, other specified & unspecified
- d475: driving

ICF Labels: Activities & Participation

Self Care

- d510: washing oneself
- d520: caring for body parts
- d530: toileting
- d540: dressing
- d550: eating
- d560: drinking
- d598: self-care, other specified

Domestic & Major life areas

- d630: preparing meals
- d640: doing housework
- d649: household tasks, other specified & unspecified
- d850: remunerative employment
- d920: recreation & leisure

ICF Clinical Practice Guideline

- Risk Factors
- Diagnostic Tests
- Clinical Outcome Measures
- Interventions
- Case Example

Risk factors

Intrinsic: *inherent to individual may or may not be modifiable*

Occupational: *may or may not be modifiable*

Risk Factor Studies

(Problems/difficulties in interpretation)

- Very few prospective (level of evidence1-2)
  - ❖Incidence only 0.8 to 14.8 per 1000 person years *(dependent on study pop.—general vs. manufacturing)*
  - ❖Would need to follow a huge population in order to draw conclusions
  - ❖NIH funding several large scale studies currently
- Statistical analysis vary (odds ratio, relative risk, hazard ratio, standardized incident ratios)

Dale et al, 2013

Intrinsic Factors: ↑ risk

Moderate (B) Recommendation to support

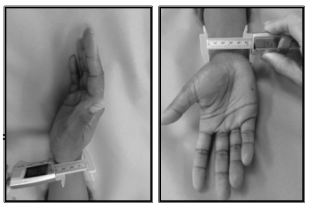
Risk Factor	Evidence level	Increases likelihood
Diabetes	2 level II; 2 level III; 1 level IV Level III SR (Dijk)	OR between 1.4-6.55 SR=2.2
Obesity: risk increases linearly with Body Mass	1 level I; 2 level II, 15 studies level III	BMI > 25 kg/m2 at least 2x risk
Female Gender	1 level I; 2 level II; 7 level III	1.5-4x more likely
Increasing age: appears to be linear	1 level I, 4 level II, 11 level III	2-4 x more likely those over 50

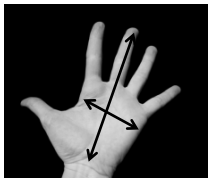
Key references: Dijk 2003, Harris-Adamson 2013, Werner 1995 & 2005, Nathan 1992 & 2002, Roquelare 2008, Vessy 1990

Intrinsic Risk Factors

"Square wrist"

- larger wrist ratio
- depth/width > 0.70
- i.e.: 39.36mm /54.02 mm = 0.73





" Short wide hand"

- Smaller hand ratio
- hand length/palm width

Intrinsic Factors: ↑ risk

Weak (C) Recommendation to support

Risk Factor	Evidence level	Increases likelihood
Square Wrist	1 level II 7 level III	OR: 42.89 Hiebs only
Short, wide hand	3 level III	OR: 1.22 Hiebs only
1st degree relative	3 level III	2-7x

Key references: Nordstrom 1997, Mattoli 2009, Hemminiki 2007, Nathan 1992 & 1993, Radecki 1994, Chiotis 2013, Cosgrove 2002, Kamolz 2004, Lim 2008, Hiebs 2014, Hemminiki 2007

Intrinsic Risk Factors -Medical Problems ↑ risk

Weak (C) Recommendation to support

Risk Factor	Evidence Level	Increases likelihood
Rheumatoid Arthritis	SR of 10 Level III studies	2.2x
Thyroid Disease	SR of 8 level II/III studies	OR: 1.4
Previous musculoskeletal problems r.e.: tendonitis, trigger finger, joint pain	1 level II, 3 level III	3-5x

Key references: Dijk 2003, Mattoili 2009, Werner 2005, Nordstrom 1997, Ferry 2000

Intrinsic Factors-Protective

Recommendation: Weak (C)

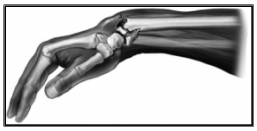
Conclusion: ↓ risk	Evidence Level	Decreases likelihood
Taller stature	3 studies—Level III	OR: 0.50 Mattoili only
Regular physical activity	3 studies--Level III	OR: 0.50-0.72

Key references: Chiotis 2013, Mattoili 2009, Nathan 1993, Eleftheriou 2012; Nordstrom 1997

Intrinsic Factors

No Recommendation can be made—only 1-2 level III studies

- Previous arm fractures
- Hand dominance
- Race



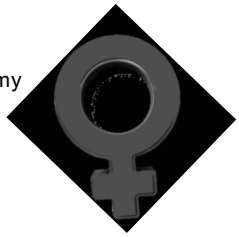
Conflicting Evidence

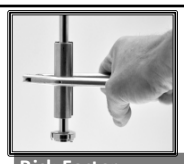
- Smoking
- Alcohol Consumption

Intrinsic Factors in Women

No Recommendation can be made—only few studies that conflict

- Pregnancy
- Parity
- Hysterectomy or Oophorectomy
- Oral contraceptives
- Hormone replacement





Occupational Factors: ↑ risk

Moderate (B) Recommendation to support

Risk Factor	Evidence Level	Increases likelihood
Forceful exertions of hand/wrist	3 level II 1 MA level II 2 SR level III	2-4 x
Repetitive mvts of hand/wrist	3 level II 2 MA level II 3 SR level III	@ least 2 x

Key references: You 2014, Barcenila 2011, van Rijen 2009, Hagberg, 1992, Palmer 2007, Evanoff 2012, Burt 2011 & 2013

Occupational Risk Factors- ↑ Risk

Recommendation: Weak (C) to support

Risk Factor	Evidence Level	Increases likelihood
Vibration exposure	1 level II 1 MA level III 3 SR level III	@ least 2.5 x
Non-neutral positions of hand/wrist	1 MA level III 3 SR level III	2.6-4.7 x
Blue collar work	1 level II 2 SRs level III	Varies by work type: OR: 76.5 meat/fish 11.4 electronic assembly

Key references: You 2014, Barcenila 2011, van Rijen 2009, Hagberg, 1992, Roquelaure 2008, Palmer 2007

Occupational Risk Factors: Conflicting Evidence

- Duration of Employment
- Psychosocial variables: dislike supervisor, non-supportive co-workers
- Computer Work

Summary of Intrinsic Risk Factors- Supported

Factor	Recommendation
Increasing Age	B
Female	B
Square Wrist	C
First degree relative	C
Short Wide Hand	C

Factor	Recommendation
Diabetes	B
Obesity	B
RA	C
Thyroid	C
Prev MSK	C

Summary of Intrinsic Risk Factors- Supported as Protective

Factor	Recommendation
Taller Stature	C
Regular Physical Activity	C

Summary of Occupational Risk Factors- Supported

Factor	Recommendation
Forceful exertions	B
Repetitive movement	B
Vibration	C
Non-neutral wrist position	C
Blue Collar work	C

ICF Clinical Practice Guideline

- Risk Factors
- Diagnostic Tests
- Clinical Outcome Measures
- Interventions
- Case Example

Differential Diagnosis/ Examination

- NCV/diagnostic US
  - specific process and cut off values are too broad to cover
  - need entire CPG on these topics
- Keep to what general PT/hand therapist does in clinic:
  - Provocative tests: i.e.: Phalen's, Tinel's, Compression
  - Tests to rule out cervical pathology or other upper extremity neuropathy
  - Sensibility exam

Definitions: Sensitivity & Specificity

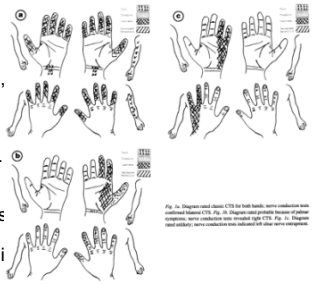
- Sensitivity: (S)
  - probability that test in question provides a + result when ref standard also +
  - higher number more likely to pick up diagnosis if present (less false negatives)
- Specificity: (Sp)
  - Probability that test in question will give (-) test result when ref. standard also (-)
  - higher the number more sure that if test positive patient has the diagnosis (less false positives)
- MacDermid and Wessel 2004:
  - SR that averaged S & Sp across various studies
  - classified a test as potentially useful if S & Sp > 50%

Definitions: Reliability

- Intra-tester = test-re-test
- Inter-tester = between testers
- kappa values: (Landis & Koch 1977)
  - 0-0.20 poor
  - 0.21-0.40 fair
  - 0.41-0.60 good
  - 0.61-0.80 substantial
  - > 0.81 almost perfect

Diagnosis: Symptoms—Katz Hand Diagram

- Patients asked to fill out hand diagram with symptoms
- Rated only on numbness, tingling or decreased sensation (not pain)
- Classic=sx in at least 2 digits in median n. distrib. (thumb-middle) but not palm
- Probable: at least 2 digits and palm included
- Possible: at least one digi
- Unlikely: none of these digits



What considered positive diagram?

From: Katz et al 1990

Diagnosis—Strong (A) Recommendation

Katz Hand Diagram	
Reliability:	
Intra-rater	substantial 0.84
Inter-rater	substantial 0.91
Level of Evidence (Reliability)	Level I: Katz, 1990
Validity	
SR: MacDermid & Wessel (2 level I, 1 level II, 3 level III-IV)	293 cases, 226 controls S = 76% Sp = 98%
Level of Evidence (Overall)	I

Diagnosis: Provocative tests

Mechanism of Action

- Most hypothesized to produce further vascular compromise to an already impaired median nerve.
  - pressure elevation within the CT with wrist posturing
  - diminishing blood flow by hand elevation
  - direct mechanical deformation or nerve stretching.
- Tinel's sign
  - occur in an area of demyelination
  - Unprotected, hypersensitive, regenerating nerve fibers produce paresthesias or electrical sensation when percussed

Provocative Tests

Difficulties in Interpretation

Considerable variability in the literature due to differences in:

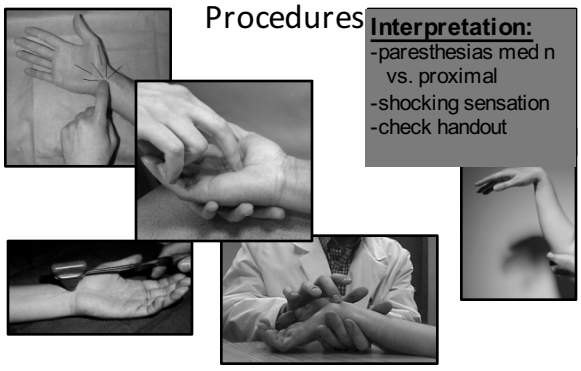
- Subject Population
- lack of clear ref. standard for dx of CTS
- how test performed
- interpretation of tests
- blinding

Provocative Tests

Difficulties in Interpretation

- Subject Population
  - asymptomatic control groups (rather than subjects with other UE) pathology=more likely to overly high S and Sp
  - sample pop. from hand surgeons office have higher incidence of CTS= lead to higher S but lower Sp than those from the general pop. or primary care facility.
- Reference Standard
  - Gold Standard? Clinical dx, electrodx studies, results of surgery
  - Electrodx studies or surgery used for "true positive" rather than "clinical diagnosis" = lower sensitivity but higher specificity

Provocative Tests: Variation in Procedures



Interpretation:
-paresthesias med n vs. proximal
-shocking sensation
-check handout

Test	Usual Procedure	Positive	Hold time	Variations
Phalen	either: -elbows ext, forearms pron, pt. holds wrist max flex -elbows flexed resting on table, forearms pron, wrist allowed to fall into full flexion	Reprod. Sx (pain, paresthesia, tingling, numbness) in the med. Nerve distribution	1 min	-wrist held passively by the examiner -dorsal hands are placed together
Tinels	Either use fingers to: -tap over course of med. n. from PPC to DWC -tap only at wrist crease (3-6 times)	pain, tingling or paresthesias in median nerve distribution	N/A	-percussion with reflex hammer -wrist in neutral or extended -(+) if electric shock sensation into hand or forearm

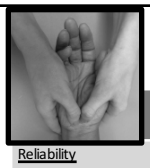
Test	Usual Procedure	Positive	Hold time	Variations
Compression (Durkan)	forearm sup., wrist neutral, manual pressure applied with examiners 2 thumbs over TCL (b_ thenar & hypothenar emin.)	Reproduction of sx (pain, paresthesias, tingling, numbness) in the med. nerve distribution	30 sec	-force over med. n. just prox. to the wrist crease -BP cuff used to measure manual force applic. of 50 or 100 mmHg -hold of 1 minute
WF (Phalen's) with compression	forearm sup., WF to 60°, pressure applied over med. n. at CT with examiner's thumb	paresthesia in median nerve distribution	1 min.	-wrist max. WF; forearm in neutral rotation and with digital pressure placed on the med. n. just prox. to DWC -30 sec hold

Test	Usual Procedure	Positive	Hold time	Variations
Wrist Extension (Reverse Phalen's)	Active wrist extension	Reproduction of sx in med. n. distribution	1 min.	-fingers also extended -palms put together -maximal wrist extension -forearm neutral rotation -30 sec hold
Gilliat's Pneumatic compression(Tourniquet)	BP cuff placed around arm above elbow & inflated to systolic BP	numbness/ tingling in med. nerve distribution	1 min.	-positive if symptoms reproduced
Hand elevation	patient elevates both hands above head as high as comfortably possible	paresthesias or numbness in median nerve distribution	1 min	positive if reproduction of symptoms -2 min hold time

Test	Usual Procedure	Positive	Hold time	Variations
Upper limb neurodynamic test (ULNT)	shoulder girdle is stabilized to prevent elevation while the following movements are sequentially added: SA, WE, forearm sup., shoulder ER, EE, cervical lateral flexion first away from tested extremity, then toward tested extremity	-reprod. sx -side-to-side differences in EE on completion of all motion sequences -contralateral neck side bending increased sx or ipsilateral side bending decreased sx	n/a	-depress the shoulder girdle instead of preventing elevation -change the sequence of test movements

Provocative Tests: Strong (A) Recommendation

	Phalen's	Tinel's
Reliability Intra-rater Inter-rater	 Good: 0.52-0.58 Substant: 0.65-0.80	 Good/subst: 0.51-0.80 Substant: 0.77-0.80
Level of Evidence (Reliability)	**Level I & II** MacDermid 1997; Marx 1998; Priganc 2003	**Level I & II** MacDermid 1997; Marx 1998; Priganc 2003
Validity SR: MacDermid & Wessel (mostly IV; some I & III) other level: I (Fought 2001, Tungen 2012)	 3000 cases; 1600 controls S=68%; Sp=73% S=80 & 90% Sp=48 & 33% Good correlation with Edx if both Phalen & Tinel +	 2640 cases; 1614 controls S=50%; Sp=77% S=79 & 39% Sp=65 & 100%
Evidence (Overall)	I	I



Provocative Tests: Moderate (B) Recommendation

	Compression (Durkan, Carpal Compress, Press. Prov)
Reliability Intra-rater Inter-rater	 substantial to almost perfect k=0.63 & 0.92 substantial= 0.64
Level of Evidence (Reliability)	Level II,III & IV Prignanc 2003, Salerno 2000, Williams 1992
Validity SR: MacDermid & Wessel Massey-Westropp (level II-IV) other level: I (Faught, Tungen)	 S = 49-89% Sp = 54-96% S =76-90% Sp =33-34%.
Evidence (Overall)	II

Provocative Tests: Weak (C) Recommendation

	Wrist Flex w_ Compression (Phalen's w_ Comp)	Wrist Extension (Reverse Phalen)	Hand Elevation
Reliability **Intra-rater** **Inter-rater** (MacDermid 1997)	 **No studies**	 **No studies** **Substant**: 0.72	 **No studies**
Validity SR: MacDermid & Wessel other level IV: Tetro 1998, Goloborod'ko 2004, Amirfeyz 2005 & 2011, Ma 2012, Ahn 2001	 190 cases; 238 ctrl S=88%; Sp=92% (3 level IV) S=86%, Sp 95% PPV= 94%, NPV 97% --S better Phalen's, Compress & Tinel --Sp & PPV better than Phalen's	 640 cases; 360 ctrl S=57%; Sp=78% (1 level I, 1 level II, 5 level IV) S =88%, Sp 98% PPV & NPV 98% -similar to Phalen's but better than Tinel	 S=75-98% Sp=88-98% --predicted + NCV better than Phalen & compression
Level-Overall	IV	IV	IV

Provocative Tests: Not Supported

	Gilliat's Pneumatic Compression (Tourniquet)	Upper Limb Neurodynamic Test (ULNT1)
Reliability	No studies	No studies for CTS
Validity SR: MacDermid (mostly IV; 1 level II) other level I	306 cases, 316 controls S =59%, Sp 61% -S = 55-67%; Sp=33-100% -S less Durkan's & Phalen's -Sp less Tinels but better Phalen -authors concluded—nothing added over traditional tests Tungen 2012	n/a -not helpful for making or ruling out CTS because likelihood ratios were b_ 0.5 & 2.00 -S = 54%-92%; Sp 13%-70%. SR:Nee 2012 (2 level I)
Recommend	Level B (moderate)	Level A (strong)

Miscellaneous tests

No conclusions can be drawn—too few studies

- finger flexion
- Flick
- Luthy's sign
- lunate press
- modified carpal compression (used oscillations over CT)
- modified pneumatic compression
- scratch collapse
- Tanzer's
- Tethered median nerve test.

Summary of Diagnostic Tests-Supported Symptoms & Provocative Tests

Test	Recommendation
Katz Hand Diagram	A
Phalen's	A
Tinel's	A
Compression	B
Wrist flexion with Compress	C
Wrist Extension (Reverse Phalen's)	C
Hand Elevation	C

Diagnosis: Sensory Tests

Semmes Weinstein Monofilaments (SWMF)
Moderate (B) Recommendation

Reliability	
Intra-rater	substantial; K= 0.71
Inter-rater	Poor to moderate k= 0.15-0.52
Level of Evidence (Reliability)	Level I: MacDermid 1997 Level II: MacDermid 1994 & Marx 1998
Validity	
SR: MacDermid & Wessel (2 level I, others III & IV)	811 cases, 561 controls S=72, Sp=62
Raija 2014: level II	-only 52% of pts. with + NCV also had + SWMF -correlation of between SWMF scores and NCV for the thumb; r=0.44. -less correl. for other med. innervated digits
Evidence (Overall)	II

Diagnosis: Sensory Tests

Static Two Point Discrimination
Weak (C) Recommendation

Reliability	
Intra-rater	substantial; ICC 0.77
Inter-rater	substantial; ICC 0.66
Level of Evidence (Reliability)	Level II: Marx 1998
Validity	
SR: MacDermid & Wessel (Level III & IV)	381 cases, 212 controls S=24, Sp=95
Marlowe 1998: level III	-Sensory peak and onset latencies of thumb correlated with 2PD of this digit -S=25%; Sp=87.5%, PPV = 85%, NPV 29% -no correlation found with middle finger
Evidence (Overall)	III

Diagnosis: Sensory Tests

Moving Two Point Discrimination

Reliability	
Intra-rater	good; ICC 0.58
Inter-rater	good; ICC 0.45
Level of Evidence (Reliability)	Level II: Marx 1998
Validity	
Level IV: Spindler 1982 as calculated by Massy-Westropp 2000	S=21
Evidence (Overall)	IV

Recommendation: Expert Opinion (F): *Do not* use in place of other sensory tests with more research.

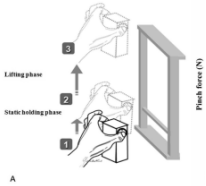
Diagnosis: Sensory Tests

256 Hz Tuning Fork
Moderate (B) Recommendation

Procedure: Buch-Jaegar 1994	-application of the branch of fork to pulp of index and small fingers -if deemed different intensity test considered positive
Reliability	
Intra-rater	none
Inter-rater	substantial; 0.71
Level of Evidence (Reliability)	Level I: MacDermid 1997
Validity	
SR: MacDermid & Wessel (1 LevelI, mostly IV)	343 cases, 170 controls S=55, Sp=81
Evidence (Overall)	III

Diagnosis: Sensory tests still to be assessed

- Vibrometry
  - Various instruments (Lundborg, biothesiometer, ATT, PCV50)
  - Various frequencies (fixed & variable)
- Current perception threshold
- Gap detection
- Pinch holding up activity test



Diagnosis: Thenar Muscle

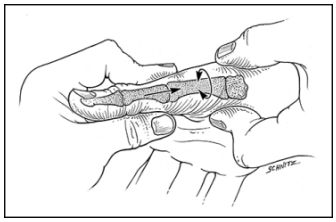
Strength & Atrophy *Weak (C) Recommendation*	
Reliability	
Intra-rater	perfect for surgeons & therapists; k= 1.00
Inter-rater	good for surgeons & therapists; k=0.50
Level of Evidence (Reliability)	Level II: Marx 1998
Validity	
SR: MacDermid & Wessel (1 LevelII & 1 level IV)	107 cases & 88 controls Strength: S = 29, Sp = 80 Atrophy: S=12, Sp=94
Ntani 2013: LevelI	-no assoc. found between thumb weakness & NCV in study of 1500 hands
Evidence (Overall)	III

Summary of Diagnostic Tests-Supported Sensory & Motor Tests

Test	Recommendation
SWMF	B
256 Hz Tuning Fork	B
Static 2PD	C
Thenar muscle strength	C
Thenar muscle atrophy	C

Diagnosis: Further Investigation

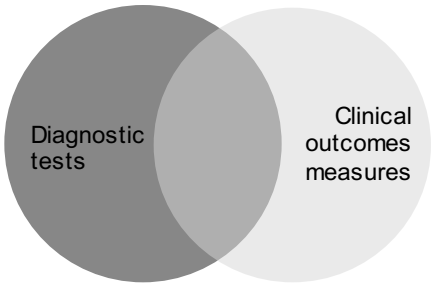
- Differential dx
  - Cervical
  - Cubital tunnel
  - OA of thumb
- Likely recommendation **F**: Expert Opinion



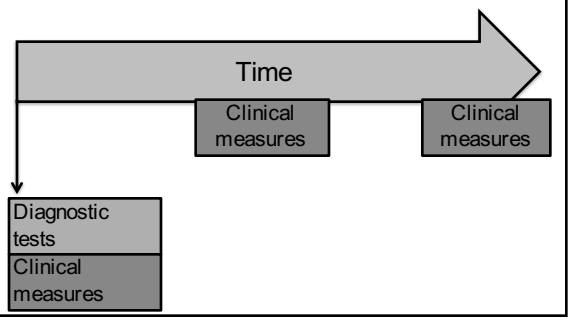
ICF Clinical Practice Guideline

- Risk Factors
- Diagnostic Tests
- Clinical Outcome Measures
- Interventions
- Case Example

Diagnostic tests vs clinical measures

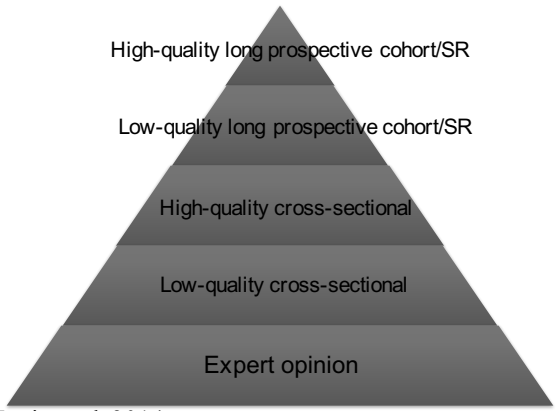


Diagnostic tests vs clinical measures



Diagnostic tests vs clinical measures

- Diagnostic tests
  - Sensitivity, specificity, likelihood ratios, etc.
- Clinical measures
  - Responsiveness, minimal detectable change, minimal clinically important difference
- No hierarchy of evidence for studies related to outcomes measures from CEBM



Martin et al, 2014

Clinical Outcomes Measures

1. Self-report
2. Performance-based
3. Measures for impairment in body structure and function

Self-report measures

Level 2 Evidence-Carpal Tunnel Questionnaire-Symptom Severity Scale (CTQ-SSS)

- 11-item questionnaire
- Levine et al, 1993
- Likert scale 1 to 5 (worst)
- Reliable and valid
- Highest sensitivity to change than any measure
- Grade of recommendation = B

Minimal Clinically Important Difference

- Cheung et al 2014
  - MCID = 0.5 points for orthosis management
  - Change in 6 weeks
- Ozyurekoglu et al
  - MCID = 1.04 after cortisone injection
- Herold-Jerosch et al 2011
  - MCID = 1.25 for those receiving surgical intervention
  - Improved versus Not improved/Worse
- Astifidus et al 2009
  - MCID = 1.36 uni/1.55 bil surgical intervention
  - Satisfied versus Not satisfied

Minimal Clinically Important Difference

- CTQ-SSS for post-surgical patients
- Ozer et al 2013
  - Diabetics vs Non-diabetics

	Diabetics	Non-diabetics
3 months	1.45	0.8
6 months	1.55	1.6

CTQ-SSS

- Severity of night pain
- Frequency of night pain
- Presence, frequency, duration of daytime pain
- Numbness
- Weakness
- Tingling
- Severity of numbness
- Frequency N/T awakens
- Difficulty grasping/using small objects

CTQ-SSS and ICF

Body structure/body function	Activity limitation	Participation restriction
CTQ-SSS		

CTQ-SSS

- Predictive validity
  - Strong predictor of failure to respond to conservative management (Boyd et al, 2005)
  - Scores <2.5 at presentation were 89% specific for success with conservative management (Ollivere et al, 2009)
  - Kaye and Reynolds, 2007
    - Scores > 2.5 had 51% probability of progression to surgery
    - Scores > 3.0 had 72%
    - Scores > 3.5 had 86%

CTQ-SSS

- No factor analysis on original instrument
- Redundancy

CTQ-SSS

- Atroshi et al 2009, 2011; Lyren and Atroshi 2012
  - Reduced 11 items to 6
  - Reliable
  - Correlates with original
  - Responsive
  - MCID = 0.9

1. Severity of pain at night
2. Severity of pain daytime
3. Severity N/T at night
4. Severity N/T daytime
5. Frequency awaken by pain
6. Frequency awaken by N/T

Self-report measures

Level 2 Evidence-Carpal Tunnel Questionnaire-Functional Scale (CTQ-FS)

- 8-item questionnaire; Levine et al, 1993
- Likert scale 1 to 5 (worst)
- Reliable and valid

1. Writing
2. Buttoning
3. Holding a book
4. Gripping a telephone
5. Opening jars
6. Household chores
7. Carrying grocery bags
8. Bathing and dressing

Self-report measures

Level 2 Evidence--DASH
- 30-item questionnaire; Hudak et al, 1996
- Likert scale 1 to 5 (worst)
- Reliable and valid

CTQ-FS and DASH

- Both are responsive, ES and SRM values are similar
- QuickDASH also responsive (Atroshi 2011, Lyren 2012)
- Responsiveness for functional measures are lower than CTQ-SSS
- Functional measures do not predict progression to surgery (Boyd et al 2005)
- BOTH: Grade of recommendation = B

Minimal Clinically Important Difference

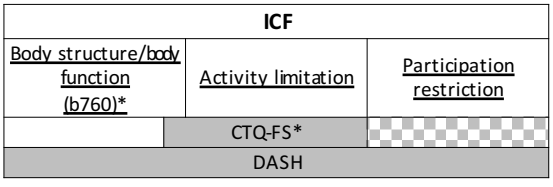
- CTQ-FS for post-surgical patients
  - Ozer et al 2013
  - Diabetics vs Non-diabetics

	Diabetics	Non-diabetics
3 months	1.95	1.25
6 months	2.05	1.45

Minimal Clinically Important Difference

- DASH for post-surgical patients
  - Amirfeyz et al, 2009
    - 20%

CTQ-FS, DASH and the ICF



b760 = control/coordination of simple and complex movements

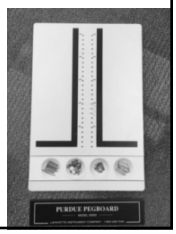
Performance-based Measures

- Data on:
  - Purdue Pegboard
  - Dellon-Modified Moberg Pickup Test
  - Jebsen-Taylor Hand Function Test
  - Nine-Hole Peg Test

Purdue Pegboard

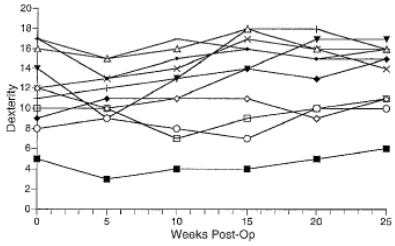
Level 4 Evidence

- Reliability and valid instrument for dexterous hand function
- CTS-conflicting evidence on ability to discriminate between those with and those without
- Pain duration and disease severity
  - Fernández-de-las-Peñas, 2009
- No correlation with EMG
  - de la Llave-Rincón et al, 2011
- Normative data are available
  - Yuedall et al, 1986
  - Desrosiers et al, 2009
  - Agnew et al, 1988



Purdue Pegboard

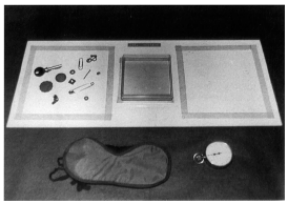
Level 2 Evidence – Responsiveness/clinical change
Olsen and Knudson, 2001



Dellon-Modified Moberg Pickup Test

Level 4 Evidence

- Reliability and valid
- Discriminates between those with CTS and control
  - Amirjani, 2011
- Normative data
  - Amirjani, 2007



Dellon-Modified Moberg Pickup Test

Level 2 Evidence –Responsiveness/clinical change
Appleby et al, 2009

Pre-op mean	Post-op mean	Mean difference
33.07±13.69	23.33±8.67	-9.74±10.81*

Responsiveness
ES = 0.71
SRM=0.90

Jebsen-Taylor Test of Hand Function

Level 2 Evidence

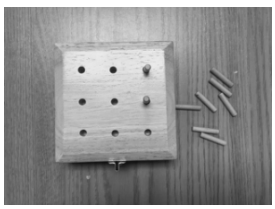
- Reliability and valid
- Not responsive following surgery
  - Effect size = 0.05
  - SRM = 0.04
  - Sears and Chung, 2010

www.euromedical.com

Nine-Hole Peg Test

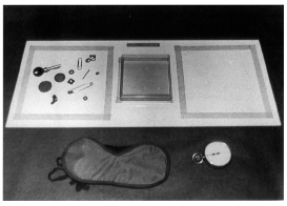
Level 2 Evidence

- Reliability and valid
- Not responsive following surgery
  - Effect size = 0.16
  - SRM = 0.12
  - Hobby et al, 2005



Performance-based Measures

- Grade of recommendation = C
  - Weak evidence to support the use of the Dellon-Modified Moberg Pickup Test



Performance Measures and the ICF

ICF		
Body structure/body function (b760)*	Activity limitation	Participation restriction
	DMPUT*	

b760 = control/coordination of simple and complex movements

Summary

Self-Report and Performance-based Measures

Measure	Supported/ not supported	Recommendation
CTQ-SSS	Supported	B
CTQ-FS	Supported	B
DASH	Supported	B
Purdue Peg Board	Not supported	C
Jebsen Taylor	Not supported	C
Nine Hole Peg Test	Not supported	C
Dellon MPUT	Supported	C

Measures of Body Function and Body Structure

- ROM, wrist or hand.
  - Excluded due to lack of evidence.
- Strength:
  - Grip, Pinch (finger tip, tripod [three jaw chuck] , key)
- Sensory:
  - Vibration, Monofilaments, moving and static 2 point discrimination, Iocognosia, Shape Texture Identification (STI) test

Body Function: Strength testing

Abductor Pollicis Brevis Strength testing

- Manual Muscle testing
  - Level 2 evidence:
    - Reliability: Marx 1998 (cohort): Reliability **Kappa 1.0**
    - Validity: Geere 2007 (systematic review, weak support)
    - Katz (1994) (cohort): (SRM=0.42; ES=0.35)
- Instrumented MMT
  - Level 1 evidence:
    - Jerosch Herold (2011): No long term change in APB strength
  - Level 3 evidence:
    - (Liu 2007): APB strength increased after 6 weeks.

Recommendation APB testing: D conflicting

Body Function: Strength testing

Grip strength

- Reliability: Evidence:
  - Level 2: Alderson and McGall (1999) found **intra-rater** reliability ICC > 0.93
- Validity:
  - Level 1: Jerosh-Herold C (2011) Prospective cohort: **NO**
  - Level 2: Systematic review Geere J (2007) **NO**
  - Level 2: Katz (1994), Amadio (1996),Boyd (2005), Wilgis (2006), Geere (2007), Astifides (2009), Itsubo (2009), Zyluk (2011): **NO**
- **Recommendation: Grade B: Grip strength NOT useful as an outcome measure.**

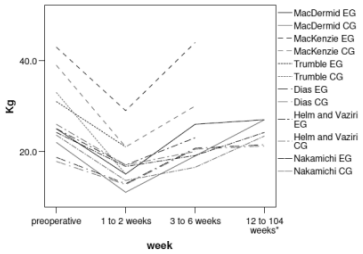


Figure 1
Line graph of pre and post-operative power grip strength. EG = experimental group, CG = comparator group. * studies which measured power grip at more than one time point between 12 and 104 weeks demonstrated minimal change in values.

Geere J 2007 Systematic review Level 2

Body Function: Strength testing

Pinch Strength

- Reliability: Evidence: Not available for patients with CTS
- Validity: Evidence:
  - Level 2 systematic review: Geere (2007) Tip pinch preferred over tripod (three jaw chuck), and key pinch.
  - Level 2: Zyluk 2011; 6 month cohort
    - 1 month post op: Grip 25% decease, key pinch 14% decrease
    - 6 month grip 12% above baseline; key pinch 4% above baseline
- **<u>Tip Pinch</u>: Recommendation: C include tip pinch**
- **<u>Tripod (three jaw chuck) and key pinch</u>: Recommendation: Grade C that key and tripod pinch are not useful as outcome measures.**

Geere J, Chester R, Kale S, Jerosh-Herold, 2007 Systematic review: Level 2

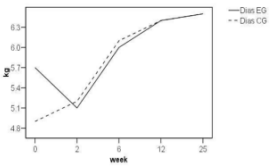


Figure 4
Line graph of pre and post-operative tip pinch strength. EG = experimental group, CG = comparator group.

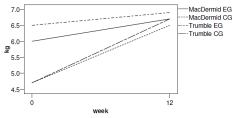


Figure 3
Line graph of pre and post-operative tripod pinch strength. Trumble et al. [20] reported a significant difference ($p < 0.05$) between groups until the 3rd post-operative month but does not report actual 2 week values. MacDermid et al. [24] reported no significant differences between groups. EG = experimental group, CG = comparator group.

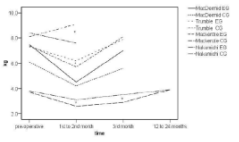


Figure 2
Line graph of pre and post-operative key pinch strength. * Statistically significant difference between groups reported. EG = experimental group, CG = comparator group.

Body Function: Sensory testing

- Vibration threshold
- Monofilaments
  - Semmes Weinstein (full and small set)
  - Weinstein Enhanced Sensory Test (WEST)
- Static and moving 2 point discrimination (2PD)
- Locognosia
- Touch Function/Shape Texture Identification (STI) test

Body Function: Sensory testing

Vibration Threshold

- Foundational: Proof of principle projects
  - Gandhi MS (2011) Equipment continues to evolve.
  - Tuning forks (30, 50, 150, 265 Hz) are used. The Automated Tactile Tester (Horch K, 1992) set at 50 and 120 Hz. **Yes/No *Nominal level of measurement Not for sale***
  - Stepwise vibrometer: frequency 50 Hz, Amplitude from high 180 to low 1 μm. (Hubbard 2004) (Z tech, Salt Lake City, UT). ***Interval level of measurement. Not for sale***
- Reliability:
  - Level 3: Hubbard MC (2004) 52 patients. Stepwise amplitude adjusted vibrometer. ICCs ranging from 0.86 to 0.89 when using the average of the second and third trial (out of 3 trials).

Body Function: Sensory testing

- **Validity Vibration**
  - Level 1 evidence:
    - Cheung et al (2014), 63 patients conservatively treated for CTS. Instrument: stepwise computer- amplitude controlled vibrometer,), set at 50Hz (Hubbard 2004.
    - Correlation between vibration sense and dexterity (NK Dexterity Small Objects Test) ranged between $r_s = 0.36 - 0.41$ ($p<0.05$)
    - Correlation DASH scores vibration: low and NS. ($p>0.05$)
    - Responsiveness: Baseline → 12 weeks:
      - Moderate clinical responsiveness (SRM = 0.61 and ES = 0.46) for responders to conservative management, defined as 0.5-point change in the CTQ-SSS.

Body Function: Sensory testing

- Validity Vibrometry Cont'ed
  - Level 3 evidence:
    - Dellon AL (1980): Crossectional 36 patients.
    - Tuning fork at 30 and 265 Hz.
- **Recommendation Vibrometry: D**
- **In support, Conflicting due to inconsistency in instruments.**

Dellon AL 1980

TABLE IV
Carpal Tunnel Syndrome

	Vibratory Perception	
	Normal	Abnormal
Two-point discrimination, abnormal	0% (0/10)	50% (13/26)
Moving two-point discrimination, abnormal	0% (0/10)	50% (13/26)
Electrodiagnostic studies, abnormal	0% (0/10)	63% (12/19)
Tinel's sign (positive), abnormal	10% (1/10)	61% (14/23)
Phalen's sign (positive), abnormal	40% (4/10)	70% (16/23)

Body Function: Sensory

- **Monofilaments**

Accuracy:

Level of evidence 5:

- Bell-Krotoski (1987) confirmed accuracy and consistency of force production under ideal circumstances.
- Max H. Haloua (2011); force affected by humidity and temperature (up to 39%)
- **Accuracy: Foundational**

Reliability:

Level 4:

- Small Kit: Marx (1998), three groups of raters, and 12 patients with a mix of diagnoses (the majority with CTS): inter-rater reliability of ICC 0.15 for all groups (0.00 to 0.43); intra-rater reliability of 0.71 for all (0.73 to 0.80)

Level 3:

- Full Kit: MacDermid (1994): A decision rule using 2.83 and 2.33 as cutoff resulted in a highest (fair) reliability (kappa 0.51) for the 2.33 cutoff when two experienced therapists measured SW scores on 39 patients.
- **Reliability: Partially conflicting**

Body Function: Sensory

Validity Monofilaments

- Level of evidence: 2
  - Katz JN (1994): 62 patients >80% satisfied with results at 3 months following surgery: Responsiveness SWM: (SRM=0.47; ES=0.41).
- Level of evidence: 3 (2 studies)
  - Elfar et al (2010), 35 patients, small kit.
    Middle finger was most affected, and the index finger the least.
    Correlations between NCV and SW scores: middle >thumb>index>small.
    A blanket statement cannot be made.
  - Raji et al (2014), 55 hands (35 patients); large kit, rater blinded.
    Thumb most affected, middle least. (thumb > index > middle).
    Correlation of r=0.44 (p<0.001) between SWM scores and NVC for the thumb (less for other median nerve innervated fingers). Diagnostically, not be supported, but the positive correlation with NCV could support the SW scores as an outcome measure.

Level/ Grade of recommendation:
D conflicting evidence in support of using Monofilaments

Body Function: Sensory

Static Two Point Discrimination

Reliability static 2PD:

Level of evidence 4:

- Marx (1998): 12 subjects (mixed CTS, neuropathy), 2 therapists, 2 hand surgeons, 2 occupational health workers:
- Inter-rater reliability: ICC 0.66 overall (ranging from 0.5 to 0.85).
  Intra-rater reliability: ICC 0.77 overall (ranging from 0.42 to 0.78).

Validity static 2PD:

Level of evidence 1:

- Herold (2011) (55 subjects): Static 2pt: Normal in more than 70% of patients; Responsiveness at
  - 4 months (SRM = 0.57; ES = 0.22
  - 8 months (SRM = 0.51; ES = 0.33)

Level of evidence 2:

- Katz (1994): 62 patients: Responsiveness at
  - 3 months (SRM = 0.59; ES = 0.51).
- Hobby et al (2005), 32 patients, Responsiveness at
  - 3-6 months: (SRM = 0.76; ES = 0.88)

Body Function: Sensory

Validity Static Two point discrimination

Level of evidence 3:

- Elfar et al (2010), 40 hands (35 patients) found the middle finger was most affected. (see Figure)

Level of evidence 4:

- Marlowe (1999) found poor correlation between static 2 PT and NCV parameters in 47 subjects (83 hands).

- **Recommendation: C Weak evidence in support of Static Two point discrimination**

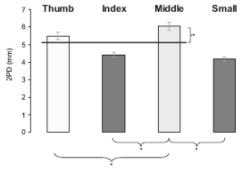


FIGURE 2: Results of 2PD by digit. Higher values represent greater 2PD measurement. Red line drawn at average value of median innervated digits. *Significant comparisons revealed the middle finger as the one with greatest loss of sensibility.

Body Function: Sensory

Moving two point Discrimination

- **Paucity of research**

Reliability:

- Level 4: Marx RG (1998)
  - Crossectional study: 12 subjects (mixed CTS, neuropathy)
  - inter-rater reliability ICC 0.45 overall (ranging from 0.37 to 0.53). Intra-rater reliability ICC 0.77 for all groups, ranging from 0.67 to 0.8 for subgroups.

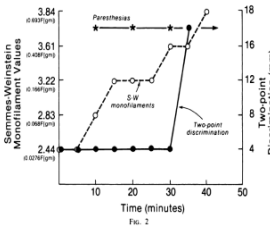
Validity

- Level 3: Spindler HA and Dellon AL (1982)
  - Crossectional study: 43 CTS patients, 74 hands, using a folded paperclip method. Moving 2PD did not become abnormal until patients presented with severe CTS.
- Foundational: Gelberman RH (1983)
  - 12 Healthy subjects. Induced carpal tunnel pressure leading to CTS symptoms: Moving and static 2PD returned at the same rate, both slower than SWM scores.

Recommendation: D conflicting

Body Function: Sensory

- Gelberman RH 1983: Foundational Induced CTS



- Spindler & Dellon, 1982

Table IV. Percent abnormal by each test procedure

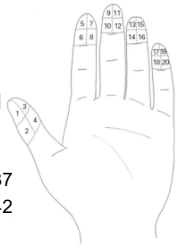
	Group (%)		
	I	II	III
Motor conduction			
Median > 4 msec	10	21	50
Median > ulnar + 1 msec	0	29	12
Total	10	50	62
Sensory conduction			
Median > 3.1 msec	50	43	72
Median > ulnar + 0.4 msec	30	43	6
Total	80	86	78
Vibratory perception	10	50	78
Moving two-point discrimination	0	0	42
Classic two-point discrimination	0	0	32
Positive Phalen test	40	64	68
Postive Tinel sign	50	57	64

Body Function: Sensory Testing

Locognosia

- Locognosia is defined as the ability to localize touch (Jerosch-Herold C 2006)
- Measurement protocol:
  - 16 zones; Scoring: Correct response 2 pts; adjacent 1 pt, otherwise 0 points.
- Reliability: None for CTS
  - 23 patients who had undergone median nerve repair (Herold 2006), the test-retest correlation coefficient for the median zone was ICC 0.924.

Body Function: Sensory testing



Locognosia

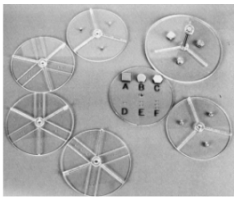
- Level 1:Validity: Jerosch-Herold 2011
  - 63 patients with CTS after surgical decompression,
  - At 4 months (N=57): ES 0.29; SRM 0.37
  - At 8 months (N=55): ES 0.42; SRM 0.42
  - Authors conclude against using locognosia as outcome measure.
- **Recommendation: B Not in support**

Body Function: Sensory and Touch function

Shape Texture Identification

Tactile Gnosis

- http://www.fysiosupplies.nl/media/PDF/STI_manual_English.pdf

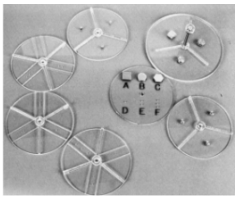


Rosen, 1998

Body Function: Sensory function/Touch function

Shape Texture Identification/Tactile Gnosis

- Score 0 (lowest) to 6 (normal)
- T/R Reliability (Rosen 1998)
- Inter-rater reliability (Rosen 2003)
- None with CTS
- CTS--Jerosch-Herold, 2011
  - 4 and 8 months post CTR
  - Responsive
  - MCID = 1.09
- **Recommendation: C**



Rosen, 1998

Summary Body Functions

Measure	Supported/ not supported	Level/ Grade of recommendation
Static 2 PD	In support	C
Finger tip pinch	In support	C
Shape/Texture ID	In support	C
Vibrometry	In support	D
Abductor Pollicis Brevis	Conflicting	D
Moving 2 PD	Conflicting	D
Monofilaments	Conflicting	D
Grip Strength	Not supported	B
Key pinch, tripod pinch	Not supported	C
Locognosia	Not supported	B

Has research been stalled after patient centered measures were promoted? The issue of conflict of interest in the development of tests and measures.....

ICF Clinical Practice Guideline

- Risk Factors
- Diagnostic Tests
- Clinical Outcome Measures
- Interventions
- Case Example

Interventions: Data Collection

Searches: February 1, 2013 to February 1, 2015.
Cinhal, Cochrane, PubMed: 1960-present
Reference lists of retrieved papers.

Results: 373 retrieved
52 rejected

Reviewed: 321 articles
39 Basic Science
28 Systematic Reviews
254 Intervention Studies

Non Surgical Interventions

- Education
- Ergonomic: engineering: keyboards, tool design
  personal: task modification
- Exercise: finger and wrist exercises, mobilization, postural training, nerve/tendon glides, stretching, therapeutic regimens, yoga
- Miscellaneous: commercial devices, kinesiotape, magnets
- Biophysical Agents: Estim, laser, heat, ultrasound; steroid delivery
- Orthoses: design, composition, wearing schedule

Study Limitations

- Inconsistent diagnostic methods.
- Inconsistent identification of stage of CTS of participants.
- Poor, if any controls.
- Lack of blinding/randomization.
- Confounded studies: (multiple interventions).
- Poor understanding of interventions: nerve glides vs. tendon glides.
- Orthoses: " All orthoses are not created equal!" Lack of detailed description of design, measured position.
- Short follow up.
- Subjective or non-validated outcome tools.
- Selective or limited statistical analysis.
- Lack of subject compliance reporting.

Education

Evidence Level: No studies located investigating isolated use of education as a treatment intervention.

Internet information: Lutsky 2013, analyzed prevalence of accurate information on the web: 65 unique sites.

Results: Misleading/unconventional information:
38% non-sponsored sites
48% sponsored sites

Marketing CT treatment or product:
33% non-sponsored websites
76% sponsored sites

Recommendation: **F** Clinicians should provide information based on available evidence regarding task modifying strategies, conservative interventions

Ergonomic

Engineering interventions: Keyboards

Conclusion: Weak evidence: use reduces pain in the short term (≤ 3 months).

Evidence Level: 2 Qualitative SR's of Level II studies evaluating alternate keyboard designs. O'Connor 2012, Huisstede 2010

Conclusion: Weak evidence: use does not prevent CTS.

Evidence Level: 1 Qualitative SR: prevention: 24 Level 2 or 3 studies included WRMSD's. Lincoln 2000

Recommendation: **C** Clinicians may suggest a trial of ergonomic keyboards to reduce carpal tunnel associated pain in the short term.

Ergonomic

Engineering: mouse design

Conclusion: weak evidence that mouse use increased carpal tunnel pressure regardless of design.

Evidence: 2 Level IV studies including 35 subjects: 21 with mild to moderate carpal tunnel and 14 normals. Schmid 2014, Keir 1999

Recommendation: **C** Clinicians should assist in developing strategies to minimize mouse use

Ergonomics

Personal Interventions: Task Modification

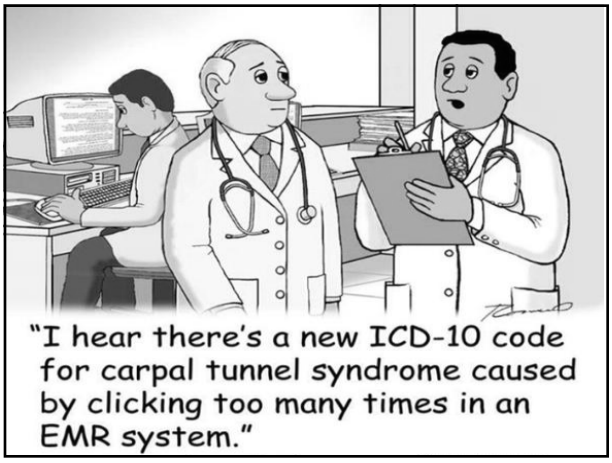
Conclusion: Weak, theoretical evidence for task modification

- ↓ Wrist extension and radial deviation + pinch/grip
- ↓ Resistance to wrist and/or fingers
- ↓ Finger range of motion
- ↓ Speed of task performance

Cobb 1995, Filius 2014, Goss 2010, Kociolek 2014, McGorry 2014, Rempel 1997, Rempel 2008

Evidence Level: **7 Level IV studies**

Recommendation: **E** Clinicians should review job tasks and recommend strategies to reduce wrist extension/radial deviation, composite flexion, resistance and speed of task performance.



Exercise/Mobilization

Conclusions: Weak evidence for short-term pain relief, M/Mod CTS

- **Yoga:** improved short-term pain (VAS) and Phalen's sign compared to wrist splint + "current treatment"*.
  No difference: night waking, grip, Tinel's short term. 7 QLSR's
- **Carpal bone mobilization:** short term improvement.
- **Nerve mobilizations**: short term relief of pain, ineffective for other symptoms or reducing progression to surgery. 6 QLSR's
- **Tendon Gliding:** combined with nerve gliding
- **Splinting:** superior to tendon/nerve glides for improving symptoms

Recommendation: **C** Clinicians may recommend a trial of ex to relieve pain in the short-term for idiopathic mild to moderate CTS in addition to other conservative interventions.

Miscellaneous: Magnets

Conclusion: Moderate evidence that the use of magnet therapy for CTS was not effective.

Level of Evidence: 2 SR's: single RCT Carter 2002 (Huisstede 2010, O'Connor 2012)

1 high quality RCT Colbert 2010

Recommendation: **B** Clinicians should not recommend magnets for the conservative treatment of CTS

Other Interventions

Conclusion: Insufficient evidence to recommend biofeedback, Bioptron, CTrak, kinesiotape or wet cupping for treatment of carpal tunnel syndrome.

Recommendation: **F** Clinicians should not recommend above interventions until additional evidence is available.

Modalities
Electrical Stimulation/TENS

Conclusion: Weak evidence that conventional TENS was effective for short-term pain reduction in adults idiopathic, mild/mod carpal tunnel symptoms.

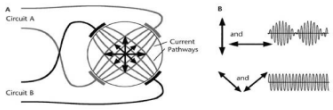
Level of Evidence: 2 Level II studies: Kara 2010, Koca 2014.

Conclusion: Weak evidence that TENS or OTS wrist splint in 15° ext. equally effective in improving VAS, BCTQ and Median N. sensory conduction velocity short term.

Level of Evidence: 1 Level II study
Koca 2014

Recommendation: C

Interferential Current



Conclusion: Weak evidence IFC was more effective than conventional TENS or OTS wrist splint in relieving pain and improving median nerve sensory conduction velocity after 3 weeks.

Level of Evidence: 1 Level II Study
Koca 2014

Recommendation: C

Electrical Stimulation Summary

Recommendation: C Clinicians may consider a trial of IFC or conventional TENS for short-term reduction of pain symptoms in adults with idiopathic, mild to moderate severity CTS.

Modalities-Superficial Heat

Conclusion: Weak evidence that use of a wrist heat wrap or microwave provide temporary short term pain relief in patients with idiopathic, mild to moderate CTS. There is insufficient evidence to recommend the use of SWD.

Level of Evidence: 1 SR of a Level II study investigating heat wrap.
Huisstede 2010 Michlovitz 2004

- 1 Level II study: microwave vs. sham Frasca 2011
- 1 Level III study: short wave diathermy
  Incebiyik 2015

Recommendation: C clinicians may use superficial heat or microwave diathermy, but not short wave diathermy for temporary pain relief in mild to moderate CTS. Clinicians should warn patients about the use of heat with diminished sensation.

Trans-Dermal Steroid Delivery

Phonophoresis

Conclusion: No evidence phonophoresis vs. placebo.

Evidence Level: No studies were found.

Conclusion: Weak evidence: phonophoresis improved strength, CMAP and SNAP short term vs. iotontophoresis.

Evidence Level: 1 Level II study of 34 subjects (M/Mod)
Bakhtiary 2013

Transdermal Steroid Delivery
Iontophoresis

Conclusion: Weak evidence placebo as effective as iontophoresis with Dexamethasone.

Evidence Level: 1 QLSR of 1 Level II study. Huisstede 2010

Conclusion: Weak evidence: steroid injection > than ionto for pain relief short and mid-term, M/Mod.
Conflicting: steroid inj. >than phono.

Evidence Level: 1 QLSR, 1 QTSR: 2 Level II trials
Huisstede 2010 Marshall 2009
1 Level III: 45 subjects.
Karaty 2009

Trans-Dermal Summary

- No studies investigating optimal pharmacological preparation or concentration.
- No studies identifying the optimal treatment parameters: frequency, intensities, duration.
- No studies evaluating long term outcomes for mild or moderate carpal tunnel syndrome.
- No studies evaluating iontophoresis or phonophoresis for severe carpal tunnel syndrome.

Recommendation: C Clinicians may consider a trial of phonophoresis with .4% dexamethasone sulphate to relieve pain in the short term in patients with mild to moderate CTS who do not respond to other conservative management and may not tolerate an injection.

Low Level Laser Therapy

Conclusion: Weak conflicting, evidence LLLT vs. placebo.

Evidence Level: No evidence: 2 QLSR's of 5 Level II trials
Huisstede 2010, Piazzini 2007

Equal to placebo: 3 QLSR's of 3 Level II trials, weak
O'Connor 2012, Goodyear-Smith 2004, Gerritsen 2002
1 Level II trial: Tascioglu 2012

Better short-term: 1 QLSR: 2 Level II trial Muller 2004
2 Level II trials: weak evidence short term.
Chang 2008 Ekim 2007

Recommendation: **D** Clinicians should not use LLLT for CTS until more evidence becomes available. No evidence for optimum wavelength, treatment parameters.

Modalities: US

Conclusion: Weak evidence that US was more effective than a placebo for short or long term CTS symptom relief.
No evidence for specific US parameters.
No evidence US superior to other non-surgical interventions.

Evidence Level: 1 QLSR of Level 2 studies (2). Page 2013

Recommendation: C Clinicians may use a trial of US for CTS symptom relief but should consider other non-surgical interventions.

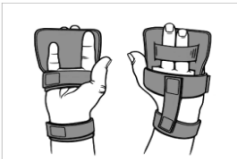
Orthoses

Night splint vs. control

Conclusion: Limited evidence night orthoses (hand or forearm based) vs. no treatment in mild/mod idiopathic CTS short-term. (≤ 3 months).

Level of evidence: 6 QLSR's, 2 Level II studies (Manente 2001, Premoselli 2006)
Ashworth 2009, Huisstede 2010, Muller 2004, Page 2012, Piazzini 2007, O'Connor 2012
1 Level II: Luchetti 1994,
2 Level IV: Celik 2015 Quin 1960

Recommendation: C clinicians may recommend a trial of immobilization for short-term symptom relief in idiopathic, mild to moderate severity carpal tunnel syndrome patients.



Orthosis
Design/Position

Conclusion: No evidence: specific design
Evidence: 7 QLSR's: 6 Level II studies
Level II: Bulut 2015, Level III: Manente 2013, Level IV: Ozgen 2011

Conclusion: Weak evidence: Wrist near neutral (varies per pt)
MP joints if included, 45° flexion
IP joints if included, slight flexion
Pronation: 45°

Evidence: 9 Level IV studies

External Pressure: 2 Level IV studies

Recommendation: F Clinicians may use any orthosis that positions the wrist at or near neutral. The addition of MP and IP joints should be based on patient response. Clinicians may consider a dorsal design to avoid pressure over the carpal tunnel.

Orthosis
Wearing Schedule

Conclusion: Weak, conflicting evidence: full time vs. night only orthosis
Weak evidence: favors orthoses applied early (≤3 mo)
efficacy known in 5 months.

Evidence Level: 6 QLSR's: 1 Level II trial: Walker 2000
Ashworth 2009 Goodyear-Smith 2004, Hisstede 2010, Page 2012, Piazzini 2007, O'Connor 2012
1 QLSR: 2 Level IV studies: Dolhanty 1986, Li 1999 Muller 2004
1 Level III: Kruger 1991
1 Level IV: Nobuta 2008

Recommendation: F Clinicians may recommend night use and day use as function allows in the short term for mild to moderate severity carpal tunnel syndrome.

Orthosis vs. Surgery

Conclusion: Surgery is more effective than an orthosis in relieving symptoms of CTS.

Level of evidence: 1 SR with meta-analysis of 2 Level II trials.

Splint favored at 1 mo, surgery: 3,6,12 mo. Verdugo 2008

3 QLSR's: same Level II trials: surgery>splint

Gerritsen 2002, Goodyear-Smith 2004. Muller 2004

4 Level IV studies. ¾: surgery >splint.

Crow 1960, Gerritsen 2003, Kendell 1960

Recommendation: B Patients should consult a surgeon for carpal tunnel syndrome symptoms that are not improved after a trial of conservative intervention.

Intervention Summary

Intervention	Supported	Recommendation
Patient Information	✔	F
Task /modification	✔	E
Surgery	✔	B
Orthoses	✔ short term	F
Reduction of mouse use	✔	C
Nerve/tendon glides	✔ pain relief	C
US	✔	C
Phonophoresis	✔ short term	C
TENS/ IFC	✔ short term pain relief	C

Interventions Summary con't

Intervention	Supported	Recommendation
Magnets	NO	B
SWD	NO	No evidence
Iontophoresis	NO	C
LLLT	NO	D

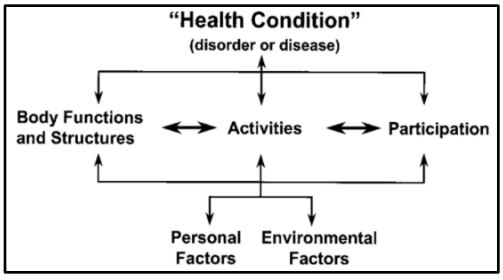
ICF Clinical Practice Guideline

- Risk Factors
- Diagnostic Tests
- Clinical Outcome Measures
- Interventions
- Case Example

Case example

- Evidence-based practitioner
  - Evidence, experience, and patient circumstances
- Weigh the CPG recommendations
- Application to a patient
  - Select tests and measures for diagnosis?
  - Risk factors? Modifiable?
  - Clinical/outcomes measures?
  - Interventions?

Case Example-Applying the ICF



History

BS/BF and AL/PR
- Insidious onset of (B) hand swelling and pain 10 mos ago
- Numbness in long and ring fingers
- Pain in the thenar eminence into forearm
- Pain with driving, grasping
- Hobby: Sewing
- Financial comptroller
- (+) NCV for CTS (B) and (R) ulnar tunnel

Personal risk factors
- BMI normal
- Non-smoker
- Female
- No exercise program
- Hashimoto's disease
- Fatigue--Autoimmune disease??

Tests and Measures

Diagnostic measures:
- Katz hand diagram (A)
- Phalen (A)
- Tinel (A)
- Compression (B)
- Monofilaments (B)
- 2-point disc (C)
- Thenar muscle strength (C)

Clinical outcomes measures:
- Tip pinch (C)
- Static 2PD (C)
- Shape-texture id (C)
- DMPUT (C)

Self-report measures:
- CTQ-SSS (B)
- CTQ-FS (B) or DASH (B)

Tests and Measures

Diagnostic measures:
- Katz hand diagram (A)
- Phalen (A) + right only
- Tinel (A)
- Compression (B)
- Monofilaments (B)
- 2-point disc (C)
- Thenar muscle strength (C)

Clinical outcomes measures:
- Tip pinch (C)
- Static 2PD (C)
- Shape-texture id (C)
- DMPUT (C)

Self-report measures:
- CTQ-SSS (B)
- CTQ-FS (B)

Interventions:

Grade C
- Ultrasound
- Tendon/nerve gliding
- Night orthosis (MPs slight flexion and wrist at neutral)

Grade F
- Patient education

Status:

4 treatments:
- Decreased pain with driving
- No pain into forearm
- No night pain
- SSS decreased to 1.9 (initial 2.5)
- FS stayed the same (initial 1.5)
- Phalen still positive

Conclusion

- Project ongoing for last 3 years.
- Large number of studies available
- A team effort
- High-quality studies directed at specific interventions that integrate best diagnostic tests and most responsive clinical outcomes measures
- More high quality studies on interventions for specific groups of patients (e.g. severity and duration of symptoms)


Thank you!
Questions??
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