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 Advanced 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: Measures, 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
  - 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 (Pakachai2012, 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

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

Neck Pain CPG Revision

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

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
    • Clinical course 0-12 weeks; 12 weeks to 1 year
  – Neck Pain with Movement Coordination Impairment
    • <50% Complete Recovery within 1 year
    • Possible helpful factors in prognosis
    • Clinical course 0-12 weeks; 12 weeks to 1 year

Neck Pain CPG Revision

• Prognosis (cont’d)
  – Neck Pain with Radiating Pain
    • Cervical Myelopathy
      • Stable Course
      • Elderly and conservative management - likely worsening
  – Neck Pain with Headache
    • No information identified

• Outcomes
  – Neck Disability Index recommended
Neck Pain CPG Revision

Questions / Audience Discussion

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 Movement Coordination Impairment
  • Literature Update
    • 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 Mobility Deficit
  • Literature Update
    • Level II: Cerv manip
    • Level III: Cerv mob, Thorac manip
    • Level II: ROM +educ +advice
      Cerv+ST stretch&strenthen
      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
  • 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 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
    • 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
  • Confidence Statement
    • We have weak confidence based on low level evidence that stretching and strengthening exercise, laser, intermittent traction, and dry needling will benefit
  • 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
    • 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: Cervicospinal and endurance exercise
    • Level III: Self-SNAG
  • 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.

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 mild
      - C6-7 mild

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

Panel Discussion
References


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

Disclosures
No relevant financial relationships
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

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Assistant Professor, DeSales University
Doctor of PT Program, Center Valley, PA
Certified Hand Therapist (CHT)

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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

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


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
  — DRLU

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

Rai & Regazzoni, 1996

Pathoanatomy

- DRF:
  - Distal 10% of the radius (3-4 cm) (Augat, 1996)
  - Various types: extra- or intra-articular
    - Raa & 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

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

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 (LS)
  - Determined by hand position during fall
  - Lunate vs. scaphoid overload
  - Region specificity to fx

Ulrich et al., 1999

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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
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)

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)

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 LT ulnar wrist pain response

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

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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

Case

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

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; Commination
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

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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 ➔ Neutralization
II. Shearing joint (Barton) ➔ Buttress
III. Compression joint ➔ Articular congruity
IV. Avulsion radiocarpal ➔ Stability joint
V. Combined mechanism ➔ High energy

Fernandez-Jupiter Classification

I. Bending metaphysis
II. Shearing joint (Barton)
III. Compression joint
IV. Avulsion radiocarpal
V. Combined mechanism (high energy)

Rikli and Regazzoni 3-Column

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### 3 Column Theory

<table>
<thead>
<tr>
<th>Column</th>
<th>Function</th>
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<tbody>
<tr>
<td>Lateral column</td>
<td>Osseous buttress + capsular attachment</td>
</tr>
<tr>
<td>Intermediate column</td>
<td>Load transmission</td>
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<tr>
<td>Medial column</td>
<td>Axis forearm rotation</td>
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### Melone Classification

<table>
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<th>Type</th>
<th>Description</th>
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### Fragment Specific - Medoff

- Intraarticular
- Radial column
- Dorsal column
- Volar rim
- Ulnar corner
- Intrarticular

### Imaging Study

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

### Radiographic Parameters

<table>
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<tr>
<th>Parameter</th>
<th>Measurement</th>
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<td>Radial inclination</td>
<td>23°</td>
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<tr>
<td>Volar tilt</td>
<td>11°</td>
</tr>
<tr>
<td>Radial length</td>
<td>12 mm</td>
</tr>
<tr>
<td>Ulnar variance</td>
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### Tear Drop Angle

- Normal: 70°
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 percutaneous pinning (CRPP)
- External fixation
- Open reduction internal fixation (ORIF)
  - Volar plate
  - Dorsal plate
  - Fragment specific plate
  - Nail plate
- Spanning dorsal bridge plate
- Bone cement

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

- 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

- 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

2. Ng CY and MQQueen MM JBJS Br 2011
3. Dario P et al Injury 2014

Ulnar Styloid

• No difference in functional outcome
• Tip vs. Base
• Displacement > 2 mm
• 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


Functional Outcome Pts > 70

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

<table>
<thead>
<tr>
<th>Group</th>
<th>Extension, degrees (%)</th>
<th>Flexion, degrees (%)</th>
<th>Pronation, degrees (%)</th>
<th>Supination, degrees (%)</th>
<th>Radial deviation, degrees (%)</th>
<th>Ulnar deviation, degrees (%)</th>
<th>Grip strength, kp (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORIF</td>
<td>57.0 ± 11.6 (87.6)</td>
<td>44.6 ± 10.4 (79.2)</td>
<td>82.2 ± 8.9 (98.4)</td>
<td>83.0 ± 9.9 (97.9)</td>
<td>26.6 ± 8.6 (94.9)</td>
<td>38.0 ± 9.4 (97.6)</td>
<td>19.4 ± 6.0 (75.3)</td>
</tr>
<tr>
<td>CAST</td>
<td>59.8 ± 7.0 (95.0)</td>
<td>49.6 ± 9.8 (88.2)</td>
<td>81.4 ± 8.6 (97.7)</td>
<td>82.5 ± 6.8 (98.4)</td>
<td>21.2 ± 8.4 (95.2)</td>
<td>36.4 ± 9.2 (96.9)</td>
<td>21.1 ± 7.0 (91.8)</td>
</tr>
</tbody>
</table>

Arora et al. J Orthop Trauma 2008

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

<table>
<thead>
<tr>
<th>Group</th>
<th>DASH (points)</th>
<th>PDRE (points)</th>
<th>Green and O’Brien</th>
<th>Pain (points)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORIF</td>
<td>11.1 (9–17.4)</td>
<td>9.3 (8–12.6)</td>
<td>Excellent</td>
<td>1.7 ± 1.4</td>
</tr>
<tr>
<td>CAST</td>
<td>11.6 (9–18.1)</td>
<td>16.9 (9–18.3)</td>
<td>Good</td>
<td>0.7 ± 1.4</td>
</tr>
</tbody>
</table>

Arora et al. J Orthop Trauma 2008
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

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

<table>
<thead>
<tr>
<th>Injury</th>
<th>Prognosis</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distal radius fracture</td>
<td>Strength OR motion OR range of motion OR endurance, dexterity OR function OR proprioception OR sensitivity OR sensation OR touch threshold OR kinesesthesia OR vibration OR cold intolerance OR 2 point discrimination, self-report OR questionnaire OR patient-reported OR outcome measure</td>
<td></td>
</tr>
<tr>
<td>Wrist fracture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distal forearm fracture</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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
- Reduced grip strength
  Grewal, et al, 2015; Roh et al., 2014

**Predictor? Gender/Sex**

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

Sex was not associated with pain or functional outcomes (Chung, Konsis, & 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 & Leonard-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., 2013)
- Pain catastrophization - Baseline score of ≥35/50 on PRWE pain scale 8.5 x more likely to report chronic ongoing pain at 1 year (Maria 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

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)

Clinical Vignette: Sallie Greene

52 yo female sustained low energy left DRF on 12-27-15
PMH: HT controlled with meds
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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**

[Diagram of ICF Classification]
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 - Qualifiers**

- ± 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: 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-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

For educational purposes. Property of Huang, Karagiannopoulos, MacDermid, Mehta, Michlovitz
Multiple SR address outcome measures
PRWE, all PRO, all measures

PATIENT RATED WRIST EVALUATION

The patient rated wrist evaluation (PRWE) is a tool that allows you have to ask about how well your wrist is in your overall function. You will be discussing your function and complications with your doctor. 

1. PAIN

Average amount of pain you have in your wrist for the past week

2. FUNCTION

Average amount of difficulty you experienced performing each of the items listed below over the past week, by rating 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 you could not do it at all.

3. 6 Wrist-Specific Activities

Average amount of difficulty you experienced performing each of the wrist-specific activities in each of the activities listed below over the past week, by rating 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 any of your usual activities.

4. Usual role

Rate the amount of difficulty you experienced performing your usual activities in each of the areas listed below over the past week, by rating 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 any of your usual activities. 

Total score

A scale that ranges from 0-100. 

Reliability estimates range 0.81-0.90

MDC95 ranges from 8-19; usually 10-12

Responsiveness-large effects

Meets or exceeds DASH

For educational purposes. Property of Huang, Karagiannopoulos, MacDermid, Mehta, Michlovitz
Distal Radius Fracture: Therapist’s Examination

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

Christos Karagiannopoulos PT PhD
Susan Michlovitz PT PhD

For educational purposes. Property of Huang, Karagiannopoulos, MacDermid, Mehta, Michlovitz
Forearm Rotation

Distal forearm approach

Mobility of joint functions (ICF code b710)

Moving arm across dorsal/volar distal forearm

Armstrong et al., 1998

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Motion</th>
<th>Intra-tester reliability</th>
<th>Intra-tester MDC value</th>
<th>Inter-tester reliability</th>
<th>Inter-tester MDC value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distal Forearm</td>
<td>Rad</td>
<td>ICC = 0.97</td>
<td>8°</td>
<td>ICC = 0.86</td>
<td>13°</td>
</tr>
<tr>
<td></td>
<td>Pron</td>
<td>ICC = 0.97</td>
<td>8°</td>
<td>ICC = 0.93</td>
<td>10°</td>
</tr>
</tbody>
</table>

Forearm Rotation

Hand-held pencil (functional) approach

Mobility of joint functions (ICF code b710)

Requires ability to make a full flat to hold the pencil

Karagiannopoulos et al., 2001

Digital ROM: Pulp-to-palm distance

Mobility of joint functions (ICF code b710)

Requires ability to make a full fist to hold the pencil

Ellis and Bruton, 2002

Digital ROM

Mobility of joint functions (ICF code b710)

Total active digital motion

Better predictive value

Sig association to DASH

MacDermid JC, JHS, 2001

<table>
<thead>
<tr>
<th>Joint</th>
<th>Intra-tester reliability</th>
<th>Inter-tester reliability</th>
<th>Inter-tester Reliability</th>
<th>MDC value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCP</td>
<td>ICC = 0.64-0.93</td>
<td>ICC = 0.67</td>
<td>ICC = 0.67</td>
<td></td>
</tr>
<tr>
<td>PIP</td>
<td>ICC = 0.68-0.94</td>
<td>ICC = 0.67</td>
<td>ICC = 0.67</td>
<td></td>
</tr>
<tr>
<td>DIP</td>
<td>ICC = 0.78-0.99</td>
<td>ICC = 0.85</td>
<td>ICC = 0.85</td>
<td></td>
</tr>
</tbody>
</table>

Lewis et al., AJOT, 2010

Wrist/Hand Edema

Effusion of joint (ICF code M25.4)

Figure-of-eight method

Leard et al., JOSPT, 2004

<table>
<thead>
<tr>
<th>Joint</th>
<th>Intra-tester reliability</th>
<th>Inter-tester reliability</th>
<th>Inter-tester Reliability</th>
<th>MDC value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCP</td>
<td>ICC = 0.99</td>
<td>ICC = 0.99</td>
<td>ICC = 0.99</td>
<td>2 mm</td>
</tr>
</tbody>
</table>

Digital Edema: Circumferential measure

Effusion of joint (ICF code M25.4)

Select anatomical points

Jansen et al., 2010

For educational purposes. Property of Huang, Karagiannopoulos, MacDermid, Mehta, Michlovitz
Grip Dynamometry
Power of isolated muscles and muscle groups function (ICF b7300)

Maximum grip
Standardized instructions

<table>
<thead>
<tr>
<th>Intra-tester reliability</th>
<th>Inter-tester Reliability</th>
<th>Responsiveness</th>
<th>MDC value</th>
</tr>
</thead>
<tbody>
<tr>
<td>r = 0.99</td>
<td>r = 0.88 – 0.92</td>
<td></td>
<td>2.73–4.68 kg</td>
</tr>
</tbody>
</table>

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

Sensori-Motor Control
Proprioceptive function (ICF b260)

Active Wrist JPS Test
• Conscious proprioception
• Simple goniometric method

<table>
<thead>
<tr>
<th>Intra-rater reliability</th>
<th>Inter-rater reliability</th>
<th>Responsiveness</th>
<th>MDC value</th>
<th>MCD Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICC = 0.85</td>
<td>ICC = 1.57</td>
<td>R = 1.53 (8 wks)</td>
<td>4* (8 wks)</td>
<td>5* (8 wks)</td>
</tr>
<tr>
<td>ICC = 2.14</td>
<td>ICC = 2.36</td>
<td>R = 12 (wks) 5* (12 wks)</td>
<td>7* (12 wks)</td>
<td></td>
</tr>
</tbody>
</table>

Karagiannopoulos et al., 2014

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)

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

Dynamometry: Load bearing/pushing
Pushing (ICF code d4451)
• Administered when UE weight-bearing permitted

<table>
<thead>
<tr>
<th>Level of evidence</th>
<th>1b</th>
</tr>
</thead>
<tbody>
<tr>
<td>P = 0.05</td>
<td>2.3</td>
</tr>
<tr>
<td>ICC = 0.61-0.90</td>
<td>1.57-2.15</td>
</tr>
</tbody>
</table>

Vincent JL, et al. JHT 2014 Correlation with DASH -0.43

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

<table>
<thead>
<tr>
<th>Intra-rater</th>
<th>Inter-rater</th>
<th>Concurrent Validity (S-W Monofilaments)</th>
<th>MDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICC = 0.91</td>
<td>ICC = 0.61-0.90</td>
<td>Spearman’s r = 0.71</td>
<td>1.57-2.15</td>
</tr>
<tr>
<td>Predictive values to CTS: Faught &amp; McKee 2002</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Specificity | Sensitivity |
-----------|-------------|
- 48%       | 80%         |

Provocative tests: median nerve/CTS
Touch function (ICF b265)
Purpose post DRF: screen for complication

<table>
<thead>
<tr>
<th>Test</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phalen*</td>
<td>68%</td>
<td>73%</td>
</tr>
<tr>
<td>Carpal compression</td>
<td>64%</td>
<td>83%</td>
</tr>
<tr>
<td>Tinel</td>
<td>50%</td>
<td>77%</td>
</tr>
</tbody>
</table>

* 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

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

JHT 2005

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

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

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

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

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

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

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

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

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

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

Is Therapeutic Massage Effective?


Is Therapeutic Massage Effective?

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

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

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

For educational purposes. Property of Huang, Karagiannopoulos, MacDermid, Mehta, Michlovitz
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

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

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

Modalities - Cryotherapy
• Limited evidence for cryotherapy on post DRF treatment paradigms
  – Low methodological quality RTCs
  – 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

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,

Orthoses
• Does static progressive splinting restore wrist/FA ROM post DRF?
  – Limited evidence: low methodological quality experimental study
  – Case series study
  – JAS PA brace study:
    – Small sample
    – 18 DRFs/38 patients
    – OAR static DRF’s
    – No functional assessment
    – No control

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Orthoses
- Does dynamic splinting restore 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

Preliminary evidence & Recommendations

- Patient education: Weak evidence to support advice and instructions on adherence to therapy
- HEP vs supervised in-clinic PT: Moderate evidence for uncomplicated cases: HEP vs supervised in-clinic therapy
- Manual Therapy & joint mobilization: Weak evidence to support specific treatment paradigms
- Strengthening: Weak evidence to support specific strengthening exercises
- Proprioceptive & NM training: Weak evidence to support specific training paradigms
- Thermal agents: Weak evidence to support use of cold or heat modalities
- Orthosis use: Weak evidence to support static or dynamic splinting

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; D RUJ Stable

6 Weeks Post-Op
Wrist Flexion 60; Extension 65

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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)

Case: 35 yo Male Fall Off Roof

35 yo Male Fall Off Roof

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

CT Scan ➔ Define Fragments

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

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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

54 y/o male s/p FOOSH

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Intra-Op

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

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

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

DRF Case with Complication

49 yr 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 only.

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

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

Participation:
- Work activity
- Housekeeping
- Recreation

Personal Factors:
- Long hours work typing
- Pre-existing 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 98, Ext 88, 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 Th: P, T1, T11 tips
  - +1 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:
    - +1 CTS testing
  - Quick DASH: 25%

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

For educational purposes. Property of Huang, Karagiannopoulos, MacDermid, Mehta, Michlovitz
An ICF-Based Clinical Practice Guideline for Carpal Tunnel Syndrome

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

Disclosure
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Practice Division Director, ASHT
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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
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)

Simplified Version of Levels of Evidence

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Evidence obtained from high-quality diagnostic studies, prospective studies, or randomized controlled trials</td>
</tr>
<tr>
<td>II</td>
<td>Evidence obtained from lower-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)</td>
</tr>
<tr>
<td>III</td>
<td>Case-control studies or retrospective studies</td>
</tr>
<tr>
<td>IV</td>
<td>Case series</td>
</tr>
<tr>
<td>V</td>
<td>Expert opinion</td>
</tr>
</tbody>
</table>

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
  - 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: 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

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
Moderate (B) Recommendation to support

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Evidence level</th>
<th>Increases likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td>2 level II, 2 level III; 3 level IV Level III SR (Dijk)</td>
<td>OR between 1.4 - 6.55 SR=2.2</td>
</tr>
<tr>
<td>Obesity: risk increases linearly with Body Mass</td>
<td>1 level I; 2 level II; 15 studies level III</td>
<td>BMI &gt; 25 kg/m2 at least 2x risk</td>
</tr>
<tr>
<td>Female Gender</td>
<td>1 level I; 2 level II; 7 level III</td>
<td>1.5-4x more likely</td>
</tr>
<tr>
<td>Increasing age: appears to be linear</td>
<td>1 level I; 4 level II; 11 level III</td>
<td>2-4 x more likely those over 50</td>
</tr>
</tbody>
</table>


Risk Factor Studies
(Problems/difficulties in interpretation)

- Very few prospective (level of evidence 1-2)
  ▶ 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**

**Weak (C) Recommendation to support**

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Evidence level</th>
<th>Increases likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Square Wrist</td>
<td>1 level II</td>
<td>OR: 42.89</td>
</tr>
<tr>
<td></td>
<td>7 level III</td>
<td>Hiibs only</td>
</tr>
<tr>
<td>Short, wide hand</td>
<td>3 level III</td>
<td>OR: 1.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hiibs only</td>
</tr>
<tr>
<td>1st degree relative</td>
<td>3 level III</td>
<td>2.7x</td>
</tr>
</tbody>
</table>


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**Intrinsic Risk Factors - Medical Problems ↑ risk**

**Weak (C) Recommendation to support**

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Evidence Level</th>
<th>Increases likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rheumatoid Arthritis</td>
<td>SR of 10 Level III studies</td>
<td>2.2x</td>
</tr>
<tr>
<td>Thyroid Disease</td>
<td>SR of 8 level II/III studies</td>
<td>OR: 1.4</td>
</tr>
<tr>
<td>Previous musculoskeletal problems r.e.: tendonitis, trigger finger, joint pain</td>
<td>1 level II, 3 level III</td>
<td>3.5x</td>
</tr>
</tbody>
</table>


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**Intrinsic Factors - Protective**

**Recommendation: Weak (C)**

<table>
<thead>
<tr>
<th>Conclusion: ↓ risk</th>
<th>Evidence Level</th>
<th>Decreases likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taller stature</td>
<td>3 studies — Level III</td>
<td>OR: 0.50</td>
</tr>
<tr>
<td>Regular physical activity</td>
<td>3 studies — Level III</td>
<td>OR: 0.50-0.72</td>
</tr>
</tbody>
</table>

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

---

**Intrinsic Factors in Women**

No Recommendation can be made—only few studies that conflict

- Pregnancy
- Parity
- Hysterectomy or Oophorectomy
- Oral contraceptives
- Smoking
- Alcohol Consumption

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**Occupational Factors: ↑ risk**

**Moderate (B) Recommendation to support**

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Evidence Level</th>
<th>Increases likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forceful exertions of hand/wrist</td>
<td>3 level II</td>
<td>2-4 x</td>
</tr>
<tr>
<td></td>
<td>1 MA level II</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 SR level III</td>
<td></td>
</tr>
<tr>
<td>Repetitive mts of hand/wrist</td>
<td>3 level II</td>
<td>@ least 2 x</td>
</tr>
<tr>
<td></td>
<td>2 MA level II</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 SR level III</td>
<td></td>
</tr>
</tbody>
</table>

**Occupational Risk Factors- ↑ Risk**

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Evidence Level</th>
<th>Increases likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration exposure</td>
<td>1 level II</td>
<td>@ least 2.5 x</td>
</tr>
<tr>
<td></td>
<td>1 MA level III</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 SR level III</td>
<td></td>
</tr>
<tr>
<td>Non-neutral positions of hand/wrist</td>
<td>1 MA level III</td>
<td>2.6-4.7 x</td>
</tr>
<tr>
<td></td>
<td>3 SR level III</td>
<td></td>
</tr>
<tr>
<td>Blue collar work</td>
<td>1 level II</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 SRs level III</td>
<td></td>
</tr>
</tbody>
</table>


**Occupational Risk Factors: Conflicting Evidence**

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

**Summary of Intrinsic Risk Factors-Supported**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Recommendation</th>
<th>Factor</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increasing Age</td>
<td>B</td>
<td>Diabetes</td>
<td>B</td>
</tr>
<tr>
<td>Female</td>
<td>B</td>
<td>Obesity</td>
<td>B</td>
</tr>
<tr>
<td>Square Wrist</td>
<td>C</td>
<td>RA</td>
<td>C</td>
</tr>
<tr>
<td>First degree relative</td>
<td>C</td>
<td>Thyroid</td>
<td>C</td>
</tr>
<tr>
<td>Short Wide Hand</td>
<td>C</td>
<td>Prev MSK</td>
<td>C</td>
</tr>
</tbody>
</table>

**Summary of Intrinsic Risk Factors-Supported as Protective**

- Taller Stature: C
- Regular Physical Activity: C

**Summary of Occupational Risk Factors-Supported**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forceful exertions</td>
<td>B</td>
</tr>
<tr>
<td>Repetitive movement</td>
<td>B</td>
</tr>
<tr>
<td>Vibration</td>
<td>C</td>
</tr>
<tr>
<td>Non-neutral wrist position</td>
<td>C</td>
</tr>
<tr>
<td>Blue Collar work</td>
<td>C</td>
</tr>
</tbody>
</table>

**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)
  - 0.0-0.20 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. dist (thumb-middle) but not palm
- Probable: at least 2 digits and palm included
- Possible: at least one digit
- Unlikely: none of these digits

What considered positive diagram? From: Katz et al 1990

Diagnosis: Strong (A) Recommendation

<table>
<thead>
<tr>
<th>Reliability:</th>
<th>Katz Hand Diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-rater</td>
<td>substantial 0.84</td>
</tr>
<tr>
<td>Inter-rater</td>
<td>substantial 0.91</td>
</tr>
<tr>
<td>Level of Evidence (Reliability)</td>
<td>Level I: Katz, 1990</td>
</tr>
<tr>
<td>Validity:</td>
<td>MacDermid &amp; Wessel (2 level I, 1 level II, 3 level III-IV)</td>
</tr>
<tr>
<td></td>
<td>293 cases, 226 controls S = 76%, Sp = 98%</td>
</tr>
<tr>
<td>Level of Evidence (Overall)</td>
<td>I</td>
</tr>
</tbody>
</table>

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: Variation in Procedures

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

<table>
<thead>
<tr>
<th>Test</th>
<th>Usual Procedure</th>
<th>Positive</th>
<th>Hold time</th>
<th>Variations</th>
</tr>
</thead>
</table>
| Phalen | either:
- elbows ext, forearms pron, pt. hold wrist max flex
- elbows flexed resting on table, forearms pron, wrist allowed to fall into full flexion | Reprod. sx (paresthesias, tingling, numbness) in the med. Nerve distribution | 1 min | - wrist held passively by the examiner
- dorsal hands are placed together |
| Tinel's | 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 |
| Compression (Durkan) | forearm sup., with neutral, manual pressure applied with examiners 2 thumbs over TCL (b. thenar & hypothenar emin.) | Reproduction of sx (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 applied:
- 50 or 100 mmHg
- hold of 1 minute |
| WP (Phalen's) with compression | forearm sup., WP to 60° pressure applied over med. n. at CT with examiners thumb | paresthesia in median nerve distribution | 1 min | writ max. WP, forearm in neutral rotation and with digital pressure placed on the med. n. just prox. to DWC
- 30 sec hold |

Provocative Tests
Hand Surgery

- 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

<table>
<thead>
<tr>
<th>Test</th>
<th>Usual Procedure</th>
<th>Positive</th>
<th>Hold time</th>
<th>Variations</th>
</tr>
</thead>
</table>
| Wrist Extension (Reverse Phalen's) | Active wrist extension | Reproduction of sx in med. n. distribution | 1 min | - fingers also extended
- palmar put together
- maximal wrist extension
- forearm neutral rotation
- 30 sec hold
- positive if symptoms reproduced |
| Gillot's Pneumatic compression (Tourniquet) | BP cuff placed around arm above elbow & inflated to systolic BP | numbness/tingling in med. nerve distribution | 1 min | |
| 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 |
### Provocative Tests: Moderate (B) Recommendation

<table>
<thead>
<tr>
<th>Compression</th>
<th>Reliability</th>
<th>Level of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phalen's</td>
<td>Intra-rater: Good (0.52-0.65); Substant: 0.65-0.80</td>
<td>Level I &amp; II</td>
</tr>
<tr>
<td>Tinel's</td>
<td>Intra-rater: Good (0.51-0.80); Substant: 0.77-0.80</td>
<td>Level I &amp; II</td>
</tr>
</tbody>
</table>

#### Reliability
- Phalen's: Intra-rater: Good, Inter-rater: Moderate; Substant: 0.64
- Tinel's: Intra-rater: Good, Inter-rater: Moderate; Substant: 0.80

#### Level of Evidence
- Tinel's: Level II

#### Validity
- Phalen's: S = 68%; Sp = 79%
- Tinel's: S = 80%; Sp = 90%

#### Evidence
- Overall: II

### Provocative Tests: Weak (C) Recommendation

<table>
<thead>
<tr>
<th>Wrist Flex Compression (Phalen's &amp; Tinel)</th>
<th>Wrist Extension (Reverse Phalen)</th>
<th>Hand Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phalen's</td>
<td>No studies</td>
<td>No studies</td>
</tr>
<tr>
<td>Tinel's</td>
<td>No studies</td>
<td>No studies</td>
</tr>
</tbody>
</table>

#### Reliability
- Phalen's: Intra-rater: No studies; Inter-rater: No studies for CTS; Substant: 0.72
- Tinel's: Intra-rater: No studies; Inter-rater: No studies for CTS; Substant: 0.72

#### Level of Evidence
- Phalen's: Level IV (MacDermid 1997)
- Tinel's: Level IV

#### Validity
- Phalen's: S = 86%; Sp = 95%
- Tinel's: S = 80%; Sp = 90%

#### Evidence
- Overall: IV

### Provocative Tests: Not Supported

<table>
<thead>
<tr>
<th>Gilliati's Pneumatic Compression (Tourniquet)</th>
<th>Upper Limb Neurodynamic Test (ULNT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability: No studies</td>
<td>No studies for CTS</td>
</tr>
</tbody>
</table>

#### Validity
- Phalen's: MacDermid (mostly IV, 1 level III), S = 65-76%; Sp = 61%
- Tinel's: MacDermid (mostly IV, 1 level III), S = 59-85%; Sp = 75%

#### Recommendations
- Level B (moderate)
- Level A (strong)
### Summary of Diagnostic Tests-Supported Symptoms & Provocative Tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Katz Hand Diagram</td>
<td>A</td>
</tr>
<tr>
<td>Phalen’s</td>
<td>A</td>
</tr>
<tr>
<td>Tinel’s</td>
<td>A</td>
</tr>
<tr>
<td>Compression</td>
<td>B</td>
</tr>
<tr>
<td>Wrist Flexion with Compress</td>
<td>C</td>
</tr>
<tr>
<td>Wrist Extension (Reverse Phalen’s)</td>
<td>C</td>
</tr>
<tr>
<td>Hand Elevation</td>
<td>C</td>
</tr>
</tbody>
</table>

### Semmes Weinstein Monofilaments (SWMF)

**Moderate (B) Recommendation**

<table>
<thead>
<tr>
<th>Reliability</th>
<th>Level of Evidence (Reliability)</th>
<th>Validity</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-rater</td>
<td>Level I: MacDermid 1997</td>
<td>SR: MacDermid &amp; Wessel (2 level I, others III &amp; IV)</td>
<td></td>
</tr>
<tr>
<td>Inter-rater</td>
<td>Level II: MacDermid 1994 &amp; Marx 1998</td>
<td>831 cases, 561 controls S=72, Sp=62</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Level II: Marx 1998</td>
<td>Raia 2014: level II</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>only 52% of pts. with + NCV also had + SWMF</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;correlation of between SWMF scores and NCV for the thumb; r=0.44,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>less correl. for other med. innervated digits</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Evidence (Overall)</td>
<td>I</td>
</tr>
</tbody>
</table>

### Diagnosis: Sensory Tests

**Static Two Point Discrimination**

**Weak (C) Recommendation**

<table>
<thead>
<tr>
<th>Reliability</th>
<th>Level of Evidence (Reliability)</th>
<th>Validity</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-rater</td>
<td>Level II: Marx 1998</td>
<td>SR: MacDermid &amp; Wessel (Level III &amp; IV)</td>
<td></td>
</tr>
<tr>
<td>Inter-rater</td>
<td></td>
<td>Marlowe 1998: level III</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Evidence (Overall)</td>
<td>III</td>
</tr>
</tbody>
</table>

**Moving Two Point Discrimination**

**Good (D) Recommendation**

<table>
<thead>
<tr>
<th>Reliability</th>
<th>Level of Evidence (Reliability)</th>
<th>Validity</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter-rater</td>
<td></td>
<td>Evidence (Overall)</td>
<td>IV</td>
</tr>
</tbody>
</table>

**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**

<table>
<thead>
<tr>
<th>Procedure:</th>
<th>Level of Evidence (Reliability)</th>
<th>Validity</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buch-Jaegar 1994</td>
<td>Level I: MacDermid 1997</td>
<td>SR: MacDermid &amp; Wessel (1 Level I, mostly IV)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Evidence (Overall)</td>
<td>III</td>
</tr>
</tbody>
</table>

- **Application of the branch of fork to pulp of index and small fingers**
- If deemed different intensity test considered positive

- **Reliability**
  - Intra-rater: none substantial; 0.71
  - Inter-rater: substantial; ICC 0.77

- **Validity**
  - 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**
  - SR: MacDermid & Wessel (1 Level I, mostly IV) 343 cases, 170 controls S=55, Sp=81

### 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**

<table>
<thead>
<tr>
<th>Strength &amp; Atrophy</th>
<th>Weak (C) Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability</td>
<td></td>
</tr>
<tr>
<td>Intra-rater</td>
<td>perfect for surgeons &amp; therapists; k=1.00</td>
</tr>
<tr>
<td>Inter-rater</td>
<td>good for surgeons &amp; therapists; k=0.50</td>
</tr>
<tr>
<td>Level of Evidence</td>
<td>Level II: Marx 1998</td>
</tr>
<tr>
<td>(Reliability)</td>
<td></td>
</tr>
<tr>
<td>Validity</td>
<td></td>
</tr>
<tr>
<td>SR: MacDermid &amp; Wessel</td>
<td>Level IV &amp; IV</td>
</tr>
<tr>
<td>NTani 2013:</td>
<td></td>
</tr>
<tr>
<td>Level II:</td>
<td>- no assoc. found between thumb weakness &amp; NCV in study of 1500 hands</td>
</tr>
<tr>
<td>Evidence (Overall)</td>
<td>III</td>
</tr>
</tbody>
</table>

**Summary of Diagnostic Tests-Supported Sensory & Motor Tests**

<table>
<thead>
<tr>
<th>Test</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWMF</td>
<td>B</td>
</tr>
<tr>
<td>256 Hz Tuning Fork</td>
<td>B</td>
</tr>
<tr>
<td>Static 2PD</td>
<td>C</td>
</tr>
<tr>
<td>Thenar muscle strength</td>
<td>C</td>
</tr>
<tr>
<td>Thenar muscle atrophy</td>
<td>C</td>
</tr>
</tbody>
</table>

**Diagnosis: Further Investigation**

- Differential dx
  - Cervical
  - Cubital tunnel
  - OA of thumb
- Likely recommendation
  - 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

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

Minimally 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

<table>
<thead>
<tr>
<th></th>
<th>Diabetics</th>
<th>Non-diabetics</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 months</td>
<td>1.45</td>
<td>0.8</td>
</tr>
<tr>
<td>6 months</td>
<td>1.55</td>
<td>1.6</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Body structure/body function</th>
<th>Activity limitation</th>
<th>Participation restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTQ-SSS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th></th>
<th>Diabetics</th>
<th>Non-diabetics</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 months</td>
<td>1.95</td>
<td>1.25</td>
</tr>
<tr>
<td>6 months</td>
<td>2.05</td>
<td>1.45</td>
</tr>
</tbody>
</table>

Performance-based Measures

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

CTQ-FS, DASH and the ICF

<table>
<thead>
<tr>
<th>Body structure/body function (b760)*</th>
<th>Activity limitation</th>
<th>Participation restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTQ-FS*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DASH</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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
  - Yueball et al, 1986
  - Desrosiers et al, 2009
  - Agnew et al, 1988

Dellon-Modified Moberg Pickup Test

Level 4 Evidence
- Reliability and valid
- Discriminates between those with CTS and control
  - Amirjani, 2011
- Normative data
  - Amirjani, 2007

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

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-McCormick Modified Moberg Pickup Test

Summary
Self-Report and Performance-based Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Supported/ not supported</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTQ-SSS</td>
<td>Supported</td>
<td>B</td>
</tr>
<tr>
<td>CTQ-FS</td>
<td>Supported</td>
<td>B</td>
</tr>
<tr>
<td>DASH</td>
<td>Supported</td>
<td>B</td>
</tr>
<tr>
<td>Purdue Peg Board</td>
<td>Not supported</td>
<td>C</td>
</tr>
<tr>
<td>Jebsen Taylor</td>
<td>Not supported</td>
<td>C</td>
</tr>
<tr>
<td>Nine Hole Peg Test</td>
<td>Not supported</td>
<td>C</td>
</tr>
<tr>
<td>Dellon MPUT</td>
<td>Supported</td>
<td>C</td>
</tr>
</tbody>
</table>

Body Function: Strength testing

**Abductor Pollicis Brevis Strength testing**

- Manual Muscle testing
  - Level 2 evidence:
    - Reliability: Marx 1998 (cohort): Kappa 1.0
    - Validity: Geere 2007 (systematic review, weak support)
    - Katz (1994) (cohort): (SRM=0.42; ES =0.35)

- Instrumented MMT
  - Level 1 evidence:
    - Jerom-Herold C (2011): No long term change in APB strength
  - Level 3 evidence:
    - (Liu 2007): APB strength increased after 6 weeks.

  Recommendation APB testing: D conflicting

Performance Measures and the ICF

<table>
<thead>
<tr>
<th>ICF</th>
<th>Activity limitation</th>
<th>Participation restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body structure/body function</td>
<td>DMPUT*</td>
<td></td>
</tr>
<tr>
<td>b760</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b760 = control/coordination of simple and complex movements

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, Locogonosis, Shape Texture Identification (STI) test

Body Function: Strength testing

**Grip strength**

- Reliability: Evidence:
  - Level 2: Alderson and McCall (1999) found intra-rater reliability ICC > 0.93

- Validity:
  - Level 1: Jerom-Herold C (2011) Prospective cohort: NO
  - Level 2: Systematic review Geere J (2007) NO

- Recommendation: Grade B: Grip strength NOT useful as an outcome measure.
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% decrease, key pinch 14% decrease
    - 6 month grip 12% above baseline; key pinch 4% above baseline
- **Tip Pinch**: Recommendation: C include tip pinch
- **Tripod (three jaw chuck) and key pinch**: Recommendation: Grade C that key and tripod pinch are not useful as outcome measures.

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 (2 tech, Salt Lake City, UT)), Interval level of measurement. Not for sale
- **Reliability:**
  - Correlation between vibration sense and dexterity (NK Dexterity Small Objects Test) ranged between $r = 0.36$ - 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**

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    - 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

Dellon AL 1980

- Validity Vibrometry Cont'd
  - Level 3 evidence:
    - Dellon AL (1980)
  - Crosssectional 36 patients.
  - Tuning fork at 30 and 265 Hz.

- Recommendation
  - Vibrometry: D
  - In support, Conflicting due to inconsistency in instruments.

### Level of evidence 4:
- Level discrimination
- Validity Static Two point Discrimination
- Validity Monofilaments

<table>
<thead>
<tr>
<th>TABLE IV</th>
<th>Carpal Tunnel Syndrome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Absent</td>
</tr>
<tr>
<td>Two-point discrimination, abnormal</td>
<td>25%</td>
</tr>
<tr>
<td>Two-point discrimination, normal</td>
<td>5%</td>
</tr>
<tr>
<td>Interphalangeal index, abnormal</td>
<td>5%</td>
</tr>
<tr>
<td>Interphalangeal index, normal</td>
<td>5%</td>
</tr>
<tr>
<td>Patients' app specific, abnormal</td>
<td>5%</td>
</tr>
<tr>
<td>Patients' app specific, normal</td>
<td>5%</td>
</tr>
</tbody>
</table>

### Level of evidence 2:
- Level 3 evidence:
  - Dellon AL (1982): 12 patients, 2 hand surgeons, 2 occupational health workers.
  - Intra-rater reliability: ICC >0.73 (80%), ranging from 0.5 to 0.8.
  - Inter-rater reliability: ICC >0.66 (70%), ranging from 0.37 to 0.53.

### Level of evidence 1:
- Katz (1994): 60 patients; Responsiveness at 6 months: SRM = 0.76, ES = 0.88

### Level of evidence 5:
- Paucity of research

**Accuracy:**
- Level of evidence 5:
  - Marx (1991): force affected by humidity and temperature (up to 30%)

**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 >0.73 for all patients.
  - Intra-rater reliability of 0.71 for all (0.73 to 0.80)

### Intra-rater reliability:
- 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 2.83 cutoff when two experienced therapists measured SW scores on 30 patients.

**Reliability:** Partially conflicting

### Body Function: Sensory

**Validity Monofilaments**
- Level of evidence 2:
  - Katz (1994): 60 patients >80% satisfied with results at 3 months following surgery. Responsiveness SWM: (SRM=0.47; ES=0.41).
- Level of evidence 3:
  - 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.

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

### Body Function: Sensory

**Validity Two point Discrimination**
- Level of evidence 3:
  - Elfar et al (2010), 40 hands (35 patients) found the middle finger was most affected. (see Figure)
  - Marlowe (1999) found poor correlation between static 2PT and NCV parameters in 47 subjects (83 hands).

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

**Paucity of research**
- Level 4: Marx RG (1998)
  - Crosssectional study: 12 subjects (mixed CTS, neuropathy)
  - 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)
  - Crosssectional study: 43 CTS patients, 74 hands, using a folded paperclip method. Moving 2PT 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 2PT 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

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

Summary Body Functions

<table>
<thead>
<tr>
<th>Measure</th>
<th>Supported/not supported</th>
<th>Level/Grade of recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static 2 PD</td>
<td>In support</td>
<td>C</td>
</tr>
<tr>
<td>Finger tip pinch</td>
<td>In support</td>
<td>C</td>
</tr>
<tr>
<td>Shape/Texture ID</td>
<td>In support</td>
<td>C</td>
</tr>
<tr>
<td>Vibrometry</td>
<td>In support</td>
<td>D</td>
</tr>
<tr>
<td>Abductor Pollicis Brevis</td>
<td>Conflicting</td>
<td>D</td>
</tr>
<tr>
<td>Moving 2 PD</td>
<td>Conflicting</td>
<td>D</td>
</tr>
<tr>
<td>Monofilaments</td>
<td>Conflicting</td>
<td>D</td>
</tr>
<tr>
<td>Grip Strength</td>
<td>Not supported</td>
<td>B</td>
</tr>
<tr>
<td>Key pinch,Tripod pinch</td>
<td>Not supported</td>
<td>C</td>
</tr>
<tr>
<td>Locognosia</td>
<td>Not supported</td>
<td>B</td>
</tr>
</tbody>
</table>

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.
Cinhd, Cochrane, PubMed: 1960-present
Reference lists of retrieved papers.

Results: 373 retrieved
52 rejected

Reviewed: 321 articles
30 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:** Lately 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:** Clinicians should provide information based on available evidence regarding task modifying strategies, conservative interventions.

Ergonomic

Engineering interventions: Keyboards

**Conclusion:** Weak evidence: use reduced 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 WRMD's.
- Lincoln 2000

**Recommendation:** 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:** 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

**Evidence Level:** 7 Level IV studies


**Recommendation:** 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.
  - Tendon Gliding: combined with nerve gliding
  - Splinting: superior to tendon/nerve glides for improving symptoms

**Recommendation:** 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.

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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 Cobert 2010

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

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Other Interventions

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

**Recommendation:** 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 III study: microwave vs. sham Frasca 2011

☞ 1 Level III study: short wave diathermy Incebeyk 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. iontophoresis.

**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  
Karany 2009
Recommendation: 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.

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: clinicians should not use LLLT for CTS until more evidence becomes available. No evidence for optimum wavelength, treatment parameters.

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 evidence

Goodyear 2011, Goodyear-Smith 2004, Gerritsen 2002


Piazzini 2007, O'Connor 2012

Chang 2008 Ekm 2007

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


1 Level II: Luchetti 1994

2 Level IV: Celik 2015 Qian 1960

Recommendation: 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


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: 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: favor orthosis applied early (≤3 mo)

Efficacy known in 5 months.

Evidence Level: 6 QLSR’s: 1 Level II trial: Walker 2000


1 QLSR: 2 Level IV studies: Dolhanty 1986, Li 1999

Muller 2004

1 Level III: Kruger 1991

1 Level IV: Nobuta 2008

Recommendation: 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: %: surgery > splint.
  Crow 1960, Gerritsen 2003, Kendall 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

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Supported</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Information</td>
<td>✔</td>
<td>F</td>
</tr>
<tr>
<td>Task modification</td>
<td>✔</td>
<td>E</td>
</tr>
<tr>
<td>Surgery</td>
<td>✔</td>
<td>B</td>
</tr>
<tr>
<td>Orthoses</td>
<td>✔ short term</td>
<td>F</td>
</tr>
<tr>
<td>Reduction of mouse use</td>
<td>✔</td>
<td>C</td>
</tr>
<tr>
<td>Nerve/tendon glides</td>
<td>✔ pain relief</td>
<td>C</td>
</tr>
<tr>
<td>US</td>
<td>✔</td>
<td>C</td>
</tr>
<tr>
<td>Phonophoresis</td>
<td>✔ short term</td>
<td>C</td>
</tr>
<tr>
<td>TENS/IFC</td>
<td>✔ short term pain relief</td>
<td>C</td>
</tr>
</tbody>
</table>

Interventions Summary con’t

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Supported</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnets</td>
<td>NO</td>
<td>B</td>
</tr>
<tr>
<td>SWD</td>
<td>NO</td>
<td>No evidence</td>
</tr>
<tr>
<td>Iontophoresis</td>
<td>NO</td>
<td>C</td>
</tr>
<tr>
<td>LLLT</td>
<td>NO</td>
<td>D</td>
</tr>
</tbody>
</table>

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

- "Health Condition" (disorder or disease)
  - Body Functions and Structures
  - Activities
  - Participation
  - Personal Factors
  - Environmental Factors
History

- Insidious onset of 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)

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!