Therapeutic Management of Carpal Tunnel Syndrome

Roslyn B. Evans, OTR/L, CHT
Philadelphia: DK Lecture 2014

Epidemiology
- > morbidity than any other illness
- 99 per 100,000
- 10% general population
- Most common surgery in US...
  500,000 per year
- Most common dx tx ASHT
- Profound economic impact > 2 billion per year

Medline Search

- Unlimited articles
- 8,615 Oct 2014
- 30 minutes?

Controversy in the Literature

- Cause
- Techniques of evaluation
- Results with conservative care
- Technique of surgery
- Value of post-operative care

Effect of occupation on CTS...
passionate debate!

Substantiating Our Interventions

- Calling for evidence
  - Insurance Companies
  - Managed care networks
  - Patients

What is Evidence Based Practice?

- The integration of best research evidence with clinical expertise and patient values
  Sackett et al. 2000
- The practice of EBP consists of:
  - Formulated clinical question
  - Systematic review of literature
  - Critical appraisal
  - Application for patients
  - Performance review

Evans RB, carpal tunnel lecture, 2014
Slide 3

rbe5  In Medline search 12/02 with the key words evidence based practice and carpal tunnel syndrome, only 2 papers came up...both on acuponhcture, NIH consensus statement
Ros Evans, 2/23/2003

Slide 5

RBE18  Be careful how you write this up...study on knee arthroscopy demonstrated that it was not effective as no evidence based outcomes....now govt is looking into denying claims for medicare, etc and other insurance companies will follow.
Roslyn Evans, 3/1/2003

Slide 6

rbe9  Move is on from opinion based education to evidence based education. the quality or research evidence available, the reliability of the evidence, the utility of the evidence, how valid is the evedence, how reliable....this was a plot on the part of the program committee to make me realize how bad my research is, and to reinforce my thoughts about being put out to pasture....however we can take hope in the fact that there are levels of research depending on quality...1 to 4 (see MacDermid)...back to level 3.
Ros Evans, 2/23/2003
**Meta-analysis**

- A statistical method for combining the results of available research studies to increase statistical power
- The steps of meta-analysis are:
  - Identification of question
  - Search and selection of trials
  - Analysis

Hinotsu S, Akaza. Gan To Kagaku Ryoho 2002

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**Clinical Exposure**

**conflicting or limiting evidence**

- Little evidence on the reliability, validity, and responsiveness to change with current non surgical treatments for CTS
- Study techniques and reporting of results are not homogeneous
  - Metaanalysis:Gerristen2002
  - Schade; 2008,Scangas 2008

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**Conservative Management**

- Little is known about the efficacy of most conservative treatments
  - Gerritsen AA, 2002, meta-analysis
- Support for therapy
  - Level IV: case series with no controls
  - Level V: expert opinion without critical appraisal or bench research
  - Splinting, US, nerve gliding, carpal bone mabs, magnets, yoga.
  - MacDermid 2004

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**The Problem: Inadequate Outcome Measures and Reporting**

- Meta-analysis is only feasible if RCT’s are clinically homogeneous:
  - Patient population
  - Interventions
  - Comparisons
  - Outcomes
  - Timing of follow-up measurement


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**Meta-analysis**

**Conservative Treatment CTS**

Gerritsen AA et al. J Neurol 2002

- Short term relief:
  - Diuretics, pyridoxine, non-steroidal anti-inflammatories, yoga, laser, acupuncture ineffective (conflicting evidence)
  - Efficacy of ultrasound and oral steroids (conflicting evidence)
  - Steroid injection effective (limited evidence).
- Long term relief:
  - Efficacy of ultrasound (limited evidence)
  - Splinting is less effective than surgery
  - Little know about efficacy of conservative tx

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**Surgical versus Non-Surgical Treatment for CTS.**


- Surgery more effective
- Significant number of patients treated medically will go on to surgery
- Risk of reoperation low
- Unclear if mild sx can be treated with splints and injection
rbe10  Possible solutions to the problems of clinical heterogeneity of outcome measures and inadequate reporting of results for randomized controlled trials (RCT's) on CTS are presented. Meta-analysis was impeded for 2 reviews on conservative and operative management of CTS. To resolve the problem of clinical heterogeneity of the outcomes there should be consensus on the validated outcomes that should be used for CTS.

Ros Evans, 2/23/2003

rbe11  Only one randomized controlled trial found. 22 female patients...11 treated with surgery, 11 with splinting and of those 8 of 11 required operation, none of operated in first group were reoperated at one year.

Ros Evans, 2/23/2003
**Evidence Based Medicine for Treatment of CTS**

- RCT’s; Systematic Reviews
  - Cochrane Database Syst Rev 2002
  - Assmus 2007; AAOS 2008
  - Uchijama J Ortho Sci: 2010
- OCTR preferred
  - Systematic review of RCT’s
  - Gerritsen 2001; Uchijama 2010

**Surgical Options for CTS**

- Cochrane Database Syst Review
  - 2014
  - Vasiliadis et al
- ECTR vs OCTR
  - Low level evidence/no significant difference
  - ECTR associated with less minor complication, no difference major
  - ECTR RTW 8 days sooner

**Guidelines Dx and Tx 2007**

- Evidence Based supradisciplinary guidelines
  - Important: accurate history: clinical tests, EMG, NCS
  - Optional: radiography, MRI, US
- German Societies
  - Assmus et al. 2007

**AAOS 2007, 2008 EBM Guidelines for Evaluation**

- Approved
  - Patient history
    - Physical exam
    - Sensory test
    - Motor test
    - Provocative testing
  - Discriminatory tests for alternate dx
  - EMG, NCS

- Not approved
  - MRI
  - CAT scan
  - Pressure sensori-motor devices in wrist or hand

**AAOS 2009**

- Conservative options
  - Recommend 9 guidelines for tx CTS
  - Local steroid injection
  - Oral steroids
  - Ultrasound
- CTR best option!
  - Level I evidence

**Adherence AAOS UE CPG**

- Members of ASSH do not universally adhere to the AAOS CLINICAL PRACTICE GUIDELINES FOR CTS
  - 53% wait recommended time before operating
  - 32% always order electodiagnostic testing
  - 30% splint PO
- Followed: 98% nighttime splinting; 85% corticosteroid injection

Evans RB, carpal tunnel lecture, 2014
Practice patterns: 25 year perspective
Leinberry et al JHS Am 2012

- Preoperatively
  - Increase use splint, corticosteroid injections
  - Tx non-operatively longer
  - Narrowed surgical indications

- Post-operatively
  - Use tourniquets, corticosteroids less
  - Place deep sutures less often
  - Decrease concomitant procedures
  - Orthotic use and time decreased

Why is this most common of all treated disorders in the upper extremity the subject of so much controversy and research?

Experience teaches that with a knowledgeable therapist and skilled surgeon is easy to diagnose, operate, and bring to functional recovery.

Well ....what do we know about carpal tunnel?

Do We Know What We Think We Know?

- Evaluation
- Conservative Management
- Surgical Management
- Postoperative Management
- Return to Work

Anatomy

- Inelastic conduit
- 9 flexor tendons
- Median nerve, anterior portion directly under TCL
- Varying synovium
- Floor: carpal bones
- Roof: TCL
- PL inserts into the TCL

ROI inserts into the TCL

Lane et al JHS AM 2014/Sept

- CTS Dx and Tx: A Survey of members of the ASSH
  - AAOS 2007-2009 developed Clinical Practice Guidelines/literature review
    - Lack strong evidence: recommendations: strong, weak, controversial
  - Survey ASSH members
    - 72% operate with +hx/exam,+steroid injection
    - 47% EDX not needed if above +
    - 79% order EDX based on CPG/
    - 57% order EDX for medical-legal implications
Tissue Fluid pressures in CT
- 2.5 mmHg in normal subjects
- 32 mmHg in patients with dx of CTS
- > 30mmHg applied over time induce nerve damage
- >50-60mmHg: complete block of sensory
  10-30 min before motor conduction

Increase in Tissue Pressure:
- Causes
- Decrease: Transectional Area
- OR-
- Increase: Volume of Contents

Increased Intratunnel Pressures: Causes
- Anatomic: CSA vs Contents
- External Forces
- Altered physiology
- Microcirculation
- Alterations in Fluid Balance

Increase in Critical Levels of Tissue Pressure : Results
- Change in intraneural microcirculation
- Alterations in vascular permeability
- Alterations in nerve fiber structure
- Nerve edema
- Restricted tissue gliding
- Deterioration of nerve function

Clinical Picture: Decreased sensibility, long finger, pain, soft edema, flexor inflammation, motor loss opponens

Elevated intra-carpal pressures
- Anatomical compression
- Inflammatory, neuropathic conditions
- Mechanical forces
- Obesity
Increase in CTP: **Altered physiology**

- **Neuropathic**
  - Diabetes: no correlation incidence
  - Alcoholism
- **Inflammatory**
  - Rheumatoid arthritis
  - Gout
  - Non-specific tenosynovitis
- **Alterations fluid balance**
  - Pregnancy
  - Menopause
  - Thyroid: modest correlation, meta analysis

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**Increase in CTP**

**Variables Influenced by Conservative Management**

- **Posture**
  - Wrist, finger, thumb, forearm position
- **Tendon load/muscle activity**
  - Palmaris Longus, FDP, FDS, FPL, Lumbricals
- **External forces**
  - Applied external pressure, vibration

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**The effect of low and high velocity tendon excursion on the mechanical properties of human cadaver SSCT**

Filius et al J Orthop Res 2014

- Fibrosis subsynovial connective tissue in CT most common histologic finding in CT
- Low-velocity tendon excursions can irreversibly damage SSCT
- Increasing velocity increases fibrosis SSCT, more likely to break than stretch

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**Risk factors: Obesity/Sex**

- **Body Mass Index**
  - \( \rightarrow 29 \) 2.5X greater than \(< 20 \) BMI
  - \( \rightarrow > 10 \) pounds
- **Female**
- **Square Wrists**
  - Aerobic activity and fitness should be stressed

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**Metaanalysis for the Evaluation of Risk Factors for CTS**: General Factors

Spahn G et al 2012

- CTS prevalence 10.6%
- Female patients
- Increase in age (40-60 years)
- Overweight or obesity
- More frequent dominant hand
- “non-white race”
- Diabetes/alcoholism

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**Metaanalysis for the evaluation of risk factors for carpal tunnel syndrome Part II. Occupational Risk Factors**

Spahn et al 2012

- Incidence in working population
  - \( \sim 11\% \) workers vs 8% general population
- Heterogeneity of study designs precludes prevalence with any job title
- Repetition
- Chronic wrist flexion
- Power grip
- Chronic vibration load
Goal of Treatment
Decrease CTP
- Non-Surgical
  - Activity modification
  - Lumbrical block splinting
  - Wrist control splint
  - NSAIDS; Injection
- Surgical
  - Release TCL, OCTR or ECTR

Normal Intratunnel Pressures
- 2.5 mmHg wrist neutral
- 31 mmHg wrist flexion
- 30 mmHg wrist extension
- >90 mmHg in CTS in wrist flex or extension

The Effect of Wrist Posture
BuKke et al 1994; Weiss et al 1995
- CT pressure lowest with wrist 2 degrees flexion, 3 degrees of ulnar deviation
- 2.5 mm Hg wrist neutral
- 30-40 mm Hg with wrist in extension

The Effect of Wrist Posture
PL tension on FR with extension
- Shape of CT changes with wrist position

The Effect of Wrist Posture
with tendon load
- CTP higher with wrist extension than flexion regardless of load (Keir et al. 1997, 2000)
- Flexor tendons increase shear forces on Median Nerve (Keir, Wells, 1999)
- Extrinsic finger muscles have the potential to move into the CT with wrist extension (Keir and Bach 2000)
Clinical Implications

**Wrist Position**

- **Splinting**
  - 2 degrees wrist flexion
  - 3 degrees ulnar deviation
- **Work and exercise position**
  - Neutral
  - Avoid wrist extension combined with load to flexors

**Combined Wrist and Finger Postures**

- **Flexor Muscle Incursion**
  - Keir, Bach 2000
- Incursion of flexor muscles into the carpal tunnel with wrist extension is a potential cause of increased carpal tunnel pressure

- **The use of flexor muscles should be avoided when the wrist and fingers are extended**

The Effect of Wrist Posture

70 mm Hg in wrist extension

The Effect of Finger Posture

Decreasing Carpal Tunnel Pressures

Lumbral Block Splinting

Wrist 0 degrees, MP 0-20 flex, IP's free; decreases long tendon excursion, lumbral entry into CT
The most distal muscle fibres from the deep and superficial finger flexors were measured relative to the pisiform bone in 8 cadaveric specimens. The mean distances from the pisiform were 9.3 mm for the FDP, and 4.9 mm for the FDS respectively. The excursions expected with wrist extension indicate that many muscles have the potential to enter the carpal tunnel, especially those within 5 mm of the pisiform bone.

Roslyn Evans, 3/1/2003
The Effect of Finger Posture

- Four lumbricals originate off FDP tendons
- Rest distal to CT with digits in extension
- Rest within CT with fingers actively flexed

The Effect of Finger Posture

- "Evans RB, carpal tunnel lecture, 2014"

The Effect of Finger Posture

- Lumbrical Incursion
  - Cobb et al. 1994
  - Finger extension: 7.8 mm distal CT
  - 50% finger flexion: 14 mm into CT
  - 75% finger flexion: 25.5 mm into CT
  - 100% finger flexion: 30 mm into CT

The Effect of Finger Posture

- MRI of CT at Level of Hook of Hamate

The Effect of Finger Posture

- CTP with Intact Lumbricals
  - Finger Position | Mean Pressure
  - Digits extended | 299 mm Hg
  - 50% fist | 313 mm Hg
  - 75% fist | 326 mm Hg
  - 100% fist | 361 mm Hg

  - No pressure change any position with excised lumbricals
  - Greatest change between 75 and 100% finger flexion

The Effect of Finger Posture

- Plotted with and without lumbricals

The Effect of Finger Posture

- Finger Flexion
  - "Alters fat compression"
  - "Flattens and displaces median nerve in the presence of lumbral muscles"
  - "Pressure deep and superficial tendons"

Ham SJ et al. JHS 21A, 1996
Ultrasonographic median nerve changes under tendon gliding exercise in patients with CTS and healthy controls
- Horng YS et al; JHT 2014
- Median nerve compresses in fist position in both patients with CTS and healthy controls
- 73 with CTS
- 53 healthy controls
- Significant changes in cross sectional area of median nerve when moving from straight to hook and hook to fist position

Clinical Significance of Studies
Decreasing CTP with Finger Position
- In some cases: Limit
  50% finger flexion, MP’s 0 to 20 degrees
  - Well developed lumbricals; + Berger
  - Flexor synovitis
  - Triggering digits
  - "Compulsive gripper"
- MP’s 45 degrees
- Keir et al. 1998

Clinical Significance of Studies
Decreasing CTP with Finger Position
- Alter work postures with repetitive gripping and sustained intrinsic contraction
- Strengthen with isometric flexion at 50% rather than repetitive flexion into DPC

The Effect of Combined Finger and Wrist Posture with Load

Combined Effect of Posture and Load
- Muscle load elevates CTP above critical pressures (defined greatest to lowest)
  - PL greatest in wrist extension
  - Load to digital flexors with wrist flexion
  - FPL with wrist in ulnar deviation
  - Forceful grip with wrist in ulnar deviation

Keir PJ, et al. JHS 22A; 1997
Pressure Changes During Activity in Normal Hands

- Normal CT Pressure 32-44 mmHg
- Power fist/hold small object: +223 mmHg
- Wrist extension: +77 mmHg
- Wrist flexion: +56 mmHg
- Hold object 10.5 cm: +46 mm Hg
- Isometric finger flexion: +41 mm Hg

Seradge et al. 1995

The Effect of Finger Tip Motions

- Tendon force in the CT are not proportional to finger tip force during rapid tapping as with key stroking
- Tendon tension continues to increase throughout keystroke impact
- Forces are cumulative and remain elevated longer than the keystroke force

Dennerline et al. 1999

The Effect of Thumb Posture

- The effect of thumb CMC joint inflammation, the pull of the opponens on the flexor retinaculum and sustained intrinsic contraction can increase CT pressure

Lumbrical Pinch Test

- Firmly pinch paper between thumb and distal phalanges of index and Long, MP’s 90, wrist neutral
- Numbness Median Nerve 60 seconds, cramping mid palm
- Correlates with Median nerve & lumbrical indentation into distal CT
Clinical Significance
- Evaluate and treat CMC joint inflammation
- Minimize pinch and grip activities
- Avoid posture that combines UD and opposition
- Increase grip size tools

The Effect of Forearm Posture

The Effect of Combined Forearm Position and MP Angles in Normal Subjects

<table>
<thead>
<tr>
<th>Position</th>
<th>Pronation</th>
<th>Supination</th>
</tr>
</thead>
<tbody>
<tr>
<td>MP 0</td>
<td>16.6 mmHg</td>
<td>53.9 mmHg</td>
</tr>
<tr>
<td>MP 45</td>
<td>11.6 mmHg</td>
<td>33.7 mmHg</td>
</tr>
<tr>
<td>MP 90</td>
<td>19.4 mmHg</td>
<td>55.2 mmHg</td>
</tr>
</tbody>
</table>

Rempel D, et al. JHS 1998

The Effect of External Force

External force on the palm increases carpal tunnel pressure; the magnitude of pressure change is dependent on location

1 kg external force in cadaver specimen

Mean Carpal Tunnel Pressure

The effect of Forearm Posture

Clinical Implications
RBE13  Flexor retinaculum 103 mmHg
Roslyn Evans, 2/16/2003
Clinical Implications

Therapy Induced Problems

Pitfalls of Generic Therapy

- Inability to diagnose associated problems
- Inappropriate splint geometry
- Application of external pressures
- Exercise regimens that increase intra-tunnel pressures

Clinical Evaluation

Responsibility shifts dependent on referral source

Clinical Examination

- History
- Symptoms
- Clinical exam upper quadrant
- CT clinical screening
- Physical provocative testing
- Diagnostic testing

"I have been coached and I know the symptoms"

Referring Dx Incorrect or Incomplete, often primary care

- Thumb CMC or other carpal arthritis
- De’Quervains, other tendonitis
- Trigger fingers
- Epicondylitis
- Double Crush
- Cervicothoracic neuropathy
- Metabolic neuropathy

Gold standard??

- Electrodiagnostic studies recommended by multidisciplinary German Societies based on evidence based reviews 2007
- 2014...survey of ASSH members
  - 47% don’t order if hx and clinical eval +
  - 57% order for medical-legal reasons
Guidelines Dx and Tx 2007

- Evidence Based supradisciplinary guidelines
  - Important: accurate history, clinical tests, EMG, NCS
  - Optional: radiography, MRI, US
- German Societies
  - Assmus et al. 2007

AAOS 2007, 2008

EBM Guidelines for Evaluation

- Approved
  - Patient history
    - Physical exam
    - Sensory test
    - Motor test
    - Provocative testing
  - Discriminatory tests for alternate dx
    - EMG, NCS
- Not approved
  - MRI
  - CAT scan
  - Pressure sensori-motor devices in wrist or hand

Diagnostic Testing CTS... for most pts with +hx and +PE, EDT are not clinically relevant; Graham B. 2008

- Value of clinical exam:
  - Radovik et al 2014
- Electrodiagnostic... searching for gold standard
- Ultrasound
  - Duncan 1999
  - Lee 1999
- Magnetic Resonance Imaging
  - Zagon 1999
  - Ando 1999
  - Jacobson 1999
  - Knidman 1998

"I'll do it my way"

Electrodiagnosis of CTS

- Electrodiagnosis is not a useful diagnostic test in patients with clinical signs of CTS
- In cases of clear cut clinical CTS, electrodiagnosis is not warranted as a diagnostic test or indicator of surgical outcome.
- Jordan et al 2001

The Value of Diagnostic Testing in Carpal Tunnel Syndrome

Szabo et al. J Hand Surg 24A 1999

"I believe everything he says" RE

- Sensitivity
  - Durkan’s compression 89%
  - SW after Phalen’s 63%
  - Hand diagram 79%
  - Night pain 98%
- Specificity
  - Hand diagram 76%
  - Tinel’s sign 71%
- Electrodiagnostic testing does not improve combo of 4 clinical tests
The Validity of Physical Testing for CTS

**Dx of CTS is clinical and not neurophysiological**  
Kitsis 2002

- Supports clinical testing over NCS, EMS  
Sooboo 1996; Richer 1999

- Sensitivity, specificity vary with comparison subjects  
Garf et al. J Hand Surg (Br) 1996


Screen for Proximal Compression

- Accessory head of FPL
- Fibrous bridge between heads of FDS
- Between humeral and ulnar heads of pronator teres
- Beneathe lacertus fibrosis; Struthers ligament; bicipital aponeurosis
- Thoracic outlet
- C6-8 radiculopathy
  - Pratt. J Hand Ther 2005; Bilecenoglu et al. 2005

Clinical Diagnostic Tests CTS

- Lumbral Provocation Test
  - Hold hand in fist for 1 minute to evaluate changes in paresthesia
  - LPT has limited use in predicting CTS compared with electrodiagnosis and hand diagram.

- Berger Test

Clinical Diagnostic Tests

- Tinel/Percussion
- Vibrometry, 256 cps tuning fork
- Static 2-point discrimination
- Phalen/wrist flexion
- Durkan/carpal compression
- Lumbral Incursion/Berger
- Reverse Phalen
- Semmes-Weinstein monofilaments

Screen for Proximal Compression

- Light touch/deep pressure thresholds
- Supports use of SW Bell-Krotski 1995
- Liberal SW kit in confirmed CTS, no utility in diagnosis
  - Pagel et al 2002

Clinical Diagnosis CTS Semmes Weinstein Monofilaments

- Conflicting Support

- Defines issues with MCBMN, CDN, ON

Carpal Compression Test (CCT)

- Direct pressure on carpal tunnel and underlying median nerve. Highly sensitive (87%) and specific 90% in diagnosis of CTS when done with thumb pressure. Durkan 1991

- Marginal utility when compared to gold standard neurophysiologic testing.  
  - Not sensitive or specific for dx CTS. Wainner et al. 2000

Evans RB, carpal tunnel lecture, 2014
Clinical Diagnosis CTS
Hand Elevation Test  Ahn DS, 2001
- Hand elevation can reproduce the symptoms of CTS
- Prospective study in 200 hands diagnosed with CTS, and control 200 hands
- Useful provocative test
  - Hand Elevation  Phalen’s  Tinel’s
    - Sensitivity: 75.5%  67.5%  67.5%
    - Specificity: 98.5%  91.0%  90.0%

Clinical Evaluation Tests
Carpal Tunnel Syndrome
- Subjective swelling: a new sign for carpal tunnel syndrome
  - Tetro et al. 1998

My Approach… quick screen
- Subjective complaints
- Semmes Weinstein neutral and after Phalen’s
- Tinel’s (percussion)
- Berger (lumbrical incursion)
- Durkan’s (external pressure)
- Soft edema, inflammation
- Provocative tests for proximal compression (forearm, cervical)

I will Recommend EMG, NCS, Surgical consult ….
- Nocturnal pain
- Daytime paresthesia
- Increase sx with sustained pinch or grip
- + provocative tests
  - Phalen’s, Berger, Tinel’s, Durkan’s, Pinch
- Semmes Weinstein > 3.61 Long digit
- Atrophy opponens

Conservative Management
- Little is known about the efficacy of most conservative treatment options
  - (Gerritsen AA, 2002, meta-analysis)

Meta-analysis
Conservative Treatment CTS
- Gerritsen AA et al. J Neurol 2002
- Short term relief:
  - Diuretics, pyridoxine, non-steroidal anti-inflammatory, yoga, laser-acupuncture ineffective (conflicting evidence)
  - Efficacy of ultrasound and oral steroids (conflicting evidence)
  - Steroid injection effective (limited evidence).
- Long term relief:
  - Efficacy of ultrasound (limited evidence)
  - Splinting is less effective than surgery
Surgical versus Non-Surgical treatment for CTS.

- Conclusion?
- Surgery more effective than splinting
- Further research to determine if surgery better than steroid injection for people with mild sx.
- Verdugo, et al.

Conservative Management CTS

- NSAIDS
- Corticosteroid injection into Carpal Tunnel
- Metabolic control other problems
- Weight loss
- Splinting

AAOS 2009

- Conservative options
  - Recommend 9 guidelines for tx CTS
  - Local steroid injection
  - Oral steroids
  - Ultrasound
- CTR best option!
  - level I evidence

Endoscopic Release CTS
Vasiliadis et al
Cochrane Database Syst Rev 2014

- OCTR and ECTR equally effective
- No major difference in complications
- ECTR earlier return to work (8 days)
- ECTR slightly better grip strength, function
- Conclusions limited
  - "High risk of bias, statistical imprecision, inconsistency in included studies".

Surgical Options for CTS
Cochrane Database Syst Review 2014
- Vasiliadis et al
- ECTR vs OCTR
- Low level evidence/no significant difference
- ECTR associated with less minor complication, no difference major
- ECTR RTW 8 days sooner
- Cochrane Database Syst Review 2008

Oral Steroids
NSAIDS

- Short term low dose oral steroids are effective for CTS.
- RCT
  - Chang MH et al 2002
Only one randomized controlled trial found. 22 female patients...11 treated with surgery, 11 with splinting and of those 8 of 11 required operation, none of operated in first group were reoperated at one year.

Ros Evans, 2/23/2003
Local Corticosteroid Injection

- Greater improvement over placebo at one month
- Symptom relief beyond one month not demonstrated
- No improvement compared to anti-inflammatory tx and splinting or laser tx

Local Steroid Injection

- Gelberman et al. Carpal tunnel syndrome. Results of a prospective trial of steroid injection and splinting. JBJS. 1980
- Indexed by American Society for Surgery of the Hand
- 22% of 41 patients were symptom free at mean 18 month follow-up with steroid injection and splinting.
- High relapse rate with more severe sx; sx greater than one year

The Efficacy of Splinting

- Supports the wear of full time neutral wrist splints over night time splinting alone. RCT. Walker et al. 2000
- Splinting combined with NSAIDS and steroid injection into CTS resulted in significant improvement. RCT. Celiker et al. 2002
- OCTR better outcomes than wrist splinting in patients with CTS. RCT. Gerritsen et al. 2002

Splinting for CTS

- Compare effectiveness of splinting for CTS with no tx, placebo or another nonsurgical intervention
- Limited evidence to support in short term
- Some benefit over other conservative tx
- Studies evaluated not homogeneous

The Efficacy of Splinting

- Splint that maintains the wrist in neutral position while restraining the digits beyond 75% of a full fist would be most effective in decreasing carpal tunnel. Apfel et al 2002
- Splint effective in reducing symptoms and functional loss. RCT. Manente G. et al 2001
- Support for Splinting. RCT. Manente et al 2001
- No Benefit: Luchetti 1998
rbe3 Ros Evans, 2/23/2003
rbe4 Walker study:
Ros Evans, 2/23/2003
**Sleeping Positions**
cervical, shoulder, elbow, wrist, and in severe cases the digits

**Neural Mobilization:** limited evidence
- Efficacy not clear
  - Systematic Review: Medina et al. 2008
- Duration, frequency, amplitude not confirmed
- Walsh
- Excessive strain with functional activities may play a role in peripheral nerve sx.

**Exercise, mobilization interventions for CTS**
_Cochrane Database Syst Rev 2012_ Page et al
- Compare ex and mobs to no tx, placebo, other non-surgical tx
- Studies heterogeneous
- Limited/low quality studies
- NO EVIDENCE TO SUPPPORT

**Tendon Gliding Through the CT**

**Manual Therapy**
No support
- Carpal Bone Mobilization
- Median Nerve Mobilization
- No Treatment
- RCT, no difference in tx.
- Tal-Akabi A, Rushton A. _Man Ther_ 2000

**Exercise**
NOPE
- Tendon and nerve gliding: No statistical improvement in full time splinting vs. full time splinting with exercise. RCT. Akalin et al. 2002
- “nerve excursion may improve axonal transport”
The Problem with Therapy Toys

- Effect of posture and load
- CT pressure < 200 mmHg in full fist

What Are They Smoking?

This nerve is crushed!

- Vitamins
- Magnets
- Carpal mobilization
- Nerve gliding
- Acupuncture
- Aerobics
- Acupuncture
- Lasers
- Therapeutic touch
- US/ Ionto

Iontophoresis

- Administration of medications by direct current
- Some reports of ionto followed by pulsed ultrasound
- Controlled studies insufficient

Robertson VJ, Baker KG. Phys Ther 2001

Ultrasound

Minimal Support

- Systematic review of 35 RCT’s for use of US in people with musculoskeletal injuries and soft tissue lesions.
- 10 RTC’s met criteria with acceptable methods
- Results of 2 trials suggest that US is more effective in treating CTS and calcific tendonitis of the shoulder than placebo US, but 6 trials suggest it is not.

Robertson VJ, Baker KG. Phys Ther 2001

Therapeutic Ultrasound for CTS

Cochrane Database Syst Rev 2013...... Page et al

Poor quality evidence from limited data to support US over placebo or any other conservative regimen

- Insufficient support of one type US regimen over another

Acupuncture (Nope)

- No evidence that acupuncture is an effective therapy for CT
- Systematic review of RCT’s
  - Sim et al. J Pain 2011
  - “She responded well to acupuncture which provided good symptomatic treatment rather than cure and allowed her to continue her work as a school crossing lady whilst she awaited surgical release”
  - Acupuncture Medicine 2002
Low level laser plus TENS
- Low level laser therapy (LLLT) plus TENS applied to acupuncture points significantly reduced pain in 11 CTS subjects in VA setting who failed surgical or conservative treatment
- Randomized Controlled Trial

Magnet Therapy
- Use of a magnet for reducing pain to CTS was no more effective than the use of placebo.
- RCT

Therapeutic Touch (TT)
Randomized Controlled Trial
- Sham TT vs. TT
- Therapeutic touch no better than placebo in influencing median motor nerve distal latencies, pain scores, relaxation scores.
- Blankfield et al 2001

Activity Modification
- Inadequate evidence to implicate occupational Factors: Lozano 2008

Would a flashlight Work as well?

CTract
- "first and only clinically proven modality for treating CTS without surgery"
National Institute for Occupational Safety and Health recognizes risk factors. Australian court system, RSI does not exist.

Ergonomic Positioning or equipment for treating CTS
Cochrane Database Syst Rev 2012
O’Connor et al

- Ergonomic vs placebo keyboards
- Insufficient evidence from RCT’s to determine if ergonomic positioning or equipment is beneficial or harmful
- No association proven
Computers and CTS
Mediouni Z et al, J Occup Environ Med 2014

Ergonomic vs placebo keyboards, insufficient evidence from RCT’s to determine if ergonomic positioning or equipment is beneficial or harmful, no association proven.

Occupational Exposure
Meta--analysis
- Prolonged exposure to non-neutral wrist increases risk for CTS 2x
- Occupational exposure to excess vibration, increased hand force and repetition increase risk of developing CTS
  – Barcenilla et al, Rheumatology (Oxford) 2012

- Decrease Carpal tunnel Pressures
  - Deltombe et al, 2001

Protective effect of Glove on Compression
No Support
- Gel padded glove does not have a protective effect on CTS induced by compression in the workplace.
- Does provide significant comfort
- Randomized Clinical Trial
- Deltombe et al 2001

Conservative Management
My Approach
- Evaluate associate problems with high index of suspicion
- Decrease Carpal tunnel Pressures
  - Splint
  - Activity modification
  - Education
- Modalities to decrease edema
- Medications to reduce inflammation

Flexor Tendonitis
CTP at 40 mmHG
CTP at 280 mmHG

Evans RB, carpal tunnel lecture, 2014
**Conservative Management**

Splint the MP Joints 0-40 Degrees

- Positive lumbral incursion
- Triggering or tenderness A1
- Flexor or extensor tenosynovitis
- The inadvertent gripper

**Postoperative Management**

Carpal Tunnel Release

**Complications**

Open and Endoscopic Release

- Wounds dehisce (early suture removal)
- Infection/suture abscess/ hematoma
- Painful scar (crossing the wrist?)
- Pillar Pain...injury to PCBMN
- Incomplete release
- Tendon adhesion
- Trigger fingers/ tendonitis
- CRPS; neuroma in continuity
- Palmaris Longus inflammation

**ASSH review/5 year period**

Palmer, Tolvonen JHS Am 1999

- 455 major complications from ECTR tx by 708 respondents
  - 100 median, 88 ulnar, 77 digital nerve lacerations
  - 121 vessel, 69 tendon lacerations
- 283 major complications from OCTR 616 respondents
  - 147 median, 29 ulnar, 54 digital nerve lacerations
  - 34 vessel, 19 tendon lacerations

**Problems to be Solved PO**

- Double-crush, compression other levels
- Loss tendon glide/ tendon adhesion
- Undiagnosed, untreated trigger fingers
- Weakness
- Pain from basilar thumb arthritis
- ADL/ ergonomic issues
- Employer expectations

*An Outcome Protocol for CTS: A Comparison of Outcomes in Patients with and without Medical Comorbidities: Cagle PJ, et al JHS Am 2014*

- 950 OCTR
- Self reported severity and functional scores
- Boston Carpal Tunnel Outcomes Questionnaire
- 2, 6, 12 weeks

- Significant improvements in sx severity and hand functional after OCTR can be expected regardless of age, co-morbidity, WC status
**Value of therapy PO Rehab**
- Limited, low evidence for PO interventions
  - Splint, wound care, exercise, cold or ice therapy, multimodal hand rehab, laser, electrical modalities, scar desensitization and arnica.
  - Peters et al: Cochrane Database Review 2013
- Faster return to work but no effect on functional recovery. Provinciali 2000
- Cost for uncomplicated CTR unjustified
  - Pomerance 2007

**Postoperative Therapy CTR Opinion Based (MINE)**
- Wound care/ prevent tension
- Education for edema control, exercise
- Wrist control splint ( MP’s/ thumb?)
- Address associated problems
  - Double crush, triggers, OA CMC
- Scar management
- Coordinate return to work

**PO Splinting CTR Debated**
- Finsen 1999
- Martins 2006
- Bury 1995
- Cebeosoy 2007
- Huemer 2007

**Does splintage help pain after CTR?**
- Randomized Clinical Trial
- 102 pt PO CTR
- No differences in pain levels
  - Bhatia et al 2000
- Little therapeutic benefit
- Trend away from splinting

**PO Splinting 2-3 weeks author preference**
- Control overuse
- Prevent inflammation
- Prevent wound site tension
- Pain relief, address issues of CMC OA
- Nerve and tendon gliding addressed with exercise

**Minimize Scar Complications**
- Short incision
- Minimize tension with splint and exercise technique
- Sutures 17 days
- Micropore paper tape

Evans RB, carpal tunnel lecture, 2014
Infection... early suture removal...

Incisions that cross the wrist

Dehisced OCTR Incision

Predictors of Return to Work.
Katz et al 1995
- Correlation with failure RTW
  - Persistent symptoms
  - Scar tenderness
- Work disability at 6 months is 29%
- Principal predictor is relief of sx and scar tenderness

Nerve Density in the Palm
Cassidy et al 1995

Tenosynovectomy not indicated
Shrum et al. 2002
AAOS 2007

Scar Management
- Paper tape
- Topical silicone gel sheeting (SGS)
- Massage
- Ultrasound
- Iontophoresis
- Lidocaine Patch 5%
- Desensitization
**Scar Management**

**Iontophoresis**
- Administration of medications by direct current
- Some reports of ionto followed by pulsed ultrasound
- Controlled studies insufficient
  
  Fedorczyk M, Micklovitz 1995

**Ultrasound**
- Insufficient support

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**Cold Therapy Treatment**
- RCT
- Efficacy ice therapy 72 patients CTR
- Patients treated with Temperature Controlled Cooling Blanket (CCT) had greater reduction in pain, took fewer narcotics, had less edema by day 3 PO than those treated with traditional ice therapy.
  
  Hochberg J. J Hand Ther 2001

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**Tendon Adhesion**

**Peri-articular Stiffness**

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**Tendon Gliding Through the CT**

Hunter and Wehbe
**Sympathetic Flare**

- Contrast baths
- Stress loading
- Daily gentle therapy
- Neurontin
- Stellate ganglion blocks
- Missed diagnosis

**Flare Reaction or Neuropraxia**

- Assess inciting lesion
- Anti-inflammatories, Medrol, Neurontin, blocks
- Patient may be overworking, therapist or splints may apply too much force.

**Results of Rehabilitation Following Carpal Tunnel Release**

- Accelerates return to work
- Does not modify functional recovery
- Does not reduce symptom occurrence

- Provinciali et al 2000
- Keilani et al 2002

**Surgeon Interest Index**

Initial Visit | During Surgery | Post-Operative
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DIL | Patient Whining Level (PWL)

*Evans RB, J of Anecdotal Results, 1999*

**Improved Results**

- Atraumatic Surgery
- Incisions that don’t cross the wrist
- Early referral to therapy
- Assessment psychosocial/other agenda
- Tendon gliding exercise/precautions
- Wrist control for OCTR