

Seeing the Light at the End of the Carpal Tunnel

Prevention & Treatment Strategies

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Hand Management Center



Is There Light at the End of the Carpal Tunnel?

CTS statistics

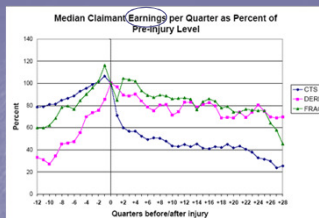
- High incidence:
 - 0.1 % to 10% of general population
 - most common nerve compression
- Direct medical costs: > 1 billion per year
- >500,000 surgeries per year in U. S.

(NY Times article, 7-14-2013)

Patterson & Simmons, 2002
O'Connor et al, 2009



Economic Burden



- Higher in CT than UE fracture
 - Washington State Dept. of Labor & Industries
 - Median days off per worker's comp claim
 - 138 for CT
 - 46 days for fracture
 - Earnings post-injury >30 % less with CTS

<http://www.lni.wa.gov/Safety/Research/OccHealth/Reports/CtsBurden/default.asp> 1/14/2015

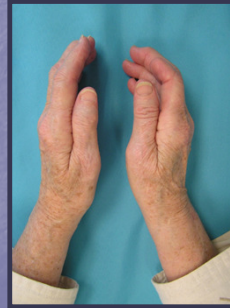
Light provided for CTS

1. Describe the pathophysiology & diagnosis
2. Identify the most likely risk factors
3. Highlight prevention techniques
4. Conservative management
5. When is surgery necessary?
6. When is therapy needed after surgery?
7. Prognosis for recovery and return to work

Clinical Practice Guideline for Conservative Management of CTS



Severe CTS



Loss of:

- muscle at base of thumb
- ability to pick up small objects, button, etc.

Pathology in CTS

■ Tunnel formed by:

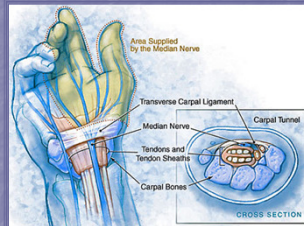
- Transverse Carpal Ligament
- Carpal bones

■ Contents of tunnel:

- 9 Flexor tendons
- Median nerve

■ Tight compartment

- Thickened tendons
- Swelling
- Enlarged bone



- Increased pressure chokes blood supply to nerve

DIAGNOSIS



Symptoms of CTS

■ Numbness, tingling, pins & needles

- median nerve distribution
- many times whole hand
- frequently drop objects

■ Pain:

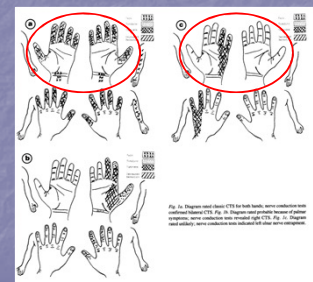
- hand & palm side of wrist
- occasionally up to shoulder

■ Symptoms usually worse at night and disturb sleep



Diagnosis: Symptoms Katz Hand Diagram

- Patients asked to fill out hand diagram with symptoms
- Rated only on numbness & tingling (not pain)
- **Classic**=sx in at least 2 digits in median n. distrib. but not palm
- **Unlikely**: none of these digits



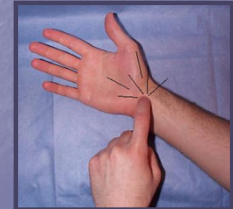
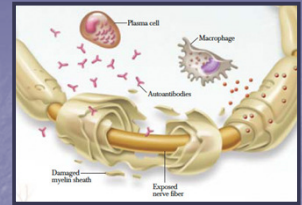
From: Katz et al 1990

Diagnosis: Symptoms Boston Carpal Tunnel Scale

- Self-report questionnaire
- Symptom Severity Scale
 - Sample questions: severity of pain, numbness/tingling
 - Scaled 1-5
 - none – very severe
- Functional Severity Scale
 - Sample questions: writing, buttoning, grip telephone
 - Scaled 1-5
 - No problem-unable to perform

Diagnosis: Provocative tests

- Tinel's sign
 - occurs in an area of nerve injury--protective covering (myelin) removed
 - electrical sensation when percussed



Diagnosis: Symptoms Boston Carpal Tunnel Scale

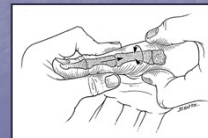
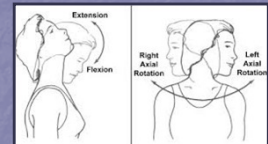
Used for:

- Baseline of symptom & functional severity
- Prognosis:
 - Scores <2.5 = 89% success with conservative management¹
 - Scores > 3.0 had 72% chance going on to surgery²
- Documentation of progress: clinically important difference
 - ↓ 0.5 conservative³
 - ↓ 1.5 for surgery⁴

Olliever et al, 2009¹
Kaye & Reynolds, 2007²
Cheung et al, 2014³
Ozer et al, 2015⁴

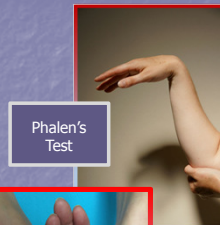
Diagnosis: Rule Out

- Cervical
- Other nerve problem
 - Thoracic outlet
 - Cubital tunnel
- OA of thumb

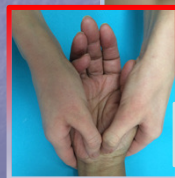


Diagnosis: Provocative tests

- Mechanism of Action: produce further vascular compromise to an already impaired median nerve – reproduces sx
- Pressure elevation within the CT with wrist posturing
- Direct mechanical deformation



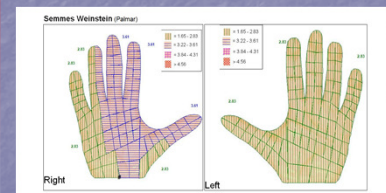
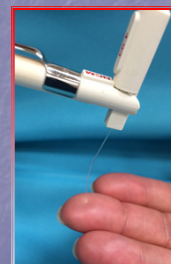
Phalen's Test



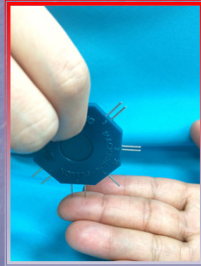
Compression Test

Diagnosis: Sensory Examination

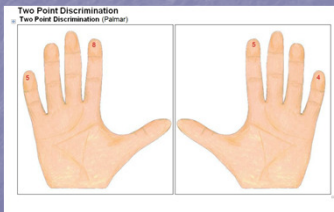
Semmes Weinstein Monofilaments



Diagnosis: Sensory Examination



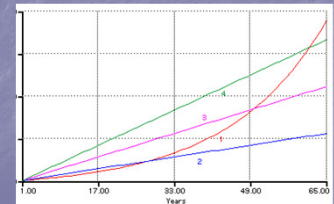
Two Point Discrimination



Support for Employer Argument

Personal Predisposing Factors
> doubles risk

- Diabetes
- Women
- Rheumatoid Arthritis
- Previous m-s problem
- 1st degree relative
- Thyroid disease
- Obesity: BMI over 25 kg/m²
- Age: over 50

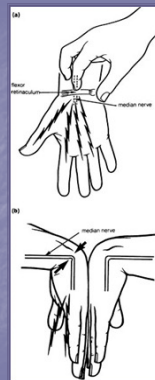


Dijk 2003
Harris-Adamson 2013

Diagnosis

Clinical Criteria (CTS-6)

- Numbness & tingling median n. distribution
- Nocturnal numbness
- Weakness &/or atrophy of thenar m.
- Tinel's sign
- Phalen's test
- Loss of 2 Point discrimination
- Clinical diagnosis is adequate
 - Value added with electrodiagnostic testing is small
 - Many authors suggests if surgery planned to r/o cervical or other problem

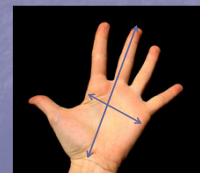


Graham et al,
Bickel

- "Square wrist" = larger wrist ratio = depth/width > 0.70



39.36 mm/54.02 mm
=0.73



- "Short wide hand" = Smaller hand ratio = hand length/palm width

Key references: Chiotis 2013, Mattoli 2009, Nordstrom 1997

Is it work related?



Protective Factors

Decreased risk

Taller stature

Regular physical activity



Key references: Chiotis 2013, Mattoli 2009, Nathan 1993, Eleftheriou 2012

Support for Employee Argument

Occupational Factors: > double risk

Risk Factor

Vibration exposure (power tools, saws)
Forceful exertions of hand/wrist
Repetitive movements of hand/wrist
Non-neutral positions of hand/wrist
Blue collar work: OR: 76.5 meat & fish processing; 11.4 electronic assembly



Key references: You 2014, Barcenila 2012, van Rijen 2009

Promote Wellness

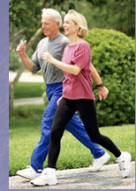
Aerobic Exercise

- Improve circulation to nerve, Prevent adhesions, improves NCV
- Increases neurotransmitter serotonin= known to improve psychological health & pain
- Lose weight/control diabetes

Nathan et al, 2001

Healthy Weight

- Obesity known risk factor
- Control diabetes
- Healthy weight Advantage



Occupational Risk Factors: Conflicting Evidence

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



Reduce Vibration



Both Win!!

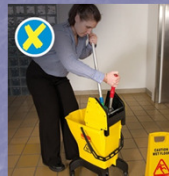
Employee

Employer



Now what can we do about it?

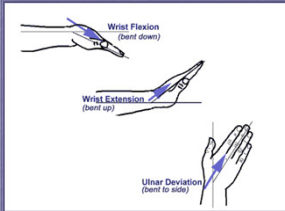
Reduce forceful exertions of hand & wrist



- Reduce force
- Spring loaded
- Sharp scissors and knives
- Bigger & textured handles take less grip force



Eliminate non-neutral wrist

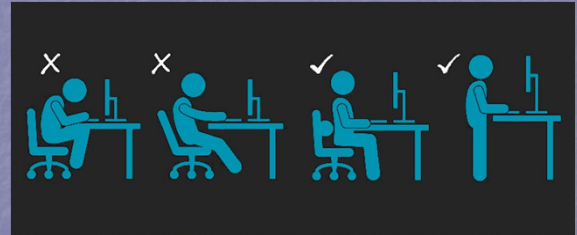


Carpal tunnel pressures increase the further from the neutral wrist position

wrist in 'level' position



Office Ergonomics



Eliminate non-neutral wrist



Bend the tool not the wrist



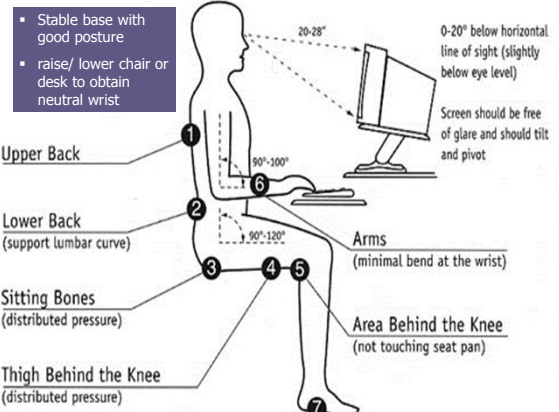
Factors ↑ chance for CTS computer users

- Non-neutral wrist
- More daily hours & more years on the computer
- Keyboard further from edge of the desk



Ali & Sathiyasekaran, 2006
Marcus et al, 2002

Bend the tool not the wrist



One size does NOT fit all



Apple Adjustable

Tittiranonda et al, 1999

- CT & tendonitis pts.
- Compared to regular keyboard
- 6 mos. use

Microsoft Natural
★ best at numbness & pain

Headrest depth 2"

Headrest height 3"

Back height 4"

Back depth 2"

Lumbar Pump

Back Angle

Seat height 16" - 21"

Seat angle

360 degree arm swivel

Arm height 7-11"

Arm width 9"

Tilt lock

Seat tension

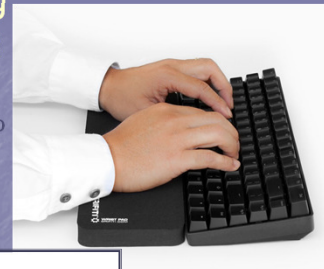
Adjustable

- Chair
- Work surfaces

<http://www.officeorganix.com/bodyb1.htm>

Keyboarding Techniques

- Relaxed fingers
- Minimum pressure to depress keys
- Use wrist rest only at rest



Split keyboard-necessary?



Effects of obesity on wrist position

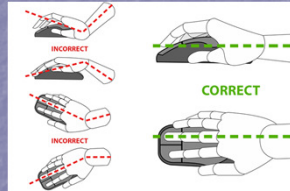
Special Mouse?



Not enough evidence to support or refute; all increase CT pressure

Mouse techniques

- Wrist neutral
- Use whole arm
- No reaching
- No squeezing
- Don't hold finger up



Effectiveness of Ergonomics Program Honeywell-Torrance, CA

- Eliminated or modified highest risk tasks
- Cost of program: \$355,000 (equipment & fees)
- Results:
 - ↑ employee satisfaction & productivity
 - ↓ Worker's comp & labor cost
- Return on investment 1,675%

Source: Wade C.
Applied Biomechanics
& Ergonomics, Inc.

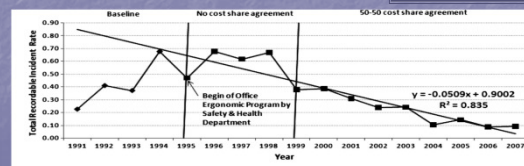
Ergonomic Assessment



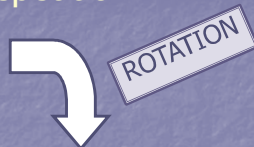
Purdue Office Ergonomics Program

- Consisted of:
 - educational website for staff on workstation set up & postures
 - on-site ergonomic assessment & equipment changes
- Significant decrease in overall CTD incidence rate (63%)
- 50% decrease in CTS
- Lower WC claims paid
- Fewer lost work days

Bidasse et al, 2010



Minimize Repetition



Let's stretch



Seradge Stretches

1. Stand with arms relaxed at your side.
2. Lift right arm out to the side, to shoulder level, palm of hand facing up. Spread fingers and hand over until fingers rest on the floor.
3. Bring fingers and wrist up, forming angle of 90 degrees.
4. Bend elbow pulling the forearm towards the shoulder.
5. Relax arm over shoulder side, arm still bent and in the hand. Then bend elbow 90 degrees.
6. Straighten elbow and fingers. Bend wrist, pulling fingers over the back. Hand is bent at wrist opposite shoulder (Repeat 1-6 with left arm).

Steps 7-13 • Both Arms

7. Bring both arms up to shoulder level, and push back of wrist together. Fingers pointing down towards the floor. Full shoulder back.
8. Bring hands up into a power position and push palms with shoulder toward.
9. Keeping palms together, move hands down over head.
10. Bring hands back behind your head, pulling shoulder back.
11. Bend both arms out to the side, to shoulder level, holding wrist down and fingers at a 90 degree angle.
12. Straighten fingers, bring arms down by your side and then back behind you. Move hands up. Wrist is down up.
13. Relax arms by your side with elbow over your hands.

Seradge: Prospective study meat packing
Full set before & after work, 1/2 set during breaks (2x)
↓ 45 % carpal tunnel syndrome

Orthotics (splints)

Piazzini et al, 2007
O'Connor et al, 2009
Systematic Reviews

- Goal: keep wrist in neutral
- Full time wear no better than night alone

Light provided for CTS

1. Describe the pathophysiology & diagnosis
2. Identify the most likely risk factors
3. Highlight prevention techniques
4. **Conservative management**
5. When is surgery necessary?
6. When is therapy needed after surgery?
7. Prognosis for recovery and return to work

Therapy Modalities

Heat

- ✓ Heat wraps, paraffin
- ✓ Effective for short term pain relief

Michlovitz 2004
Chang 2014
Bakhtary 2013

Ultrasound

- ✓ Uses pulsed sound waves to improve circulation, decrease pain, promote nerve regeneration
- ✓ Can add dexamethasone to gel (decrease edema, thin tissue)
- ✓ 6 treatments

Non-operative Treatment Options for CTS

- Therapy Management
 - Orthotics
 - Modalities
 - Exercise
 - Education
- Hand Surgeon
 - Steroid injection

Interferential Electrical Current

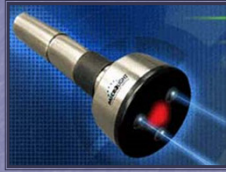
- Better than TENS & wrist splint in ↓ sx & improving NCV
- Frequency 4000 Hz, modulation of 20 Hz
- 15, 20 min treatments

Koca 2014

Other Treatments

■ Laser: conflicting evidence

(Tascioglu 2012, Chang 2008, Ekim 2007)



■ Magnets: ineffective

(Colbert 2010)



Predicting success with Conservative Rx

- 93 % fail if 3 or more following:
 - > 50 y.o.
 - Sx present > 10 mos.
 - Constant paresthesias
 - Trigger finger
 - Phalens + less 10 sec.
- Discuss surgery with pt. if atrophy
- Boston Carpal Tunnel Sx Score
 - If less than 2.5 out of 5 will likely succeed with conservative

Kaplan et al, 1990
Olivere et al, 2007

Treatment: Education

■ Modifiable risk factors

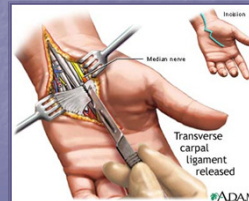
- Lose weight
- Neutral wrist
- Computer set-up
- Eliminate vibration

■ Exercises

- Stretching (Seradge/Yoga)
- Core & Scapular strengthening
- Aerobic exercise



Treatment Options for CTS Hand Surgeon



- Steroid injection
- Surgery

Effectiveness: Conservative vs. Surgery

(Jarvik et al, 2009; multicenter RCT)

■ Therapy

- ligament stretching
- tendon gliding exercise
- splint use
- work modification
- US offered if not improved
- 79% had at least one visit

■ Surgery stat. better in sx & function at 1 yr

- Clinical difference marginal
- 61% conservative avoided surgery

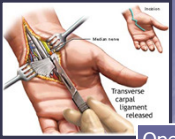

Success of steroid injections



- Better than placebo at 1 month
- Results are not maintained long term
- No better than splints + NSAIDs at 8 weeks

Huisstede et al, 2010
Systematic review

Surgery

Open

Endoscopic

- Release of transverse carpal ligament
 - Increases space in CT
 - Improves blood flow
- Open vs. Endoscopic: results same
 - patient satisfaction, Boston CT Sx score
 - grip & pinch strength
 - Sensation return
- Endoscopic
 - Less scar pain short term
 - Earlier return to work
 - Increased chance of nerve injury (usually reversible)

Systematic Reviews
 Zuo et al, 2015
 Sayegh & Starch, 2015
 Hu et al, 2016

Indications for therapy f/u

- High Boston Carpal Tunnel score at 2 weeks post*
- Excessive hypersensitivity/pain
- Significant edema—leads more scar & stiffness
- Inability to make a full fist within 2 weeks
- Inability to RTW within 1 month
- Heavy or highly repetitive job

*Mallick et al, 2007

Complications (most common)



- Scar pain & hypersensitivity to touch
- Laceration of palmar cutaneous branch of the median nerve
- Tendons stuck in scar
- "Pillar Pain"
 - Pain in thenar or hypothenar eminence
 - Nerve regeneration into the muscle
 - Surgery changes muscle position; soreness from trying to overcome new configuration
 - Adhesion of nerve/tendons/scar

Post-op Therapy: Exercises

Median nerve gliding



Tendon gliding



Post-operative Therapy

Research

- Not routinely needed¹
- Those who received therapy
 - No difference in Boston CT scores
 - Quicker recovery?
 - Returned to work 10 days sooner (32 vs. 42 days)³

Pomerance & Fine¹
 Turner et al²
 Provinciali et al³
 Cebesoy et al⁴

Home Program

- Wound care
- Edema control
- Massage
- Nerve and tendon glides
- Immobilization & splints not needed
 - Those that wore bulky dressing and started motion immediately do better¹

Post Operative Therapy

- Edema control
 - Retrograde massage (CPT 97124)
 - Compression wrap/isotoner glove
 - Contrast baths
- Paraffin with stretch (CPT 97018)




Desensitization

Neuromuscular Re-education; CPT 97112

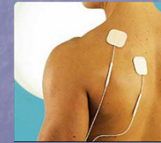


- Vibration
- Texture rubs/immersion
- Fluidotherapy (CPT 97022)



Pillar Pain/nerve pain

- Ultrasound (CPT 97035)
- Transcutaneous Electrical Nerve Stimulation (TENS; CPT 64550)
 - Effective in multiple studies in treating nerve pain



Scar Management



Massage
(CPT 97124)



Myofascial Release
(CPT 97140)

- ✓ Decrease hypersensitivity
- ✓ Stretch fascial adhesions limiting nerve glide
- ✓ Soft tissue elongation

Therapeutic Exercise

Thenar muscle strengthening



Grip strengthening
(4 wks post op)

Scar Management

Silicone Gel (A6025)

- Pad tender area
- Smooth scar



Gel Shell Splint



Return to work

depends on:

- Physician preference
- Type of job
 - No forceful gripping for 3-4 weeks
- Healing potential
 - Older, diabetic, smoker take longer
 - Inflammatory phase of healing: 4-7 days
 - More bleeding-more scar

Less likely to RTW if:

Work Factors

- Greater time off work^{2,3}
- Short duration working^{2,5}
- Poor supervisor, dislike job¹
- Higher job stress⁶
- No available modified work: 2x less likely⁷

Politin et al¹, Gallagher et al², Hildebrandt et al³,
Beissner et al⁴, Lancourt & Kettlehut⁵, Feuerstein
et al⁶, Bonzani⁷

Work Conditioning

(CPT 97545 initial 2hrs; 97546 add'l hrs)

- UE chronic pain: 34% greater RTW¹
- Minimum: 3 days wk; 3-4 wks
- Key feature: Job simulation



Feuerstein et al¹

Less likely to RTW if:

Psychological Factors

- Depressed: Beck > 16, 84-86% not RTW^{1,2}
- High hysteria^{3,4}
- Pessimistic in recovery expectations: 30% less likely⁵
- Doubt about RTW: 67% not RTW⁶

Ash et al¹, Politin et al², Millhous
et al³, Gallagher et al⁴, Cole et
al⁵, Hildebrandt et al⁶

Recovery following CTR



- 70-90% good-excellent outcomes

Kronlage, 2015
Turner, 2010

Less likely to RTW if:

Other Factors

- Disabled family member¹⁵
- Attorney representation: (58% vs. 35%)¹³, (73% vs. 32%)¹⁴

Beissner et al⁷, Stutts & Kasden¹⁵,
Peterson¹³

Predictors of Poor Outcomes

Physical

- Muscle wasting
- NCV normal pre-op
- Fragile health
- Alcohol consumption (> 2 drinks per day)
- Smoking
- Co-morbid condition
 - Diabetes: 26 %
 - Thoracic Outlet: 80 %
 - Cervical: 27 %

Other

- Worker's compensation
 - 38-53% poor outcomes
 - Slower return to work
- Attorney representation

Light at the end of the Talk & Carpal Tunnel

Prevention
Benefits Of Therapy
When Surgery Needed
Outcomes

