Contemporary management of peripheral entrapment neuropathies

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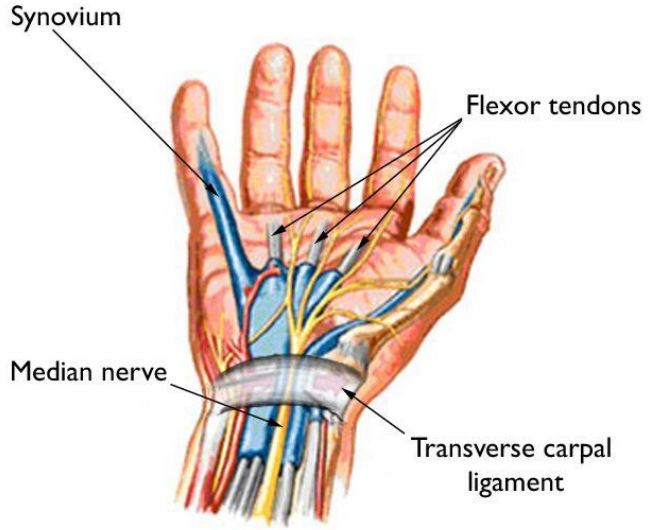
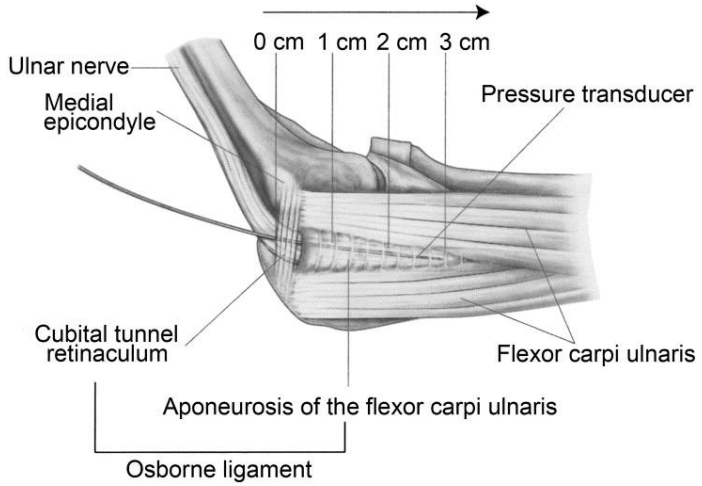
What are peripheral entrapment neuropathies

- **Pressure-induced injury to a peripheral nerve**
- **Compression and/or irritation as they travel through narrow anatomical spaces**
- **The most common entrapment neuropathy is carpal tunnel syndrome (CTS) with a lifetime risk of 10%**
- **Other common entrapment neuropathies include cubital tunnel syndrome and Morton's neuroma**





(Toussaint et al., 2010)

Symptoms of peripheral neuropathies

Loss of function:

- Numbness, loss of sensation
- Weakness, motor deficits
- Reduced reflex

Gain of function:

- Dysesthesia - “Tingling”, “Pins and needles”, “burning”, “stinging”
- Nerve trunk pain –deep aching, cramping
- Radiating pain – “sharp”, “shooting”
- Aggravated by positions that irritates the nerve (e.g. tension / pressure)

(Nee & Butler, 2006)

Outcomes of peripheral neuropathies

INTERVENTIONS – ASSISTIVE TECHNOLOGY

C Clinicians may educate their patients regarding the effects of mouse use on carpal tunnel pressure and assist patients in developing alternate strategies, including the use of arrow keys, touch screens, or alternating the mouse hand. Clinicians may recommend keyboards with reduced strike force for patients with CTS who report pain with keyboard use.

INTERVENTIONS – ORTHOSES

B Clinicians should recommend a neutral-positioned wrist orthosis worn at night for short-term symptom relief and functional improvement for individuals with CTS seeking nonsurgical management.

C Clinicians may suggest adjusting wear time to include daytime, symptomatic, or full-time use when night-only use is ineffective at controlling symptoms in individuals with mild to moderate CTS. Clinicians may also add metacarpophalangeal joint immobilization or modify the wrist joint position for individuals with CTS who fail to experience relief. Clinicians may add patient education on pathology, risk identification, symptom self-management, and postures/activities that aggravate symptoms.

C Clinicians should recommend an orthosis for women experiencing CTS during pregnancy and should provide a postpartum follow-up evaluation to examine the resolution of symptoms.

INTERVENTIONS – BIOPHYSICAL AGENTS

C Clinicians may recommend a trial of superficial heat for short-term symptom relief for individuals with CTS.

C Clinicians may recommend the application of microwave or shortwave diathermy for short-term pain and symptom relief for patients with mild to moderate idiopathic CTS.

C Clinicians may offer a trial of interferential current for short-term pain symptom relief in adults without pacemakers with idiopathic, mild to moderate CTS. As with all electrical modalities, contraindications should be taken into consideration before choosing this intervention.

B Clinicians should **not** use low-level laser therapy or other types of nonlaser light therapy for individuals with CTS.

C Clinicians should **not** use thermal ultrasound in the treatment of patients with mild to moderate CTS.

D There is conflicting evidence on the use of nonthermal ultrasound in the treatment of patients with mild to moderate CTS, and therefore no recommendation can be made.

B Clinicians should **not** use iontophoresis in the management of mild to moderate CTS.

C Clinicians may perform phonophoresis within nonsurgical management of patients with mild to moderate CTS for the treatment of clinical signs and symptoms.

B Clinicians should **not** use or recommend the use of magnets in the intervention for individuals with CTS.

INTERVENTIONS – MANUAL THERAPY TECHNIQUES

C Clinicians may perform manual therapy, directed at the cervical spine and upper extremity, for individuals with mild to moderate CTS in the short term.

D There is conflicting evidence on the use of neurodynamic mobilizations in the management of mild to moderate CTS.

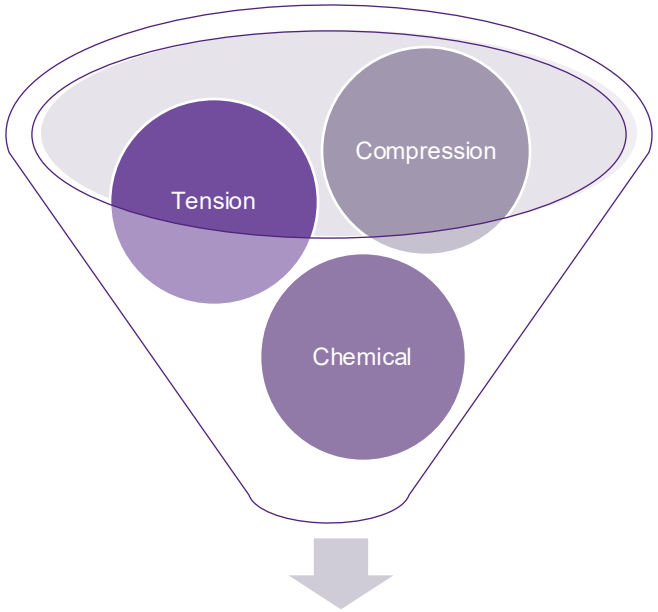
INTERVENTIONS – THERAPEUTIC EXERCISE

C Clinicians may use a combined orthotic/stretching program in individuals with mild to moderate CTS who do not have thenar atrophy and have normal 2-point discrimination. Clinicians should monitor those undergoing treatment for clinically significant improvement.

*These recommendations and clinical practice guidelines are based on the scientific literature accepted for publication prior to November 2018.

(Erickson et al., 2019)

Physical stresses on nerves



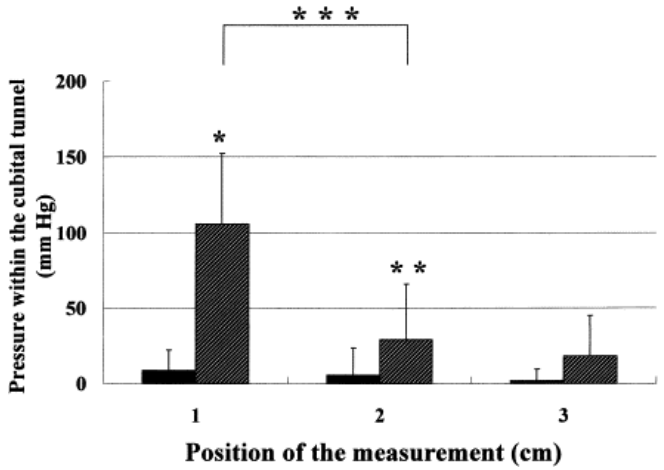
Compromised intraneural circulation and inflammatory response

Table II. Mean carpal tunnel pressure ± s.e.m. (range) in various wrist positions in two series of patients with carpal tunnel syndrome

	Mean pressure in mmHg		
Position of wrist	Gelberman et al 1981 (n = 15)	Rojviroj et al 1990 (n = 61)	Normal (n = 32)
Neutral	32 ± 0.98 (2 to 50)	11.87 ± 1.53 (1.5 to 62.2)	3.48 ± 0.43
90° palmarflexion	94 ± 5.18 (20 to 250)	26.60 ± 2.56 (5 to 81.8)	9.32 ± 1.06
90° dorsiflexion	110 ± 5.68 (15 to 250)	32.78 ± 3.21 (4 to 111.2)	12.68 ± 1.16

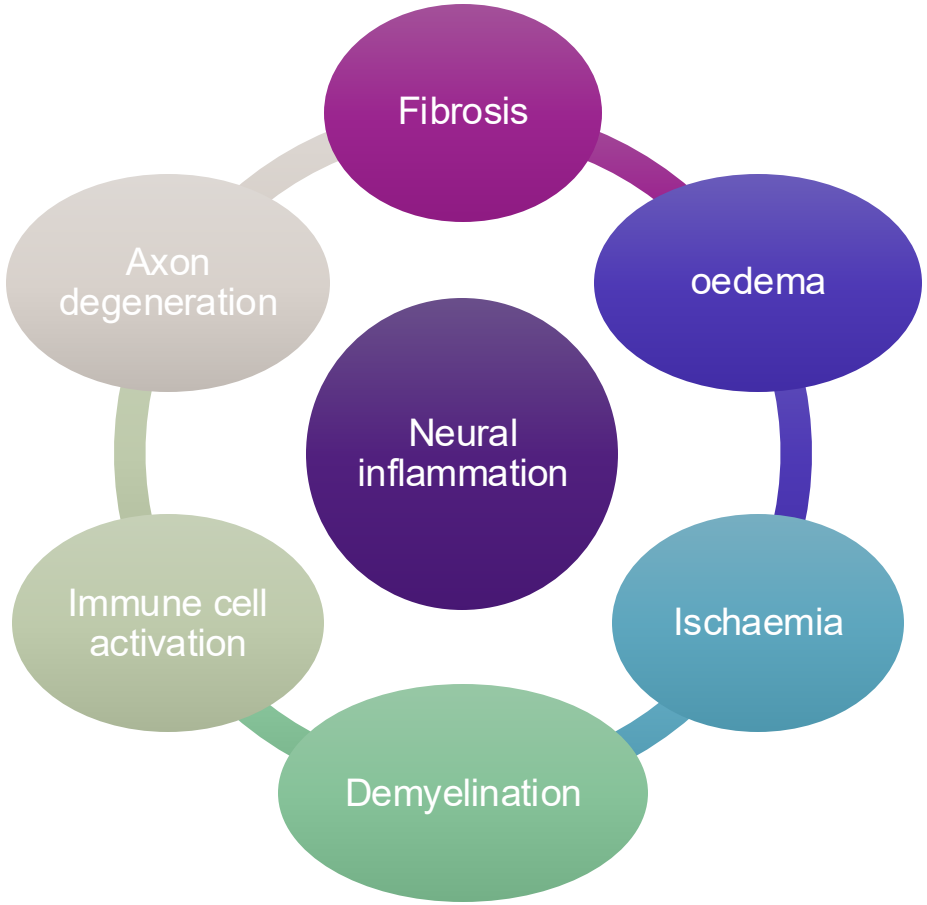
Increased carpal tunnel pressure at wrist end range motion (Rojviroj et al., 1990)

- **Significantly elevated in CTS patients**
- **Reduced intraneural blood flow on prolonged compression**



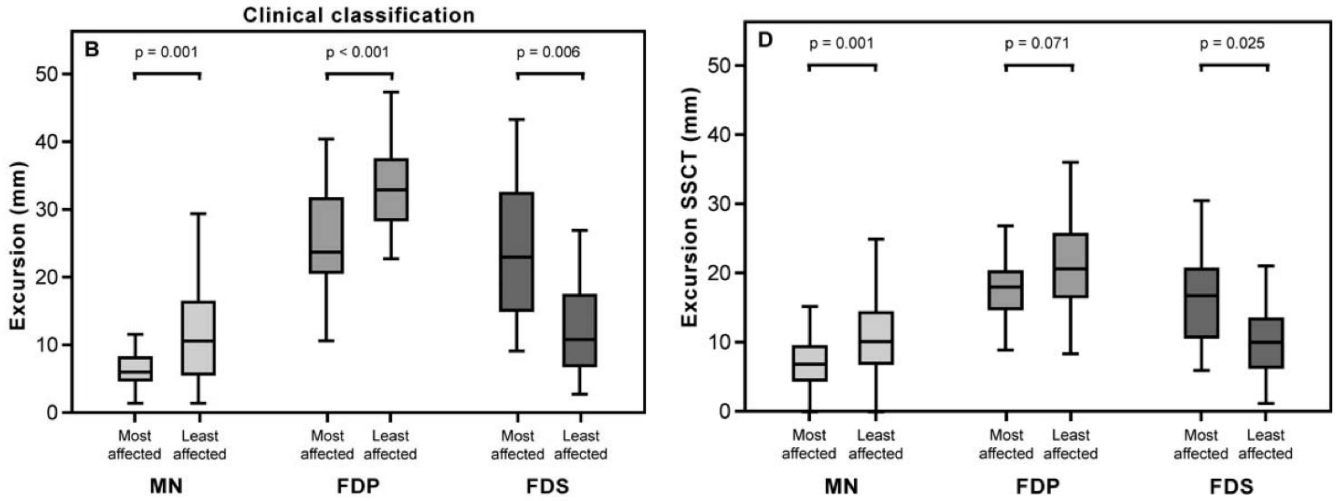
- **Increased extraneural pressure in elbow flexed (▨) position in cubital tunnel patients** (Iba et al., 2006)
- **Increased ulnar nerve strain in elbow flexion** (Wright et al., 2001)
- **Combined compression and elongation of the ulnar nerve tractions the nerve at the elbow**

What happens when a nerve gets irritated



(Schmid et al., 2020)

Reduced median nerve excursion in patients with more severe CTS compared to mild CTS



(Korstanje et al., 2012)

What are the treatment options?

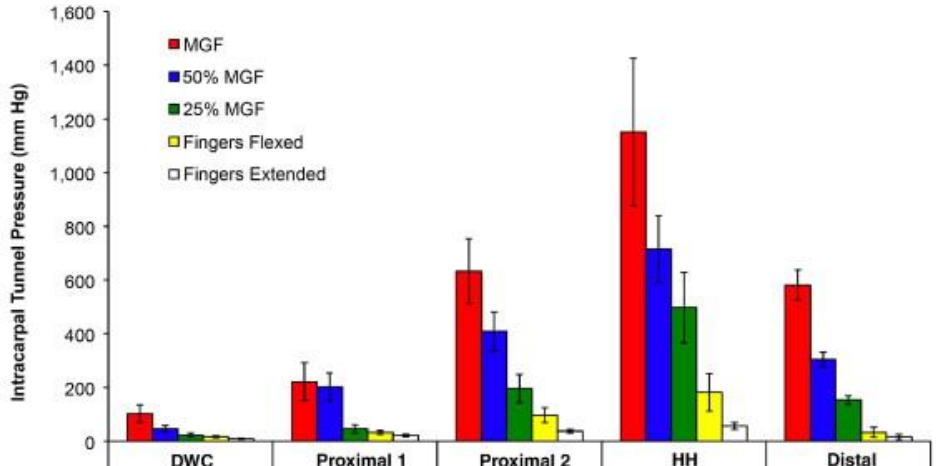
Unloading the nerve: Rest and relieve

Posture and ergonomics

Orthotics

Activity, posture and ergonomics

Increased carpal tunnel pressure in gripping



	DWC	Proximal 1	Proximal 2	HH	Distal
MGF	* 102 (-13-254)	* 221 (23-737)	# * 633 (39-1203)	# 1,151 (149-2500)	# * 582 (434-793)
50% MGF	* 46 (-13-121)	* 202 (-14-656)	# 409 (25-785)	# 715 (85-1436)	* 305 (176-471)
25% MGF	* 23 (-11-64)	46 (-12-102)	196 (6-417)	# 497 (64-1197)	153 (97-222)
Fingers Flexed	* 17 (3-38)	* 33 (-2-82)	97 (-10-367)	182 (10-875)	* 33 (-39-210)
Fingers Extended	9 (-1-19)	22 (1-56)	37 (1-72)	56 (10-184)	17 (-4-130)

Proximal-to-Distal Location

(Goss & Agee, 2010)

Increased carpal tunnel pressure when typing with an extended wrist

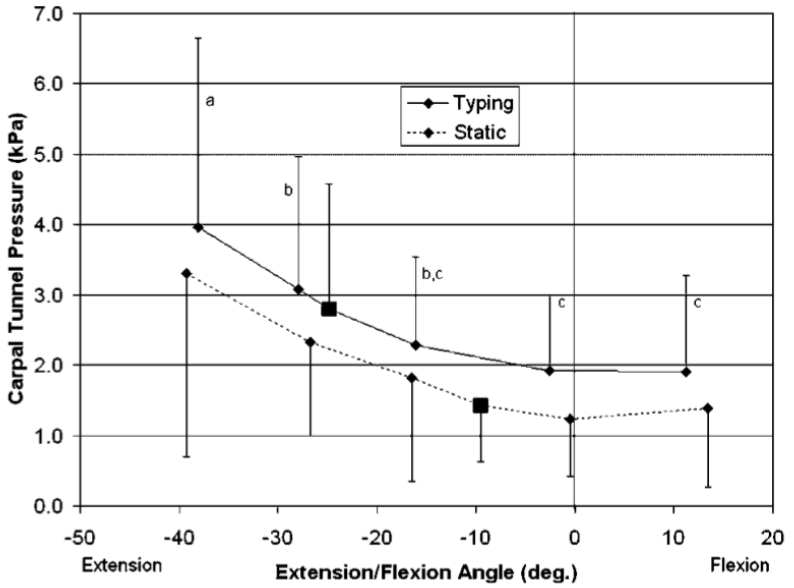


Figure 2. Mean carpal tunnel pressure versus mean right wrist flexion/extension angle ($N = 20$). Values represent means $\pm$ SD. Typing pressure values with a common superscript letter were not significantly different from each other. Values for the conventional keyboard are labeled as -■- and were not included in the analysis.

(Rempel et al., 2008)

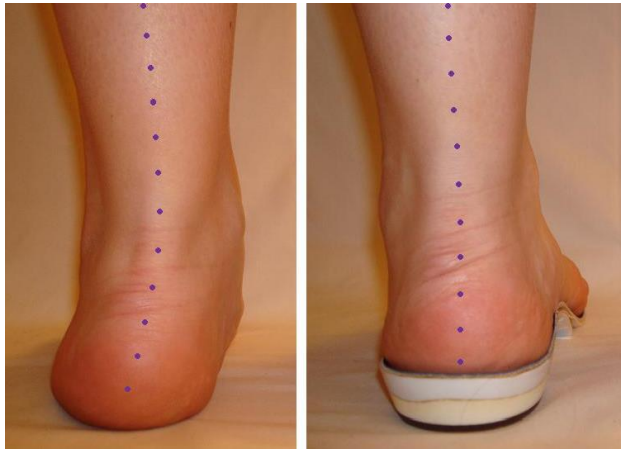
Orthotics

Reduce pressure and inflammation on the nerve:

- **Immobilize in the position of least internal pressure**
- **Reduce tendon and nerve movement through the tunnel**
- **Reduce the contents of the tunnel**

Elbow brace for cubital tunnel syndrome

Wrist splint for carpal tunnel syndrome



Arch support for Tarsal tunnel syndrome

Insoles with metatarsal pad for Morton's neuroma

(Lawrence & Erickson, 2021; Porretto-Loehrke & Soika, 2021)

Evidence for orthotics

Reduction in median nerve intraneural edema in CTS patients compared to no treatment

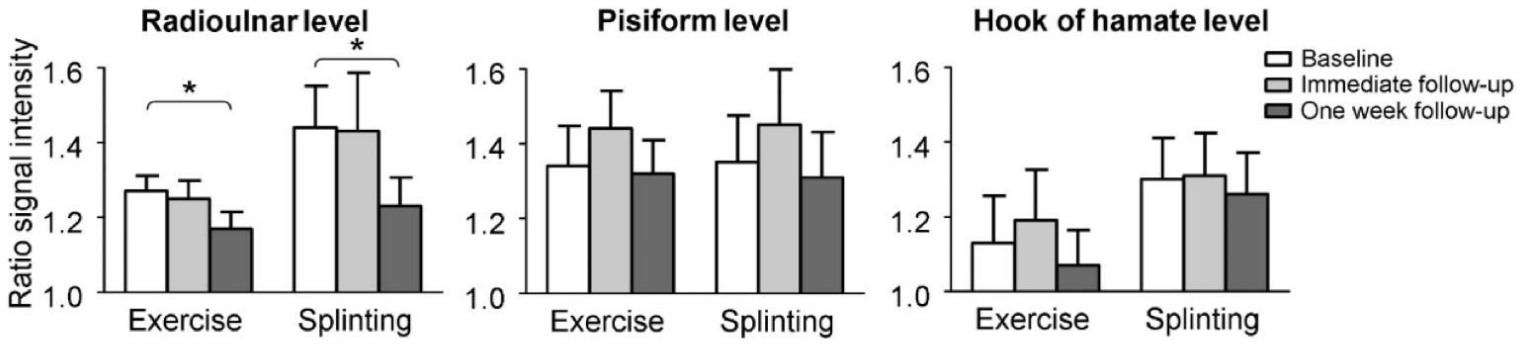


Figure 3. Signal intensity ratio of the median nerve over time at the level of the radioulnar joint, the pisiform and the hook of hamate. *Indicates statistical significance between baseline and 1-week follow-up measures ($p < 0.03$). The error bars represent the standard error of the mean.

(Schmid et al., 2012)

Limited evidence supporting the efficacy of splinting in carpal tunnel and cubital tunnel syndromes

- **Some evidence supporting carpal tunnel splint is more effective than no treatment in the short term** (Figueiredo et al., 2024; Page et al., 2012)
- **Insufficient evidence to determine efficacy of cubital tunnel splint due to high risk of bias** (Bateman et al., 2025)

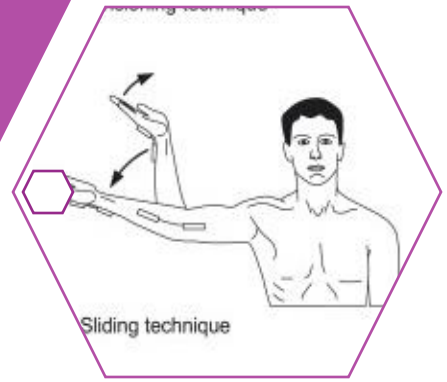
Relatively inexpensive with no side effects, small benefits may justify its use in conservative management

Addressing Neurodynamics

Interface mobilisation

"Sliders"

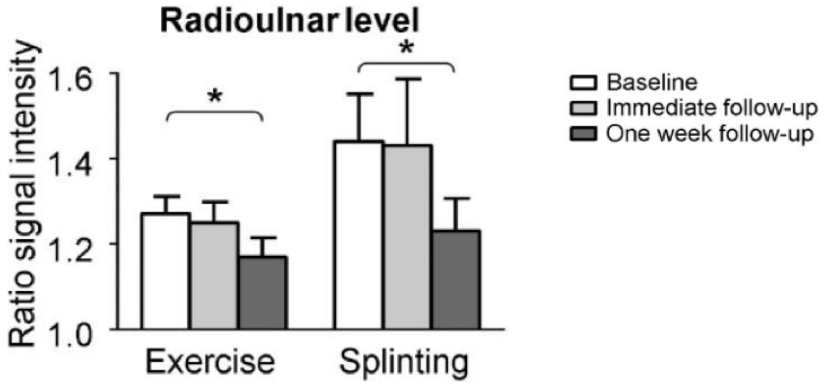
"Tensioners"



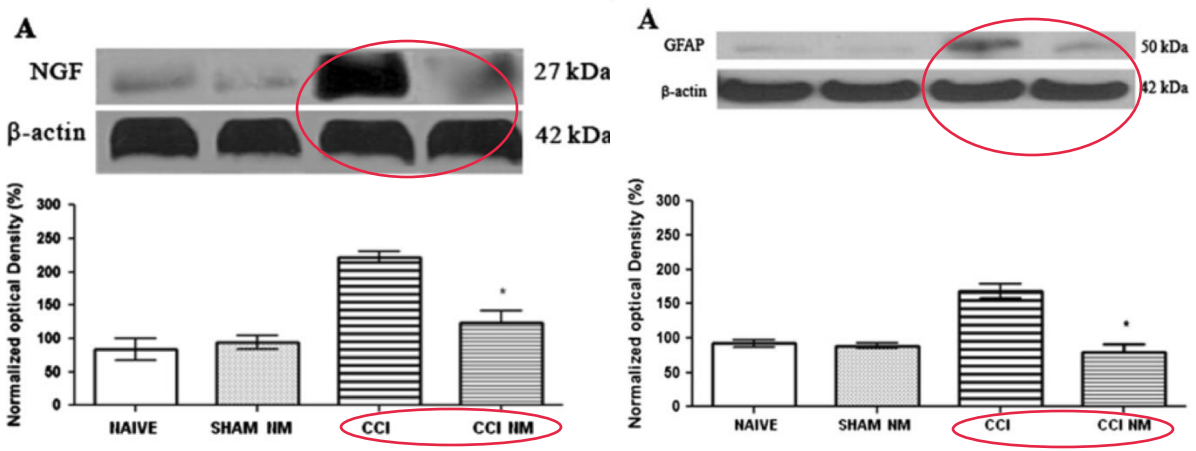
Mechanisms of neural mobilisation

- Normalise impaired nerve movement
- Facilitate descending pain modulation
- Reducing intraneural and extraneural oedema
- Dispersing inflammatory markers
- Influence neuro-immune response

(Coppieters & Nee, 2015)



Reduced intraneural oedema in CTS patients after 1-week nerve and tendon gliding exercise program (Schmid et al., 2012)

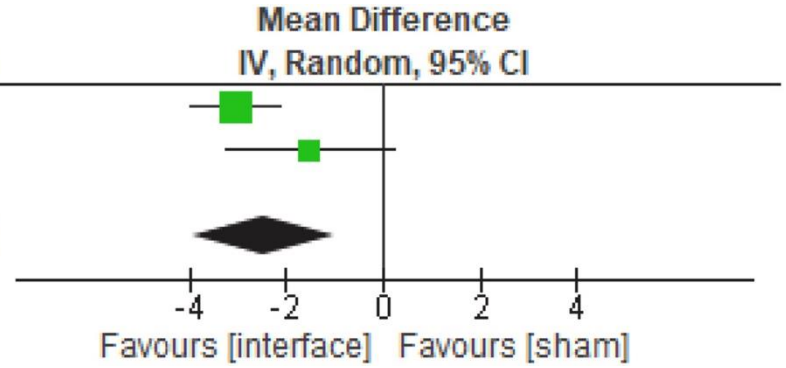


Reduced nerve growth factors and glial cell activation after neuro mobilization (Santos et al., 2013)

Efficacy of interface treatment

Study or Subgroup	interface treat Mean	SD	Total	sham/placebo Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Jimenez del Barrio 2018	0.42	0.82	36	3.48	2.67	36	61.8%	-3.06 [-3.97, -2.15]
Shem 2020	2.7	2.31	19	4.21	2.92	17	38.2%	-1.51 [-3.24, 0.22]
Total (95% CI)			**55**			**53**	**100.0%**	**-2.47 [-3.94, -0.99]**

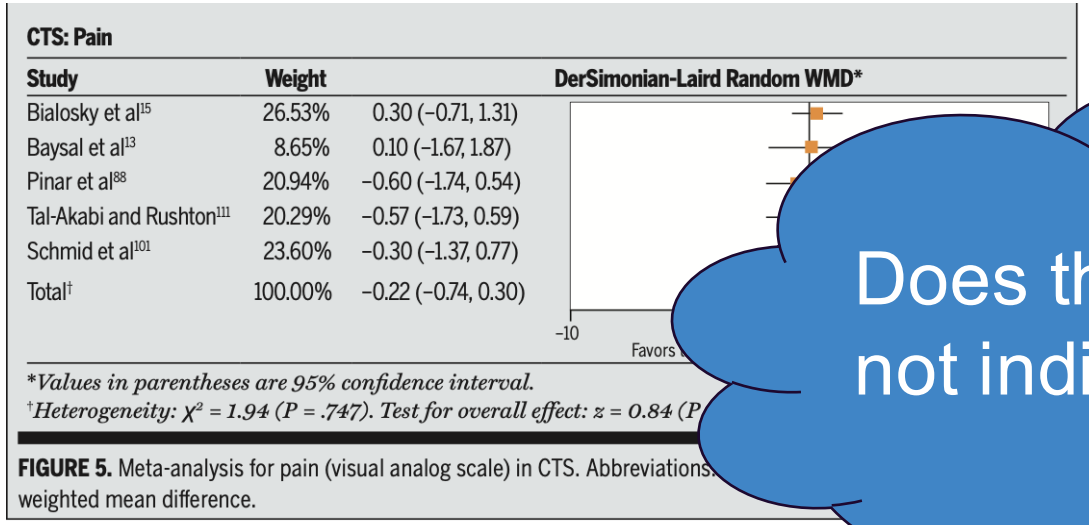
Heterogeneity: Tau² = 0.70; Chi² = 2.40, df = 1 (P = 0.12); I² = 58%
Test for overall effect: Z = 3.28 (P = 0.001)



- **More often used in treatment for spinal radiculopathies**
- **Less commonly used in peripheral entrapment neuropathies**
- **Wide range of manual techniques used as "interface treatment" in studies on peripheral neuropathies**
- **Effective compared to sham, similar efficacy compared to other neural mobilization**
- **"Open the container" and "Create space" for the nerve to move**

(Iogna Prat et al., 2024)

Nerve mobilization efficacy



CTS: Pain

Study	Weight	DerSimonian-Laird Random WMD*
Bialosky et al[15]	26.53%	0.30 (−0.71, 1.31)
Baysal et al[13]	8.65%	0.10 (−1.67, 1.87)
Pinar et al[88]	20.94%	−0.60 (−1.74, 0.54)
Tal-Akabi and Rushton[111]	20.29%	−0.57 (−1.73, 0.59)
Schmid et al[101]	23.60%	−0.30 (−1.37, 0.77)
Total†	100.00%	−0.22 (−0.74, 0.30)

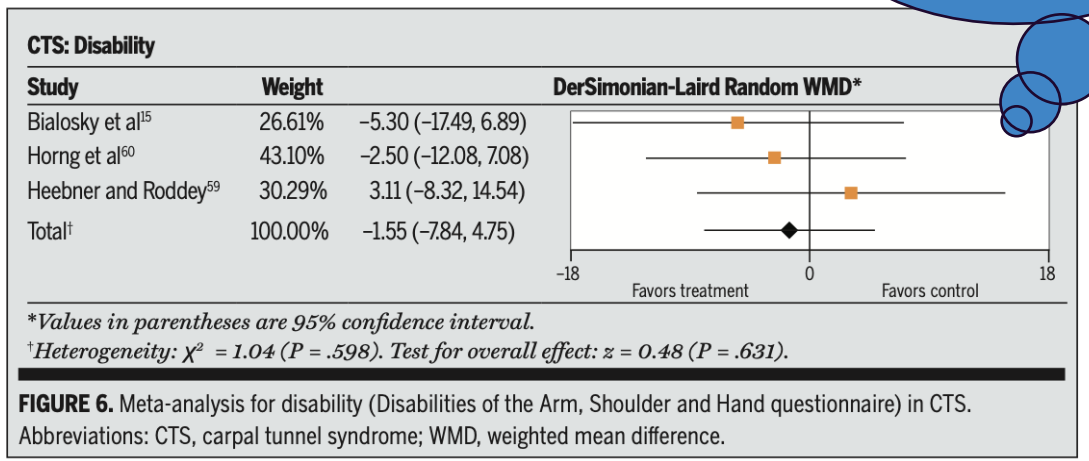
−10

Favors

*Values in parentheses are 95% confidence interval.

†Heterogeneity: χ^2 = 1.94 (P = .747). Test for overall effect: z = 0.84 (P

FIGURE 5. Meta-analysis for pain (visual analog scale) in CTS. Abbreviations: weighted mean difference.



CTS: Disability

Study	Weight	DerSimonian-Laird Random WMD*
Bialosky et al[15]	26.61%	−5.30 (−17.49, 6.89)
Horng et al[60]	43.10%	−2.50 (−12.08, 7.08)
Heebner and Roddey[59]	30.29%	3.11 (−8.32, 14.54)
Total†	100.00%	−1.55 (−7.84, 4.75)

−18 0 18

Favors treatment Favors control

*Values in parentheses are 95% confidence interval.

†Heterogeneity: χ^2 = 1.04 (P = .598). Test for overall effect: z = 0.48 (P = .631).

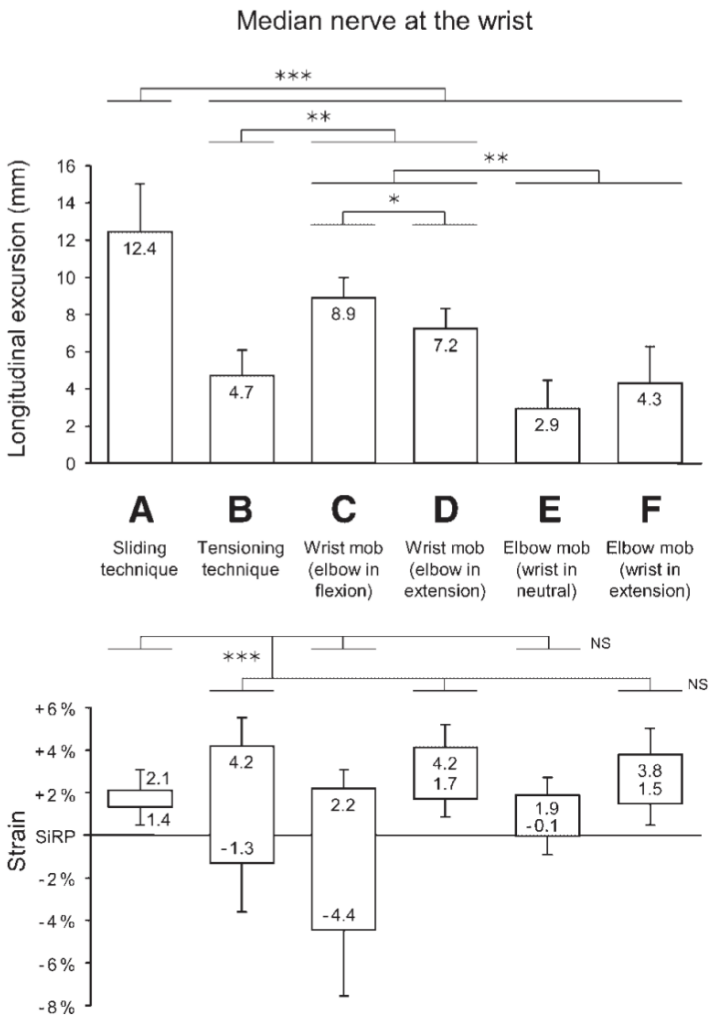
FIGURE 6. Meta-analysis for disability (Disabilities of the Arm, Shoulder and Hand questionnaire) in CTS. Abbreviations: CTS, carpal tunnel syndrome; WMD, weighted mean difference.

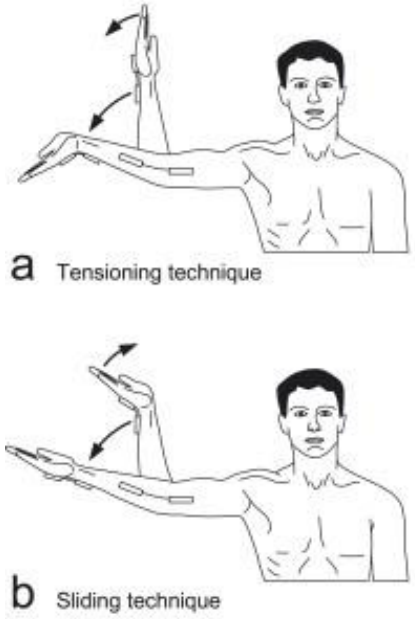
Does that mean it is not indicated?

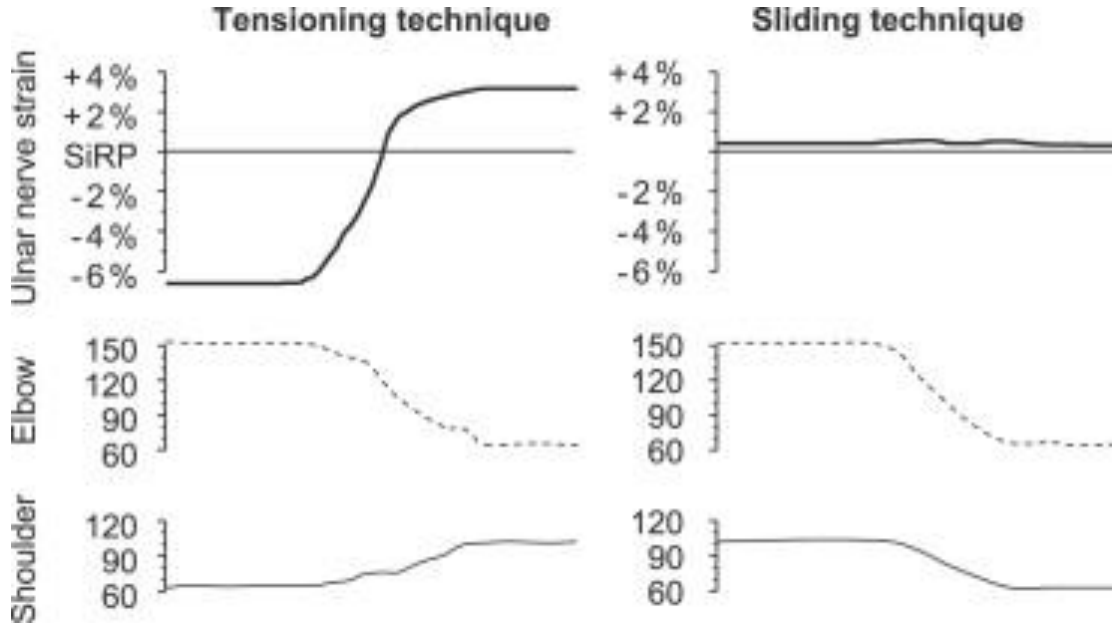
- **Systematic review on neural**
- **eck pain, not**
- **ther entrapment**
- **scarcity of**
- **hrane review on exercise for CTS:**
  - **Neurodynamic treatment was better than no treatment but not superior to other interventions**
  - **No added improvements when combined with other intervention.**

(Basson et al., 2017; Page et al., 2012)

Sliding vs tensioning



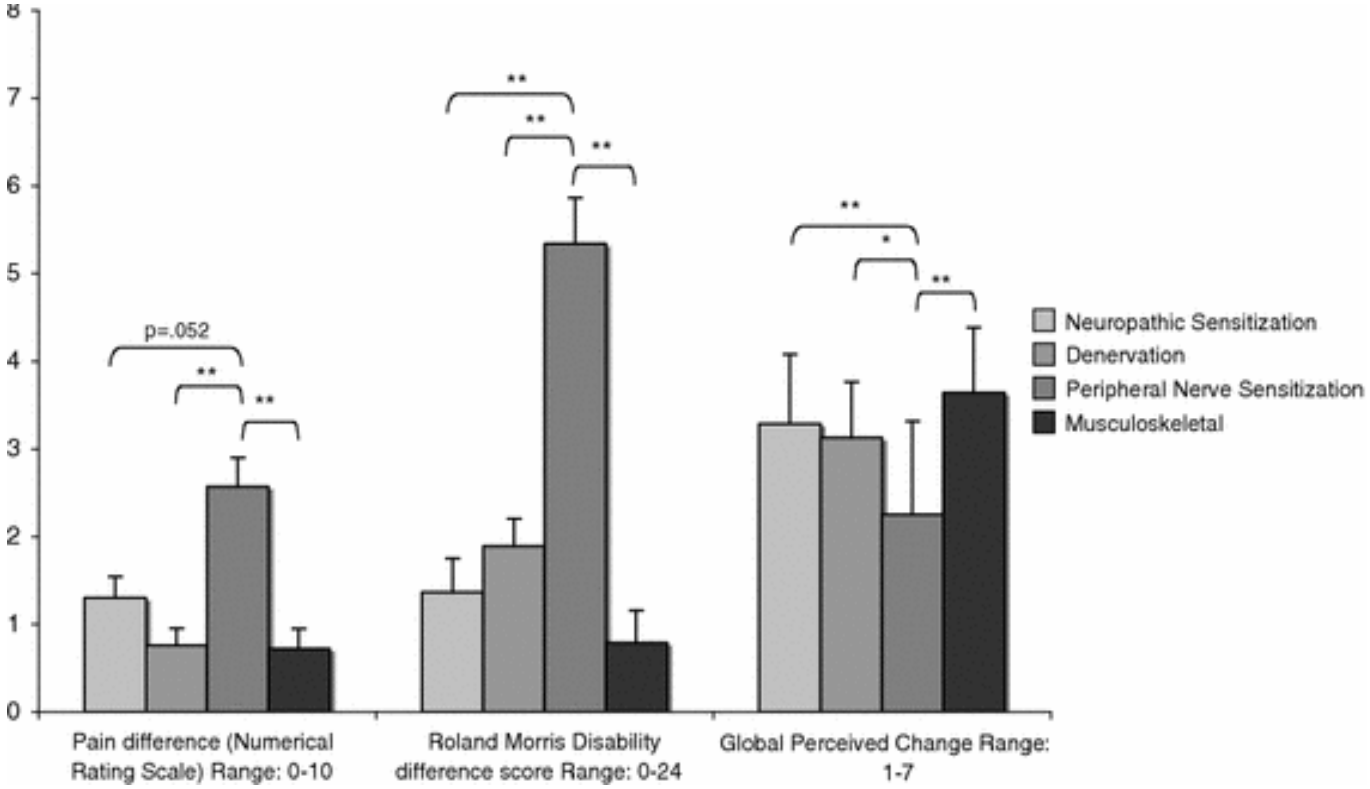




- **Increased nerve strain in median and ulnar nerve tensioners**
- **Sliders result in increased excursion with less strain**

(Coppieters & Alshami, 2007; Coppieters & Butler, 2008)

Who might benefit more from neurodynamic intervention?



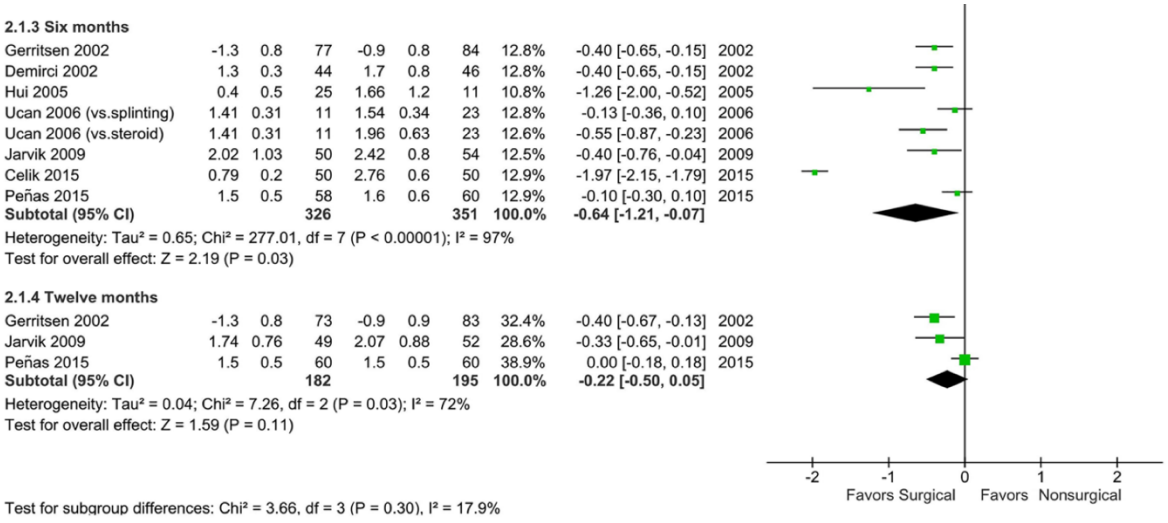
Peripheral nerve sensitization:

- **Increased nerve mechanosensitivity**
- **No neurological deficits**
- **Absence of neuropathic pain features**

(Schäfer et al., 2011)

Surgery?

- **Studies favor slightly better results in mid to long term for CTS**
- **Surgery also associated with higher complications rates**
- **Decision for surgical opinion based on symptoms severity and response to conservative management**



2.1.3 Six months									
Gerritsen 2002	-1.3	0.8	77	-0.9	0.8	84	12.8%	-0.40 [-0.65, -0.15]	2002
Demirci 2002	1.3	0.3	44	1.7	0.8	46	12.8%	-0.40 [-0.65, -0.15]	2002
Hui 2005	0.4	0.5	25	1.66	1.2	11	10.8%	-1.26 [-2.00, -0.52]	2005
Ucan 2006 (vs.splinting)	1.41	0.31	11	1.54	0.34	23	12.8%	-0.13 [-0.36, 0.10]	2006
Ucan 2006 (vs.steroid)	1.41	0.31	11	1.96	0.63	23	12.6%	-0.55 [-0.87, -0.23]	2006
Jarvik 2009	2.02	1.03	50	2.42	0.8	54	12.5%	-0.40 [-0.76, -0.04]	2009
Celik 2015	0.79	0.2	50	2.76	0.6	50	12.9%	-1.97 [-2.15, -1.79]	2015
Peñas 2015	1.5	0.5	58	1.6	0.6	60	12.9%	-0.10 [-0.30, 0.10]	2015
Subtotal (95% CI)			**326**			**351**	**100.0%**	**-0.64 [-1.21, -0.07]**	
Heterogeneity: Tau² = 0.65; Chi² = 277.01, df = 7 (P < 0.00001); I² = 97%									
Test for overall effect: Z = 2.19 (P = 0.03)									
2.1.4 Twelve months									
Gerritsen 2002	-1.3	0.8	73	-0.9	0.9	83	32.4%	-0.40 [-0.67, -0.13]	2002
Jarvik 2009	1.74	0.76	49	2.07	0.88	52	28.6%	-0.33 [-0.65, -0.01]	2009
Peñas 2015	1.5	0.5	60	1.5	0.5	60	38.9%	0.00 [-0.18, 0.18]	2015
Subtotal (95% CI)			**182**			**195**	**100.0%**	**-0.22 [-0.50, 0.05]**	
Heterogeneity: Tau² = 0.04; Chi² = 7.26, df = 2 (P = 0.03); I² = 72%									
Test for overall effect: Z = 1.59 (P = 0.11)									
Test for subgroup differences: Chi² = 3.66, df = 3 (P = 0.30), I² = 17.9%									

Surgery vs non-surgery for self-reported symptom severity in CTS (Shi et al., 2020)

Table Severity and duration of CTS and suitable treatment options

Severity and duration of CTS are the main factors when deciding on the type of treatment. Both severity and duration were divided into five subgroups. For each subgroup of patients the suitable treatment options are indicated below:

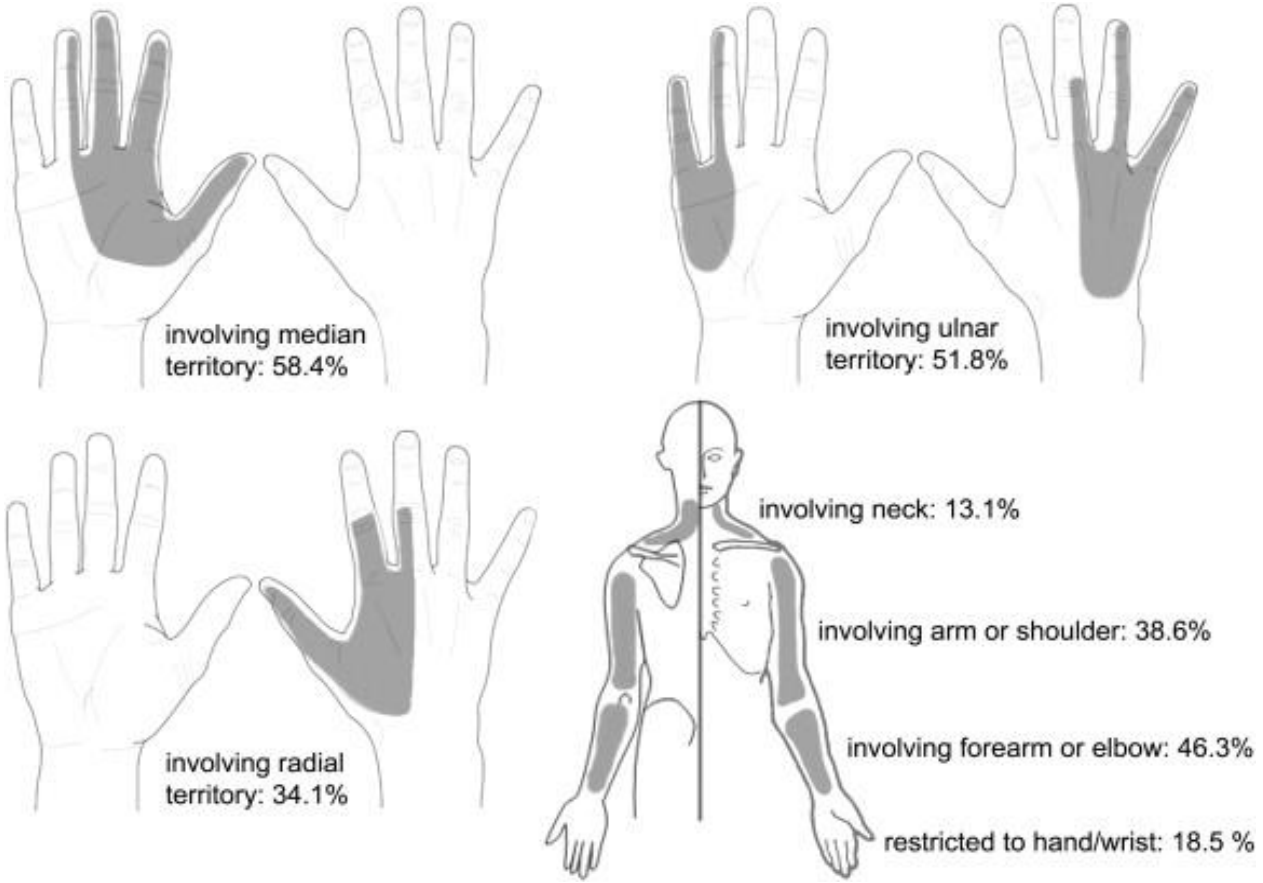
DURATION	1 Very mild symptoms	2 Mild symptoms	3 Moderate symptoms	4 Severe symptoms	5 Very severe symptoms
5 Chronic stage ≥ 6 months	IS	Note 1 and 2	IO	IO	IO
4 Chronic stage 3 ≤ 6 months	IS	IC, ICS	IC, ICS, IO	IC, ICS, IO	IO
3 Subacute stage 2 ≤ 3 months	IS	IS, IC, ICS	IS, IC, ICS, IO	IC, ICS, IO	IO
2 Subacute stage (1 ≤ 2 months)	IS	IS, IC, ICS	IS, IC, ICS	IC, ICS	Note 1 and 3
1 Acute stage (≤ 1 month)	IS	IS	IS	IS	Note 1 and 4
	Very mild symptoms [A]				Continuous very severe symptoms [B]
	SEVERITY				

IS: Instructions plus splinting;
IC: Instructions plus corticosteroid injection;
ICS: Instructions plus corticosteroid injection plus splinting;
IO: Instructions plus operative treatment/surgery.

(Huisstede et al., 2014)

Treating “central” processes

Extra-territorial and bilateral symptoms in peripheral entrapment neuropathies are common



(Schmid et al., 2013)

Summary and take-home messages

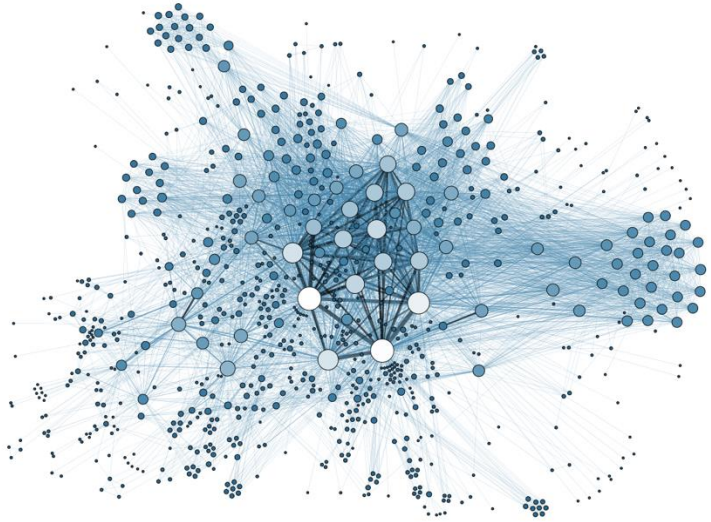
Management should be guided by the underlying mechanisms

- No single best treatment

Physiotherapy management involves a combination of de-loading the nerve and restoring of normal nerve movement

- Choice of treatment depends on the stage and presentation of symptoms
- De-loading strategies suits best for compression type, neural mobilization for nerve mechanosensitivity

Don’t forget education and reassurance



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