

Focal peripheral neuropathies

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No disclosures

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Goals

- Understand various types of focal neuropathies
- How we diagnose focal neuropathies

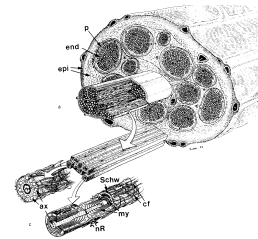
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Outline 90 min

- Eine kurze Einleitung
 - Structure and function of peripheral nerves
 - Pathophysiology of peripheral neuropathies
- Causes of focal neuropathies
 - Entrapment neuropathies
 - Neuromyothology and clinical neurophysiology
 - Temporary compression
 - Parsonage -Turner syndrome (neuralgic amyotrophy)
 - Traumatic
 - Iatrogenic neuropathies
- Aspects of neurophysiological diagnosis

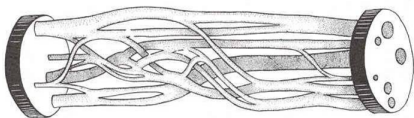
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Peripheral nerve



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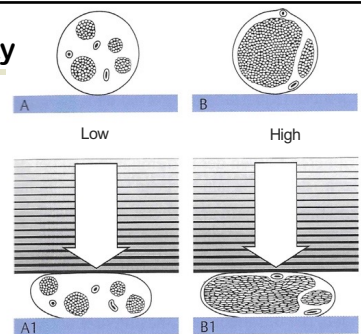
Fascicles



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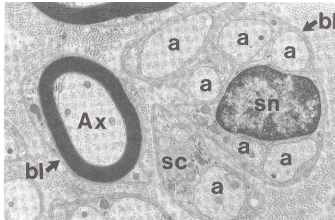
Vulnerability

- Sciatic nerve lesions
- Tibial nerve – mild
 - Peroneal nerve - moderate



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Microscopic structure



Myelinated nerve = Ax

Unmyelinated axons = a

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Microscopic anatomy

- Myelinated nerves
 - Diameter 2-20 μm
 - 7000/mm²
 - Distance between nodes of Ranvier 0,2-2 mm
- Unmyelinated nerves
 - Diameter 0,2-2,5 μm
- Unmyelinated : myelinated nerves = 4:1

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Axon types

| Type | Diameter | Function |
|------------|---------------------|-------------------------|
| A α | 12-20 μm | Touch , alfamotoneurons |
| A β | 5-12 μm | Touch |
| A γ | 3-6 μm | Gammamotoneurons |
| A δ | 2-5 μm | Cold, pain |
| B | 1-2 μm | Autonomic preganglionic |
| C | 0.3-1 μm | Pain, heat, autonomic |

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Causes of focal nerve lesions

- Mechanical compression
 - Chronic - Entrapment neuropathies
 - Temporary compression
- Immune mediated
 - Parsonage-Turner sdr (neuralgic amyotrophy)
 - Vasculitis
- Trauma
 - Stretch
 - Compression
 - Cutting

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Causes of focal nerve lesions

- Iatrogenic
 - Surgical
 - Needlestick
 - Toxic
 - Compression
 - Radiation therapy
- Infectious (herpes zoster)
- Tumors
 - Benign and malignant

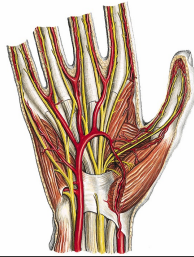
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Predisposing factors

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Narrow passages - Median nerve

- CTS
- Ulnar nerve in the cubital tunnel

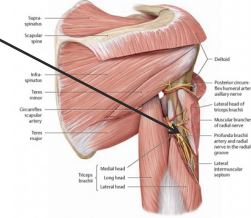


Putz and Pabst (ed) Sobotta. Atlas of Human Anatomy. 20th edition. Urban & Schwarzenberg

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Proximity to bone – Radial nerve

- Radial nerve - humerus
- Ulnar nerve - elbow
- Peroneal nerve - knee



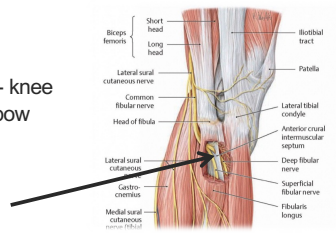
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No protective tissue - Peroneal

- Peroneal nerve - knee
- Ulnar nerve - elbow



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Patient related risk factors

- Obesity
 - CTS, meralgia paresthetica
 - Protective for Parsonage-Turner syndrome
- Age
 - CTS, Morton's metatarsalgia
- Gender
 - Women: CTS, Morton's metatarsalgia
 - Men: Ulnar neuropathy

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Patient related risk factors

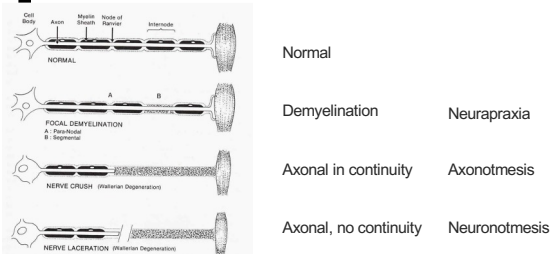
- Polyneuropathies
 - Diabetic PNP
 - HNPP (Hereditary neuropathy with liability to pressure palsies)
- Bony deformities
 - Rheumatoid arthritis, arthrosis, fractures

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Pathophysiology

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Different types of nerve lesions



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Nerve compression pathophysiology

- Acute physiological block
 - Minutes, < 1 hour
 - Conduction block - ischaemia
- Demyelinating reversible
 - Weeks to months
 - Conduction block - mechanical factors
- Axonal degeneration (Wallerian degeneration)
 - Mechanical factors with ischaemia

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Ischaemia

- Alteration of nerve conduction within few minutes
- Complete conduction failure after 30-40 minutes
- 3 hours of ischaemia - no axonal degeneration
 - (Parry GJ, Linn DJ. *Transient conduction block following acute peripheral nerve ischaemia. Muscle Nerve* 1985; 8: 409-412)
- > 4 hours damage to blood vessels, infarction of muscle
 - (Lundborg G. *Ischaemic nerve injury. Experimental studies.... Scan J Plastic Reconstr Surg* 1970; suppl 6)

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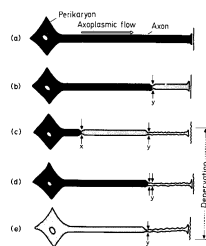
Axon susceptibility to compression

Ochoa J, Fowler TJ, Gilliat RW. *Anatomical changes in peripheral nerves compressed by a pneumatic tourniquet. J Anat* 1972;433:433-

- Demyelination in myelinated axons
- Axons with a diameter < 5 μm less affected
- Relative sparing of pain and temperature
- Temporary compression neuropathies do not cause pain

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Double crush syndrome



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Double crush syndrome

- Upton ARM, McComas AJ. *The double crush in nerve entrapments. Lancet* 1973;2:359-362
 - 115 patients with median or ulnar nerve neuropathies
 - 70% had evidence of cervical radiculopathies on EMG!!!!???
- Wilbourn AJ, et al. *Double-crush syndrome: a critical analysis. Neurology.* 1997; 49: 21-29.
 - Critical analysis does not support the existence of a double crush syndrome in clinical practice

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Most common focal neuropathies in the EMG lab at Turku University Hospital

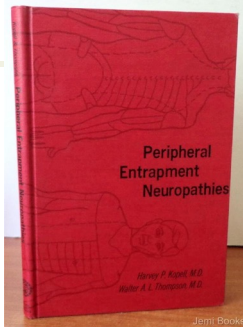
| Diagnosis | Female | | Male | | Total | | Chi-test |
|-------------------------------|--------|----|------|----|-------|---------|----------|
| | N | % | N | % | N | % focal | |
| Lumbar radiculopathy | 250 | 57 | 191 | 43 | 441 | 22,8 | ns |
| Carpal tunnel syndrome | 273 | 66 | 140 | 33 | 413 | 21,4 | p<0.01 |
| Ulnar nerve lesion | 56 | 36 | 98 | 64 | 154 | 8,0 | p<0.01 |
| Cervical radiculopathy | 55 | 36 | 96 | 64 | 151 | 7,8 | p<0.01 |
| Brachial plexopathy | 39 | 39 | 61 | 61 | 100 | 5,2 | p<0.01 |
| Morton's metatarsalgia | 86 | 89 | 11 | 11 | 97 | 5,0 | p<0.01 |
| Peroneal nerve lesion | 27 | 29 | 66 | 71 | 93 | 4,8 | p<0.01 |
| Radial nerve lesion | 42 | 54 | 36 | 46 | 78 | 4,0 | ns |
| Mononeuropathy in the leg | 37 | 62 | 23 | 38 | 60 | 3,1 | p<0.01 |
| Bell's palsy | 34 | 58 | 25 | 42 | 59 | 3,1 | ns |
| Median nerve lesion (not CTS) | 17 | 30 | 39 | 70 | 56 | 2,9 | ns |

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Entrapment neuropathies

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HP Kopell and VAL Thompson
Peripheral Entrapment Neuropathies
The William and Wilkins Company, Baltimore,
1963



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Entrapment neuropathy

"...a region of localized injury and inflammation in a peripheral nerve that is caused by mechanical irritation from some impinging anatomical neighbour"

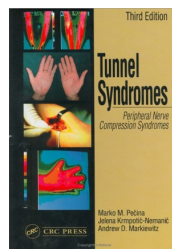
HP Kopell and VAL Thompson
Peripheral Entrapment Neuropathies
The William and Wilkins Company
Baltimore, 1963

"Chronic compressive neuropathy caused by surrounding anatomical structures"

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55 syndromes! Neuromythology

All that shines is not gold!!!



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Entrapments - upper extremities

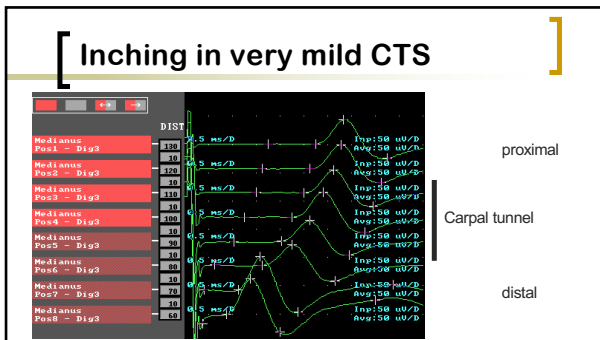
Common

- Carpal tunnel syndrome

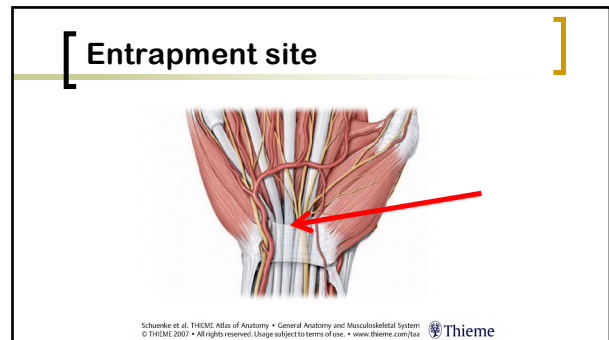
Rare

- Ulnar nerve at the elbow
 - Temporary compression much more common than entrapment
- Plexus brachialis

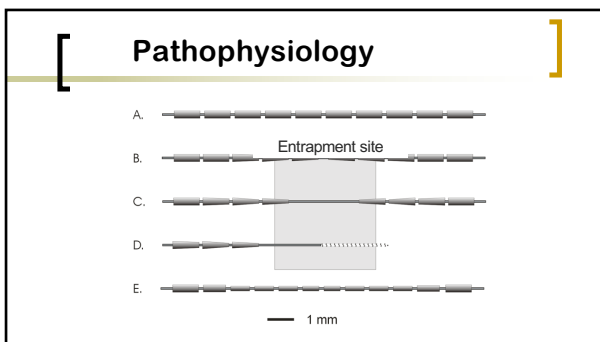
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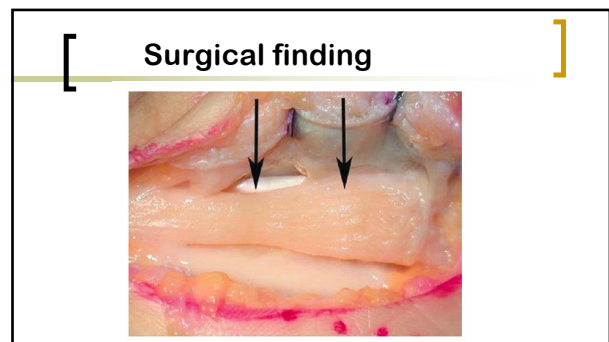
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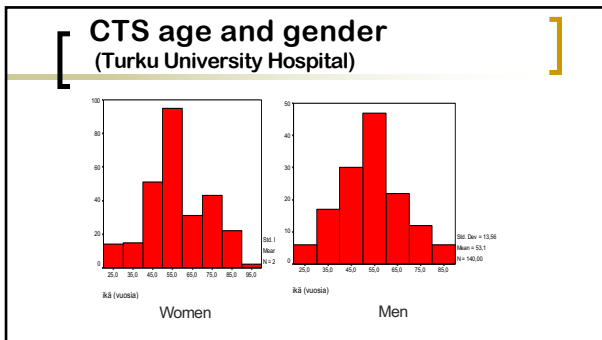
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- ### Predisposing factors
- Gender female:male 2:1
 - Age >45
 - Obesity
 - Heavy manual work
 - Diabetes
 - Wrist fractures (15% of all classical radial bone fractures)
 - Pregnancy
 - Acromegaly
 - Smoking
 - Surgery for breast cancer
 - Polyneuropathy
 - Hereditary liability to pressure palsies
 - Amyloidosis
 - Hemodialysis

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- ### Incidence and prevalence of CTS
- Prevalence in >18 year olds Marche, Italy 1.9%
 - Clin Exp Rheumatol 2005;23:9
 - Prevalence in Sweden 2.1% in men and 3.0% in women
 - JAMA 1999;282:153
 - Incidence in UK: 88 men and 192 in women/100 000
 - JNPP 2006;77:263
 - Incidence in Toscana: 329 per 100 000
 - Neurology 2002;58:289
 - Incidence in Rochester: men 52 and women 149/100 000
 - Neurology 1988;38:134
 - **Lifetime risk of CTS**
 - **Women 10%**
 - **Men 5%**

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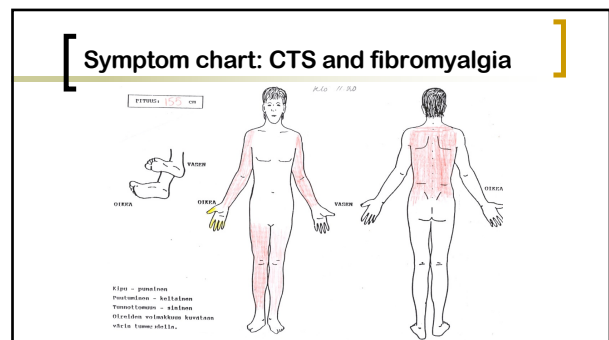
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- ### Diagnosis
- Symptoms
 - Clinical findings
 - Neurography
 - Imaging studies
 - MRI
 - Ultrasound

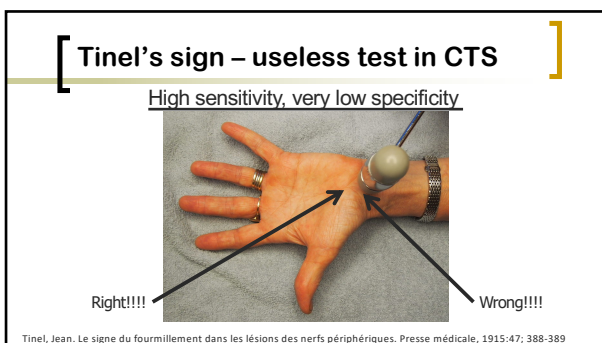
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- ### Symptoms
- Numbness in fingers 1-4
 - Worse at night
 - Initially in digits 3-4
 - Activity involving fingers
 - Loss of sensation (severe CTS)
 - Loss of hand dexterity (severe CTS)
 - Sometimes non-specific shoulder discomfort
 - **Wrist pain not a typical symptom!**

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Different neurophysiological methods

- Motor neurography
- Sensory neurography
- Special neurography techniques
- Needle EMG
- Psychophysiological methods
 - sensation thresholds
- Tests of autonomic function

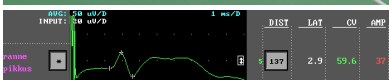
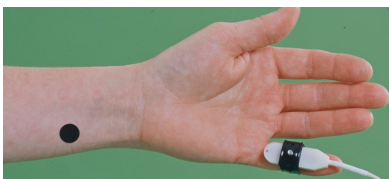
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N.medianus – sensory neurography



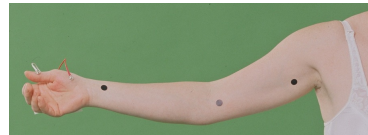
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N.ulnaris – sensory neurography



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N.medianus - motor neurography



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EMG



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Role of EMG

- Abnormal findings in thenar muscles in severe CTS
- Presence of fibrillation potentials and signs of collateral reinnervation helps to assess the degree of axonal damage
- May be used to identify a proximal lesion
- Not a part of routine CTS testing

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[AAEM and AAN guideline]

Neurology 2002;58:1589-



Special Article

Practice parameter: Electrodiagnostic studies in carpal tunnel syndrome

Report of the American Association of Electrodiagnostic Medicine, American Academy of Neurology, and the American Academy of Physical Medicine and Rehabilitation

C.K. Jabbecki, MD, M.T. Andary, MD, M.K. Florator, MD, PhD, R.G. Miller, MD, C.A. Quartly, MD, M.J. Vennix, MD, and J.R. Wilson, MD

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[AAEM and AAN CTS practice parameter]

- Standard
 - Neurography across the wrist of the median nerve and if the result is abnormal of one other nerve in the symptomatic limb
 - if segment > 8 cm and the result is normal, palm to wrist or comparison to ulnar
- Guideline
 - Motor neurography of median nerve and ulnar nerves
- Option
 - EMG of CV-Th1 muscles

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[CTS – Neurography protocol]

- Sensory
 - Median nerve digit 2
 - Median nerve digit 3
 - Median nerve digit 4
 - Ulnar nerve digit 5
 - Ulnar nerve digit 4
 - (palm to wrist)
- Motor
 - median
- Always bilaterally

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[Severity of CTS]

Padua, L, Lo Monaco M, Padua R, Gregori B and Tonali P.
Neurophysiological classification of carpal tunnel syndrome: assessment of 600 symptomatic hands
 Ital J Neurol Sci 1997;18:145-150

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[Normal finding]

N.medianus, sens

N.ulnaris, sens

N.medianus, mot



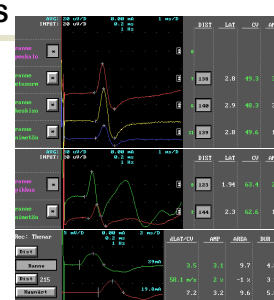
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[Very mild CTS]

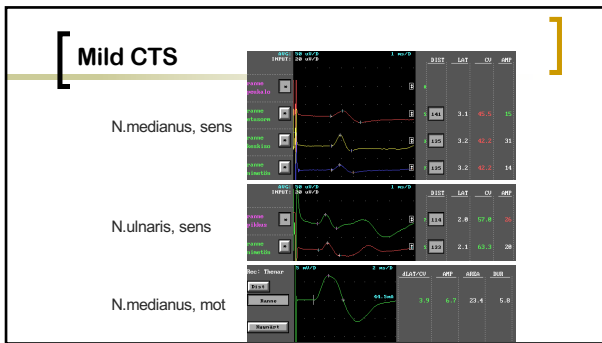
N.medianus, sens

N.ulnaris, sens

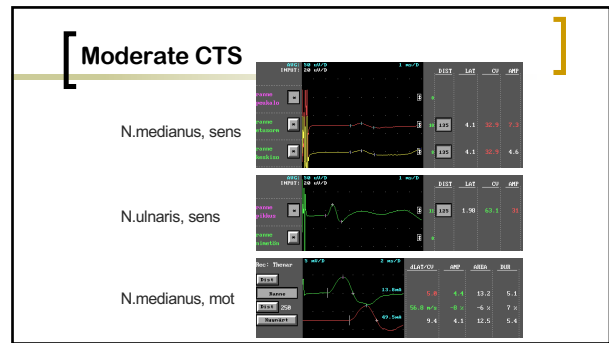
N.medianus, mot



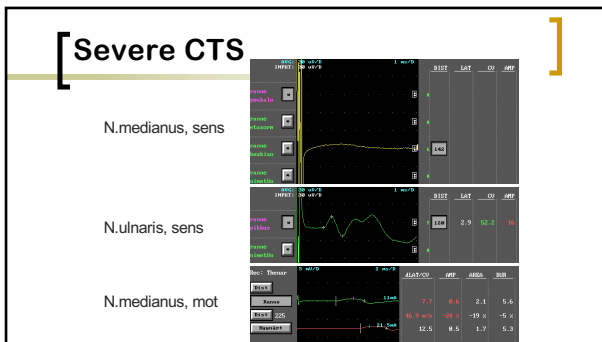
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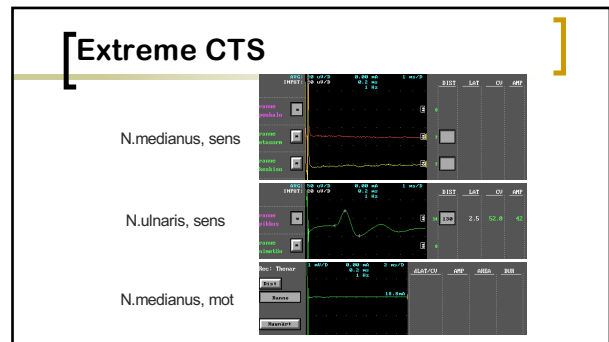
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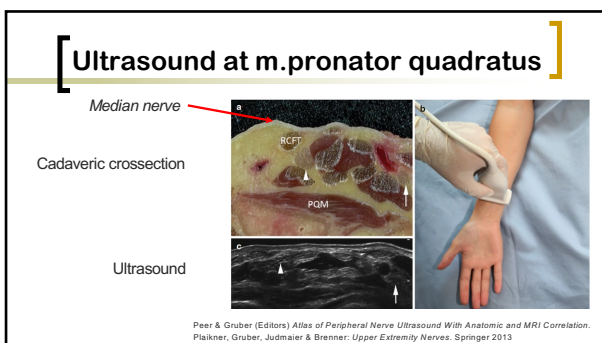
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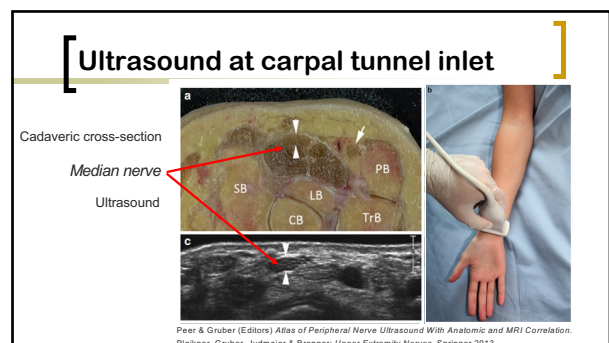
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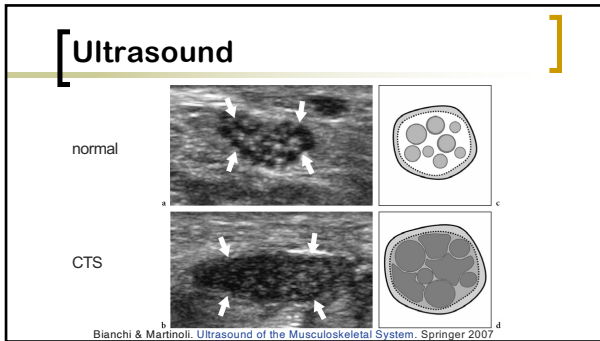
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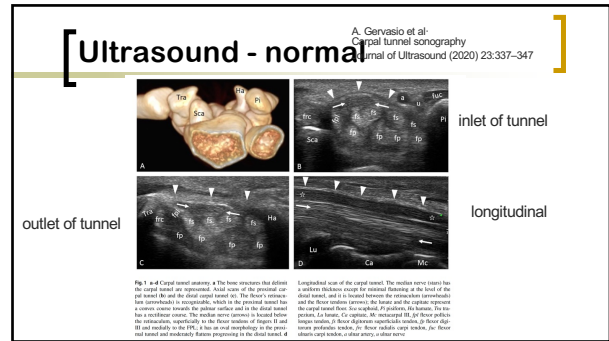
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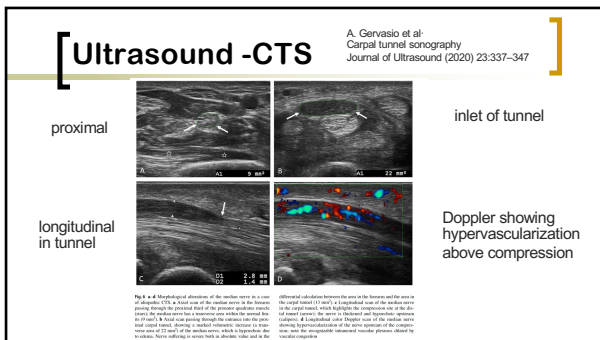
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- ## [Ultrasound]
- Area of median nerve proximal to the tunnel
 - > 9-12 mm²
 - Wrist to forearm (at m.pronator quadratus) area ratio
 - >1.4
 - Hypoechoic nerve in the tunnel
 - Nerve flattening
 - Bowing of flexor retinaculum
 - Thinning of nerve longitudinally in outlet of the tunnel
 - Reduced longitudinal mobility

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- ## [Ultrasound]
- Structural information
 - Identifies structural abnormalities
 - Lipoma
 - Ganglion
 - Aneurysm
 - Tumors
 - Scars
 - Inflammation

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- ## [Neurography vs Ultrasound]
- ENG and US complement each other
 - Equally sensitive and specific
 - Ultrasound has no discomfort
 - Ultrasound can diagnose unusual anatomical features
 - Neurography can find other neuropathies
 - Neurography can be done by technologists
 - Neurography is less time consuming
 - Postoperative
 - ENG identifies post-operative recovery
 - US can diagnose failed transection of the ligament

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Treatment

- Before treatment evaluate causes of CTS
 - Is there a significant reversible cause?
 - Pregnancy
 - Unusual temporary physical activity
- Splinting during the night
 - Alleviates symptoms at night
 - Does not treat the entrapment
- Surgery
- Local injection of steroids
 - Not recommended, danger of needle injury to the nerve

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ABSTRACT: Patients (n = 3336) who had been tested for suspected carpal tunnel syndrome (CTS) were contacted by postal questionnaire and their opinions sought of the overall subjective outcome of any treatments using a five-point rating scale. Operative results were compared with preoperative nerve conduction, clinical and demographic variables, and a multiple logistic regression analysis used to identify significant prognostic factors. Among 1268 surgical procedures that were identified, the overall surgical success rate was 69%. Preoperative nerve conduction study findings, greater age, lower symptom scores, longer disease duration, and male gender were significant predictors of poor outcome. Nerve conduction studies had the strongest effect, with patients with middle-grade abnormalities having better results than those with either very severe or no abnormality. Surgical carpal tunnel decompression has a significant failure rate. The preoperative nerve conduction studies account for a proportion of the total variation in outcome. © 2001 John Wiley & Sons, Inc. *Muscle Nerve* 24: 935-940, 2001

DO NERVE CONDUCTION STUDIES PREDICT THE OUTCOME OF CARPAL TUNNEL DECOMPRESSION?

JEREMY D.P. BLAND, FRCP

EEG Department, Kent and Canterbury Hospital, Eddelbert Road, Canterbury, Kent, CT1 3NG, UK

Accepted 7 March 2001

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Surgical outcome

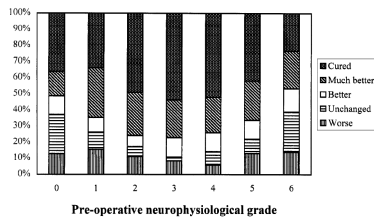


FIGURE 1. Subjective outcome of carpal tunnel decompression in relation to preoperative neurophysiological grade

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Good prognosis

- Young age
- Female sex
- Short duration of symptoms
- Moderate nerve conduction abnormality

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Clinical Neurophysiology 116 (2005) 275-283

www.elsevier.com/locate/clinph

What symptoms are truly caused by median nerve compression in carpal tunnel syndrome?

Daniel Bocchese Nora^{a,b,c,e,*}, Jefferson Becker^{a,b,c,e}, João Arthur Ehlers^{b,d,e}, Irenio Gomes^{b,c,d,e}

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^ePARG: Porto Alegre Research Group in Neuromuscular Diseases, Brazil

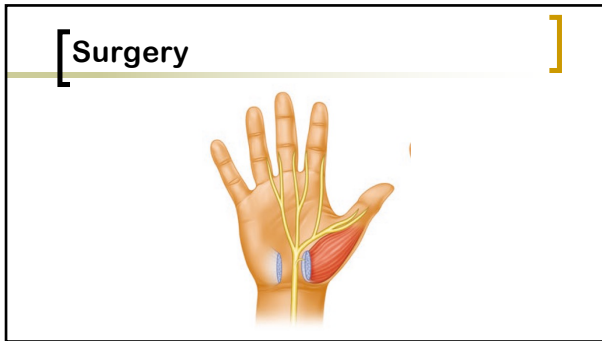
Accepted 27 August 2004
Available online 30 September 2004

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Splinting

- Purpose is to prevent finger flexion during the night
- Not necessary to keep the wrist straight or stable
- Effective in mild and moderate CTS
- While waiting for the surgery
- Useless in severe CTS
- Can be used to support the clinical diagnosis

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Splinting vs Surgery in the Treatment of Carpal Tunnel Syndrome: A Randomized Controlled Trial

Content: Carpal tunnel syndrome (CTS) can be treated with nonsurgical or surgical options. However, there is no consensus on the most effective method of treatment.

Objective: To compare the short-term and long-term efficacy of splinting and surgery for relieving the symptoms of CTS.

Design, Setting, and Patients: A randomized-controlled trial conducted from October 1998 to April 2000 at 13 neurological outpatient clinics in the Netherlands. A total of 176 patients with clinically and electrophysiologically confirmed idiopathic CTS were assigned to wrist splinting during the night for at least 6 weeks (89 patients) or open carpal tunnel release (87 patients). 167 patients (84%) completed the final follow-up assessment 18 months after randomization.

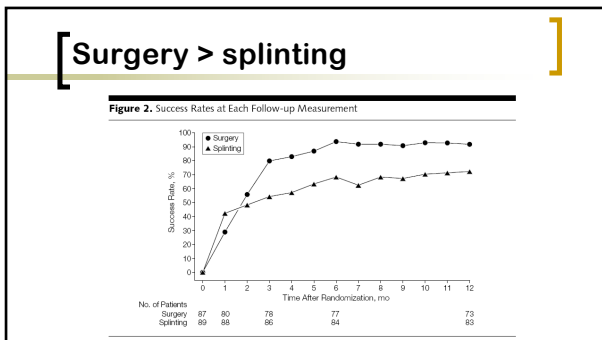
Main Outcome Measures: General improvement, number of nights waking up due to symptoms, and severity of symptoms.

Results: In the intention-to-treat analysis, surgery was more effective than splinting on all outcome measures. The success rates (based on general improvement) after 3 months were 80% for the surgery group (62/78 patients) vs 54% for the splinting group (46/86 patients), which is a difference of 26% (95% confidence interval [CI] 12%-40%, $P < 0.01$). After 18 months, the success rates increased to 90% for the surgery group (61/68 patients) vs 75% for the splinting group (59/79 patients), which is a difference of 15% (95% CI, 3%-27%, $P = .02$). However, by that time 41% of patients (12/29) in the splint group had also received the surgery treatment.

Conclusion: Treatment with open carpal tunnel release surgery resulted in better outcomes than treatment with wrist splinting for patients with CTS.

JAMA. 2002;288:1245-1251

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Results of carpal tunnel release

J. J. W. Prick^a, G. Blaauw^b, J. W. Vredevelde^c and S. J. Oosterloo^d

^aDepartment of Neurology, Medisch Spectrum Twente, Oldenzaal; ^bDepartment of Neurosurgery, University Hospital, Maastricht; ^cDepartment of Clinical Neurophysiology, Atrium Medical Center, Heerlen; and ^dUniversity of Twente, Enschede, The Netherlands

Keywords: We evaluated, by means of a prospective study, the results of carpal tunnel release carpal tunnel syndrome both clinically and electrophysiologically in 188 patients with a carpal tunnel syndrome. A questionnaire was completed by patient and surgeon pre- and post-operatively (6 and 12 months after operation), when physical examination, electromyography and nerve conduction tests were also performed. Full pre- and post-operative results were available for 136 patients and 82% of the patients were satisfied with the results of the operation. Symptoms caused by median nerve compression showed the greatest improvement and no fixed patterns with regard to unsatisfactory results were found. If pain persisted in the wrist, many patients considered the operation to have been unsuccessful. Electrophysiological improvement occurred in all patients and at 12 months follow-up, median nerve conduction was normal in 21% of cases. Thus distal sensory latency remained abnormal in 79% of the patients, emphasizing the need for caution when recurrence of carpal tunnel syndrome is diagnosed in such cases.

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Clinical Neurophysiology 112 (2001) 1237–1242

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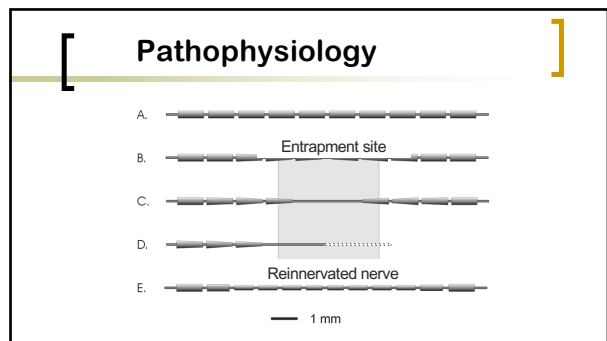
Clinical and neurophysiological outcome of surgery in extreme carpal tunnel syndrome

M. Mondelli^{a,*}, F. Reale^b, R. Padua^a, I. Aprile^c, L. Padua^{d,e}

^aServizio di EMG ASL 7, Via Pian d'Orto, 9, 53100 Siena, Italy
^bNeurochirurgia 1, Azienda Ospedaliera Senece, Italy
^cDipartimento di Ortopedia Osp. S. Giacomo, Roma, Italy
^dIst. di Neurologia Università Cattolica del 'S. Cuore', Roma, Italy
^eFAIR Osp. Fatebenefratelli Isola Tiberina, Roma, Italy

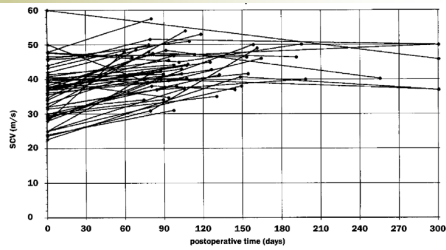
Accepted 2 April 2001

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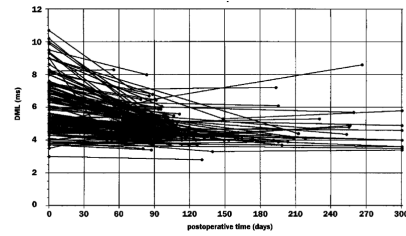
Sensory CV after surgery



Borish & Haussman. Journal of Hand Surgery (British and European Volume, 2003) 28B: 5: 450-454

93

Distal motor latency after surgery



94

US postoperatively

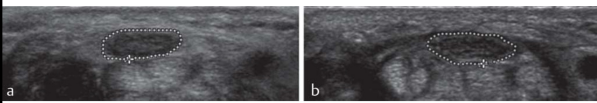
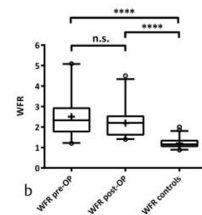


Fig. 4 CSA of the median nerve in a 72-year-old male patient a: preoperative, CSA 0.252 cm², VAS 7, b: 12 months postoperative CSA 0.276 cm², VAS 0.

95

US postoperatively

- Thickening does not change after surgery



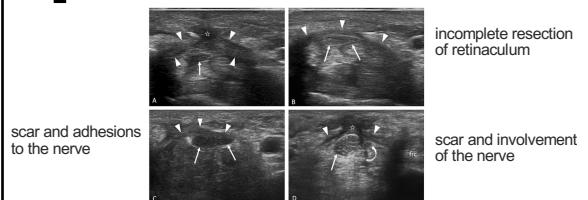
96

Problems following surgery

- Wrong diagnosis!
- Other problems for the symptoms, tendinitis...
- Painful scar
- Incomplete division of transverse carpal ligament
- Iatrogenic neuropathies
 - Palmar cutaneous branch
 - Recurrent motor branch
 - Palmar digital nerves
- Recurrent entrapment following complete transection of the carpal ligament is extremely rare!!!

97

Ultrasound – failed surgery



A. Gervasio et al. Carpal tunnel sonography Journal of Ultrasound (2020) 23:337-347

98

Damage to the sensory palmar branch of median nerve

- Loss of sensation in the palm
- Allodynia
- Clinical diagnosis
- Neurography cannot be done on this nerve

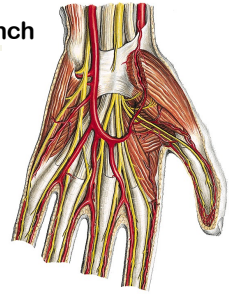


Putz and Pabst (ed) Sobotta, Atlas of Human Anatomy, 20th edition, Urban & Schwarzenberg

99

Damage to the motor branch

- Following surgery sensory symptoms improved
- Weakness of thumb opposition and abduction
- Neurography shows improved sensory CV and reduced CMAP amplitude

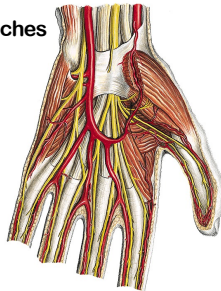


Putz and Pabst (ed) Sobotta, Atlas of Human Anatomy, 20th edition, Urban & Schwarzenberg

100

Damage to sensory palmar branches

- Often just a partial lesion
- Sensory abnormality in one or two palmar digital nerves



Putz and Pabst (ed) Sobotta, Atlas of Human Anatomy, 20th edition, Urban & Schwarzenberg

101

Summary

- CTS is the most common peripheral neuropathy
- Paresthesia main symptom
 - Starts in digits 3 and 4
 - While sleeping
 - Driving car and cycling
- Multiple predisposing factors – identify them
- Often related with heavy manual work
 - There are also other problems, tendinitis etc...
- Mild asymptomatic ENG abnormalities are common

102

Final word

Beware of overdiagnosis

Always consider: Do the ENG abnormalities explain the symptoms?

103

Myth

- A **myth** is a traditional story
- Events that may be historical
- Often supernatural
- Explaining the origins of a cultural practice or natural phenomenon
- Myths are stories that are understood as being exaggerated or fictitious

104

[Odin – His ravens: Munin and Hugin]

Hugin (hägen=tanken, "thought")

Munin =minnet, "memory"



Odin is the god of war and poetry in Nordic mythology.
Corresponds to Wotan in the Germanic mythology

105

[John F. Kennedy, 1962]

"The great enemy of truth is often not the lie — deliberate, contrived, and dishonest — but the myth — persistent, persuasive, and unrealistic. Too often we hold fast to the cliches of our forebears. We subject all facts to a prefabricated set of interpretations. We enjoy the comfort of opinion without the discomfort of thought."

106

[Neuromythological neuropathies]

- Disorders that only exist in textbooks
- Poorly documented
- Not detected by ENMG or imaging studies
- Only diagnosed by clinical features
- Reports indicate excellent surgical results
 - Short follow-up times
 - No controlled evidence-based studies

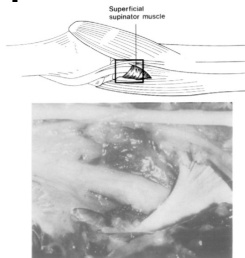
107

[Neuromythology - arms]

- Posterior interosseous syndrome
 - Chronic painful entrapment does not exist
 - Posterior interosseous nerve lesions occur
 - Parsonage-Turner syndrome (neuralgic amyotrophy)
- Pronator syndrome
 - Does not exist
- Quadrilateral space syndrome
- Anterior interosseous syndrome
 - Not an entrapment
 - Parsonage - Turner syndrome

108

[Posterior interosseus syndrome]



Carl-Olof Werner. Lateral elbow pain and posterior interosseus nerve entrapment. Acta Orthopædica Scandinavica. Supplementum 174. 1979

109

[Site of maximum pain]

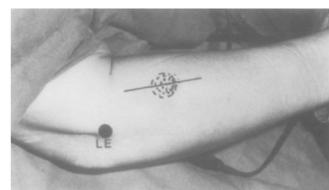


Fig. 4. Entrapment site and line of incision. The right forearm seen from the side. Dotted area: maximal tenderness over the nerve. LE: lateral epicondyle. Straight line: skin incision.

110

— **FFG journal 1980:50:125-133** —

NEUROPHYSIOLOGICAL INVESTIGATION OF POSTERIOR INTEROSSEOUS NERVE ENTRAPMENT CAUSING LATERAL ELBOW PAIN

INGMAR ROSEN and CARL-OLOF WERNER
Departments of Clinical Neurophysiology and Orthopedic Surgery, University Hospital, S-221 85 Lund (Sweden)

(Accepted for publication: March 27, 1980)

Some refractory cases of 'tennis elbow' pain have been suggested to be due to an entrapment neuropathy of the posterior interosseous nerve (Kopell and Thompson 1963; Capenar 1966; Giannetti 1968; Roles and Maudsley 1972; Dewey 1973; Narakas 1974; Spinner and Spencer 1974; Comtet et al. 1976; Lister 1977). The hypothesis was supported by good results from surgical decom-

decrease of the motor conduction velocity of the posterior interosseous nerve across the **supinator muscle was found in 3 cases only and slight EMG changes in 5.** The entrapment diagnosis was thus confirmed by routine neurophysiological techniques in rather few cases. In order to investigate if a more elaborate neurophysiological technique would lend further support to this diagnosis a study was

111

Pronator syndrome

112

J Hand Surgery 2011:36:907-909

EVIDENCE-BASED MEDICINE

Pronator Syndrome

Steven Prosciatti, MD, Craig M. Rodner, MD

THE PATIENT
An active 42-year-old woman presents with the insidious onset of aching pain in the proximal volar forearm that has developed over the past 3 months. She also experiences occasional paresthesias radiating into the palm, thumb, index finger, and middle finger, and the radial half of the ring finger. Her symptoms are aggravated by her daily, repetitive activities at work. She does not report symptoms at rest and denies the presence of nocturnal symptoms. She presents for a second opinion after a hand surgeon she consulted diagnosed pronator syndrome (PS) and offered operative treatment.

THE QUESTION
How is pronator syndrome diagnosed and treated?

median nerve by either an anomalous ligament of Struthers or the lacertus fibrosus in the antebraclial fossa.² The diagnosis of PS is typically considered in patients with aching pain in the proximal volar aspect of the forearm that is aggravated by activities.¹⁻³ Most patients in published series are women in their forties. Some patients are described as having paresthesias in the thumb, index, middle, and radial ring fingers³ and decreased sensation in the skin overlying the thenar eminence, because this area is innervated by the palmar cutaneous branch of the median nerve, which originates proximal to the transverse carpal ligament.⁴ Several clinical maneuvers are advocated to determine the site of proximal median nerve entrapment, but there is no evidence regarding the diagnostic performance characteristics of these tests. All of the exami-

113

SHORTCOMINGS OF THE EVIDENCE

Given that there is no pathophysiology that can be objectively measured in most patients diagnosed with PS (ie, there is no experiment that can be done to verify or falsify the diagnosis), we tend to use the language of faith rather than science when discussing this diagnosis, as in "I believe (or don't believe) in PS." Belief in the diagnosis of PS is based on subjective operative findings and relief after surgery, but there is a paucity of controlled trials to demonstrate that operative treatment is more effective than other treatments, or even sham operative treatment. Even among those who believe in PS, the diagnosis is infrequent and therefore difficult to study.

114

Alberto Brandolini's principle

- "The amount of energy needed to refute bullshit is an order of magnitude bigger than that needed to produce it"

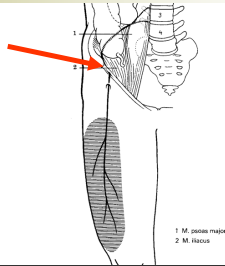
115

Entrapments – lower extremities

- Morton's metatarsalgia
- Meralgia paresthetica

116

[N.cutaneus femoris lateralis]



124

[Meralgia paresthetica]

- Numbness of the lateral side of the thigh
 - Standing
 - Walking
 - Lying prone with straight legs
- Rarely pain
- Severe obesity

125

[Recording of n.cut.fem lat]

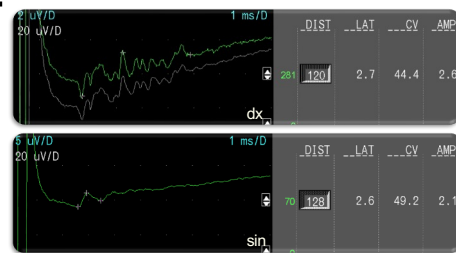
Recording electrode above spina iliaca anterior superior

Spina iliaca anterior superior



130

[Meralgia paresthetica on the right side]



131

[Neuromythology - legs]

- Tarsal tunnel syndrome
 - Poorly documented
 - Other tibial nerve lesions at the ankle do occur
- Peroneal nerve at the knee
 - Not an entrapment
 - Acute temporary or repeated temporary compression
- Piriformis syndrome
 - Sciatic nerve compression by m.piriformis

132

[University hospital of Turku focal neuropathies]

| | | | |
|----------------------------------|-----------|----------------------------|-----------|
| Lumbar radiculopathy | 441 (23%) | Other nerve lesion in foot | 60 (3%) |
| CTS | 413 (21%) | Other neuropathy in arm | 55 (2%) |
| Ulnar nerve lesion (elbow) | 154 (8%) | Meralgia paresthetica | 31 (2%) |
| Cervical radiculopathy | 151 (8%) | Lumbosacral plexopathy | 39 (2%) |
| Brachial plexopathy | 100 (5%) | Sciatic nerve lesion | 29 (2%) |
| Metatarsal entrapment neuropathy | 97 (5%) | Other cranial nerve lesion | 22 (1%) |
| Peroneal nerve lesion | 93 (5%) | Trigeminal nerve lesion | 2 (1%) |
| Radial nerve lesion | 78 (4%) | Tibial nerve lesion | 11 (0.5%) |
| Facial nerve lesion | 70 (3%) | Phrenic nerve lesion | 8 (0.5%) |
| Median nerve lesion | 68 (3%) | Thoracic radiculopathy | 7 (0.5%) |

133

Temporary nerve compression

134

Temporary compression

- Radial nerve in the humerus
 - Saturday night palsy
- Ulnar nerve at the elbow
- Ulnar nerve at the wrist
- Brachial plexus
- Peroneal nerve at the knee
 - Strawberry pickers palsy
- Sural nerve in the foot
- Digital nerves in the hand
- Radial nerve braches in the hand

135

Epidemiology

- 20-40/100 000/year
- men > women
- Non-dominant side affected more often

136

136

Confusing terminology

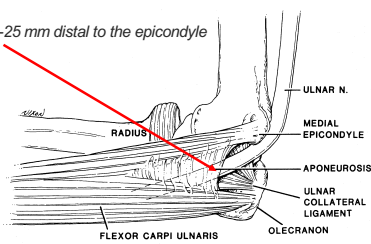
- Entrapment
 - Not synonymous with focal neuropathy
- Cubital tunnel syndrome!
 - Literature often uses term for any ulnar neuropathy at the elbow
- Tardy ulnar palsy
 - Arthrosis of the elbow
- Localization?
 - Retroepicondylar, cubital tunnel, diffuse
- Etiology
 - Temporary or repeated compression caused by static elbow flexion
 - Entrapment in the cubital tunnel

137

137

Ulnar nerve at the elbow

Aponeurosis 5-25 mm distal to the epicondyle



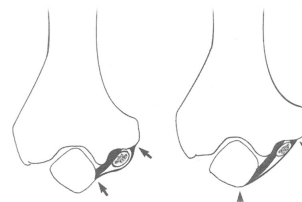
Kincaid JC. Muscle Nerve 1988;11:1005-1015

138

138

Cubital tunnel - rest and flexion

Elbow extended Elbow flexed



139

139

[Ulnar neuropathy at the elbow 1]

- Temporary compression
 - Retroepicondylar
 - By far most common, 90%
- Cubital tunnel syndrome
 - Entrapment in the cubital tunnel
 - Rare, < 1%
- Chronic structural compression "Tardy ulnar palsy"
 - Diffuse along the retroepicondylar region
 - Quite common
 - Arthrosis, previous supracondylar humerus fracture
 - Quite common, 10%

140

140

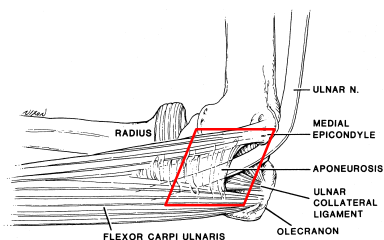
[Ulnar neuropathy at the elbow 2]

- Traumatic
 - Elbow luxation, together with median nerve
 - Fractures
- Iatrogenic
 - Elbow arthroplasty
 - Perioperative in association with surgical procedures

141

141

[Cubital tunnel]



Kincaid JC. Muscle Nerve 1988;11:1005-1015

142

142

[Cubital tunnel syndrome]

- Entrapment of the ulnar nerve in the cubital tunnel
- **Rare**
- Usually, normal elbow
- Often young people
- Painless
- Slow evolution
- Conservative or surgical treatment?
- Good surgical results

143

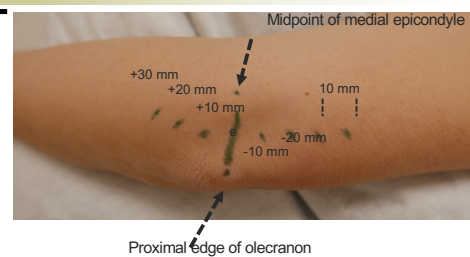
143

[Ulnar nerve short segment study]



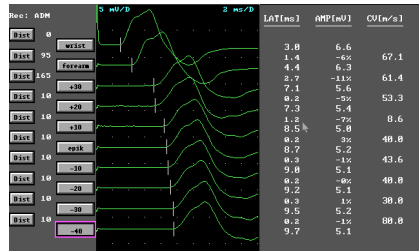
144

[Reference line]



145

[Mild cubital tunnel syndrome]



146

[Arthrosis of the elbow]



147

[Tardy ulnar palsy]

- Deformity of the elbow joint
 - Previous supracondylar humerus fracture
 - Arthrosis of the elbow
- Extension defect of the elbow
- Always painless
- Onset with mild numbness in digits 4 and 5
- Patients come when muscle weakness is evident
- Diffuse involvement of nerve across elbow
- Should always be evaluated for surgery
 - Surgical results are never excellent!!!!
 - Intra-neural scarring

148

[The non-dominant side is exposed]



149

[The sofa may be dangerous..]



150

[Reading in chair is not good...]



151

[Mobile phone also problem.....]



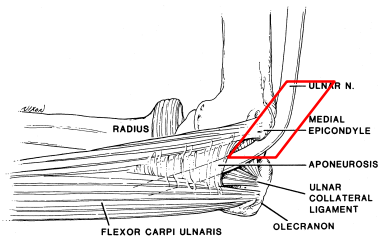
152

[Temporary compression]

- Often acute, sometimes subacute or chronic
- Common
- Men > women
- Non-dominant hand more often affected
- No pain!
- Numbness of fingers 4-5
 - Dorsal side of hand
- Weakness
 - Little finger flexion
 - Spreading of fingers

153

[Retroepicondylar groove]

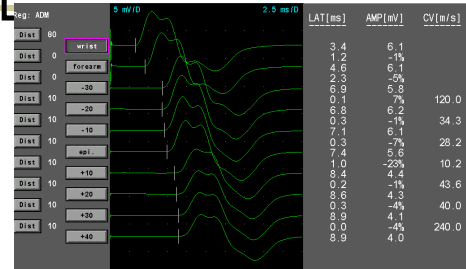


Kincaid JC. Muscle Nerve 1988;11:1005-1015

154

154

[Retroepicondylar ulnar nerve lesion]



155

[Ulnar numbness in the night]



Picture courtesy of Jesus Panigua

156

[Ulnar numbness only in the night]

- Rarely neurophysiological abnormalities
- Temporary compression due to static flexion
- Educate patient
 - Causal mechanism
 - How to avoid the static flexion

157

157

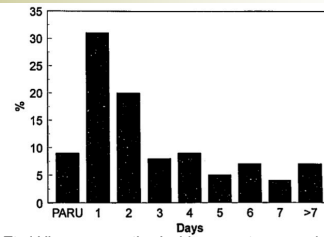
Perioperative ulnar neuropathy

- Before surgery
- During surgery
- **Postoperative period in the hospital**
- Convalescent period at home

158

158

Perioperative ulnar neuropathies do not originate on the operating table!

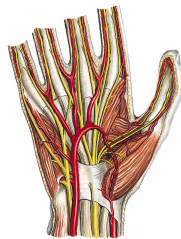


Warner MA. Et al Ulnar neuropathy. Incidence, outcome and risk factors in sedated or anesthetized patients. *Anesthesiology* 1994;81:1332-1340

159

159

Ulnar nerve at the wrist



Putz and Pabst (ed) Sobotta, Atlas of Human Anatomy, 20th edition, Urban & Schwarzenberg

160

Ulnar nerve at the wrist

- Temporary compression
 - Cyclist's palsy
 - Crutches
- Entrapment
 - Ganglion
 - Aneurysm
 - Lipoma

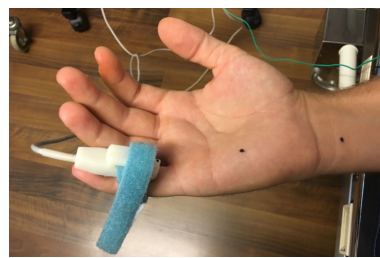
161

Cyclists palsy



162

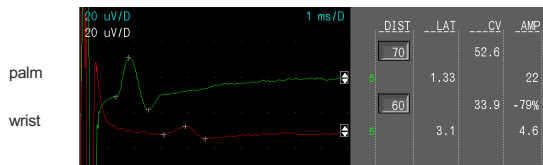
Fractionated neurography at wrist



163

163

Fractionated neurography



164

Peroneal nerve- knee



Schuenke et al. THIEME Atlas of Anatomy • General Anatomy and Musculoskeletal System
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165

Peroneal nerve at the knee

- Strawberry picker's palsy
 - Often bilateral
- Slimmer's palsy
- Static flexion of knee
- During night
 - Probably compression

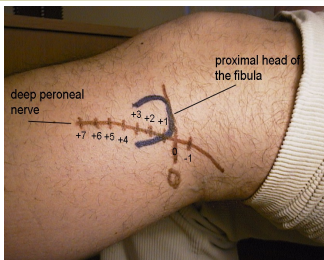
166

Peroneal nerve compression



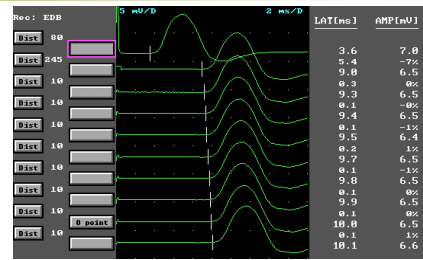
167

Stimulation sites



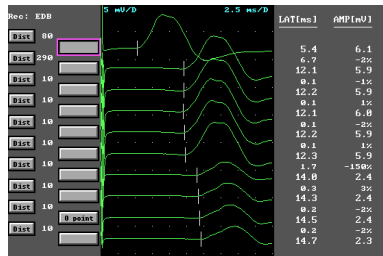
168

Peroneal nerve inching-normal



169

[Slimmer's palsy]



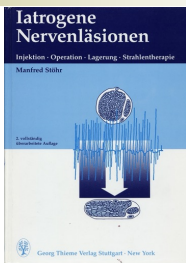
170

[Traumatic neuropathies]

- Incisions by sharp objects
 - Median and ulnar nerves at the wrist
- Dislocation of joint
 - Humerus luxation: axillary nerve in Median and ulnar nerves in elbow
- Crush
 - Radial nerve in upper arm
- Gunshot wounds
- Stretch
 - Plexus brachialis

202

[Iatrogenic neuropathies]



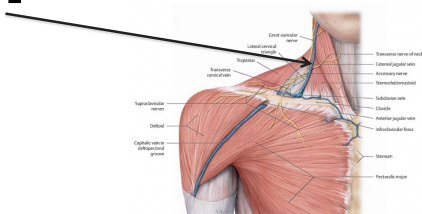
203

[Iatrogenic]

- Direct injury during surgery
- Compression
- Hematoma
- Needlestick
- Injection of material close to nerve
- Radiation therapy

204

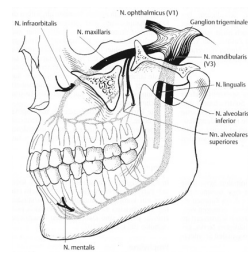
[Accessory nerve]



Schuenke et al. THIEME Atlas of Anatomy • General Anatomy and Musculoskeletal System
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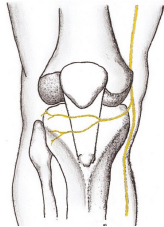
205

[Inferior alveolar nerve]



206

[Inferior patellar nerve]



37/60

Kartius et al. The localization of the infrapatellar nerve in the anterior knee region. Arthroscopy 1999;15:577-

207

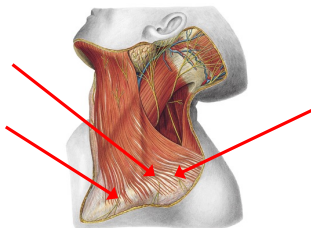
[Sural nerve]



Sobotta: Atlas of human Anatomy
UrbanSchwarzenberg

208

[N.supraclaviculares]



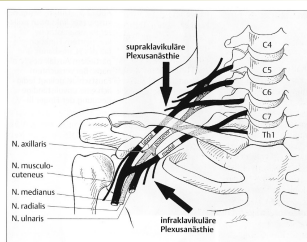
209

[Direct injury during surgery]

- Dupuatre's contracture
 - Digital nerve lesions
- Surgery in the groin and abdomen
 - Iliohypogastric nerve
 - Ilioinguinal nerve
 - Genitofemoral nerve

212

[Plexus anesthesia]



213

[Peripheral nerve tumours]

- May occur anywhere
- Mostly benign
- Suspect if a nerve lesion occurs in an unusual place
 - Sciatic nerve lesion in the buttock
 - Median nerve lesion in the forearm
- Ultrasound

214

[History is important]

- Careful history is essential
 - In 70% of patients the diagnosis can be made with history and clinical exam
- History is essential for etiology
 - Neurophysiological findings do not differentiate between chronic entrapment and temporary compression

215

[Clinical findings]

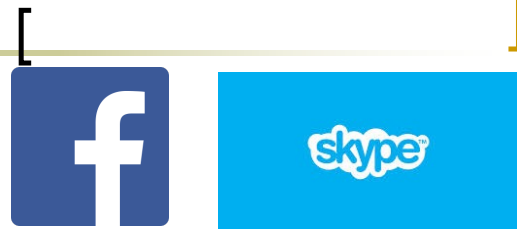
- Inspection
 - Atrophy
 - Scars
 - Deformities
- Reflexes
- Muscle strength
- Sensation
 - Not reliable

216

[Goals of electrodiagnosis]

- Localize lesion
- Characterize lesion
 - Axonal
 - Demylinating
 - Conduction block
- Severity
- Time course

217



Facebook or Skype neuropathy?

218

[]

Woman 73 years, right-handed

219

[Referral from orthopedic surgeon]

- 4 weeks of increasing numbness in little finger
- Before surgery we wish to confirm that the ulnar neuropathy is at the wrist

220

[History]

- Previously healthy
- Right-handed
- 4 weeks of increasing numbness of ulnar fingers

221

[Clinical findings]

- Reduced sensation of the ulnar fingers and dorsal side of the hand
- Weakness of little finger abduction and flexion
- On palpation ulnar sulcus at elbow is normal

222

[Differential diagnosis?]

- ?

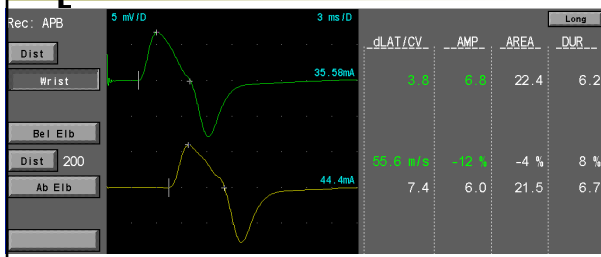
223

[Differential diagnosis?]

- Ulnar neuropathy at the elbow
- Wrist very unlikely
- C8 or lower trunk of plexus brachialis also unlikely

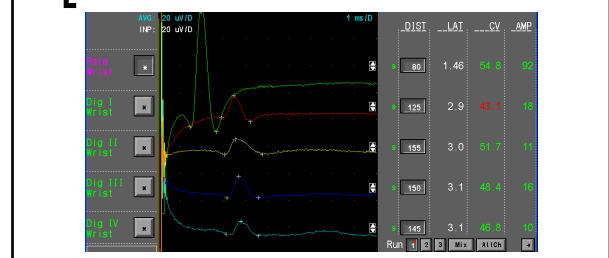
224

[N.medianus sin - motor]

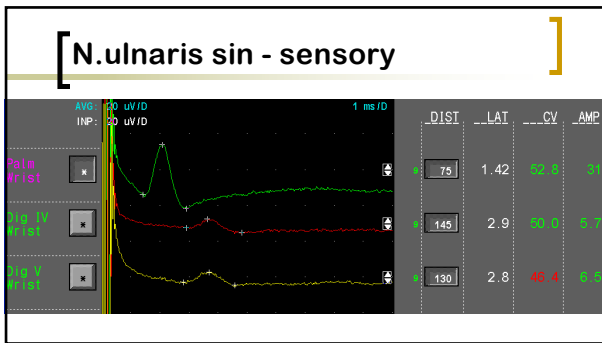


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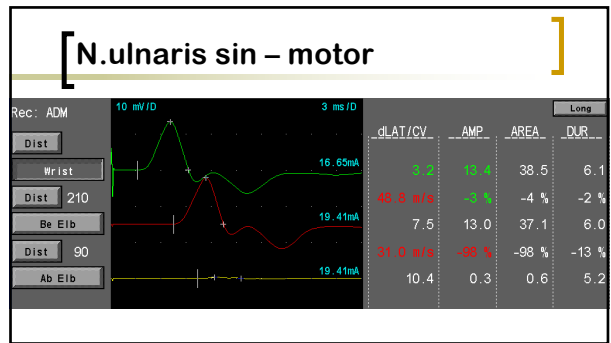
[N.medianus sin - sensory]



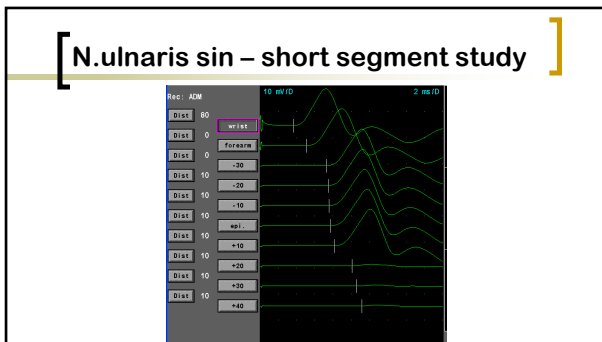
226



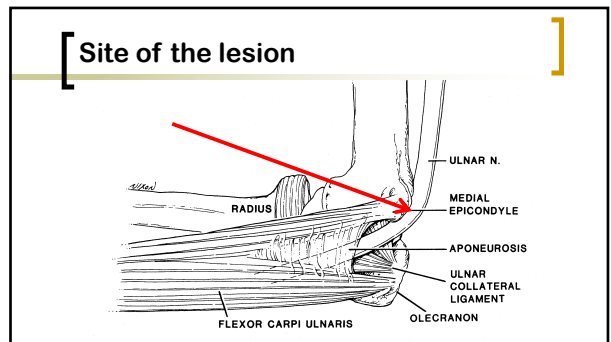
227



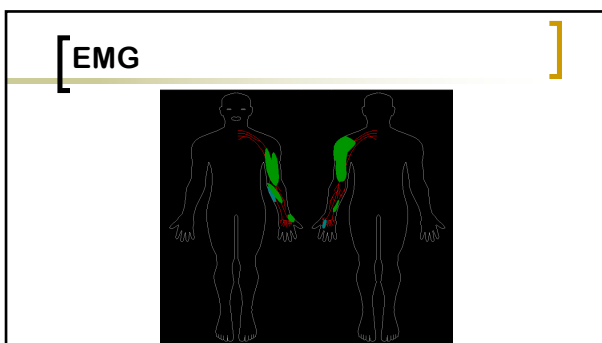
228



229



230



231

- ### [Conclusion]
- Ulnar neuropathy at the elbow on the left side
 - 10-20 mm above the medial epicondyle
 - Mostly a conduction block
 - Mild axonal involvement
 - Etiology?

232

Additional information

- Two weeks prior to the onset of symptoms her favorite grandson had acquired her a computer equipped with Skype and Facebook 6 weeks ago
- The last 5 weeks she spent 1-2 hours daily on the computer in touch with her own 2 children and 5 grandchildren

233

Grandmother with facebook



234

Etiology

- Repeated compression of the ulnar nerve at the elbow caused by static flexion of the elbow
- Spontaneous recovery symptoms in 3 months

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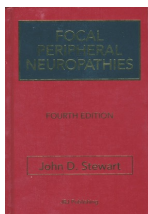
Take home messages

- It is not enough to localize and characterize the neuropathy - **you need to find the cause!**
- Most ulnar neuropathies are caused temporary compression
- Patient is the culprit
- True entrapments are rare in a normal elbow
- Ulnar neuropathies often in the non-dominant hand
- Men > women

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Stewart Focal Peripheral Neuropathies

JBJ Publishing, 2010



- The textbook on focal neuropathies.**
- A must in the bookshelf of every EMGer

Available from AANEM

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Müller-Wahl, Tegenthoff Läsionen der peripherer Nerven und radikuläre Syndrome

11. Überarbeitete Auflage, Thieme, 2020



- German
- Superb textbook on focal neuropathies.
- Excellent anatomy

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[Game over]

