

Focal peripheral neuropathies

Björn Falck, MD, PhD
Turku, Finland
bjornfa@gmail.com

No disclosures

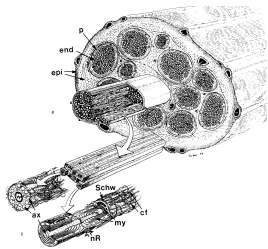
1

Outline 60 min

- Eine kurze Einleitung
 - 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

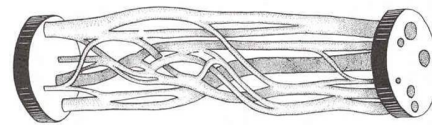
2

Peripheral nerve



3

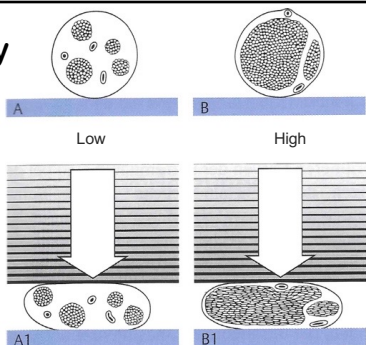
Fascicles



4

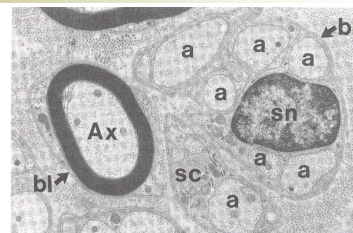
Vulnerability

Sciatic nerve lesions
 • A. Tibial nerve – Low
 • B. Peroneal nerve - High



5

Microscopic structure



Myelinated nerve = Ax

Unmyelinated axons = a

6

Microscopic anatomy

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

7

Axon types

Type	Diameter	Function
A α	12-20 μm	Touch , alfa motoneurons
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

8

Causes of focal nerve lesions

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

9

Causes of focal nerve lesions

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

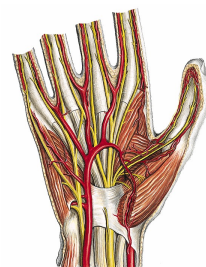
10

Predisposing factors

11

Narrow passages - Median nerve

- CTS
- Ulnar nerve in the cubital tunnel

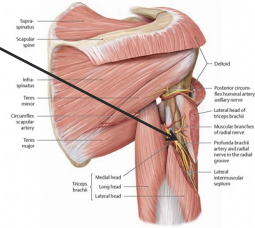


Putz and Pabst (ed) Sobotta. Atlas of Human Anatomy. 20 th edition. Urban & Schwarzenberg

12

Proximity to bone – Radial nerve

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

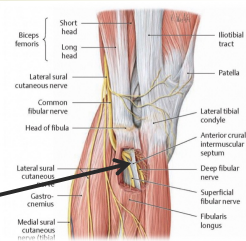


Schuenke et al. THIEME Atlas of Anatomy • General Anatomy and Musculoskeletal System © THIEME 2007 • All rights reserved. Usage subject to terms of use. • www.thieme.com/ta

13

No protective tissue - Peroneal

- Peroneal nerve - knee
- Ulnar nerve - elbow



Schuenke et al. THIEME Atlas of Anatomy • General Anatomy and Musculoskeletal System © THIEME 2007 • All rights reserved. Usage subject to terms of use. • www.thieme.com/ta

14

Patient related risk factors

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

15

Patient related risk factors

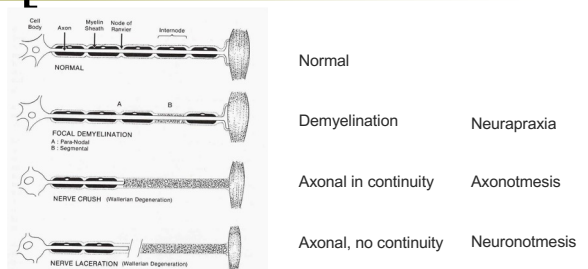
- Polyneuropathies
 - Diabetic PNP
 - HNPP (Hereditary neuropathy with liability to pressure palsies)
- Bony deformities
 - Rheumatoid arthritis, arthrosis, fractures

16

Pathophysiology

17

Different types of nerve lesions



18

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

19

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 nerves, blood vessels, infarction of muscle
 - Lundborg G. *Ischaemic nerve injury. Experimental studies.... Scan J Plastic Reconstr Surg* 1970; suppl 6

20

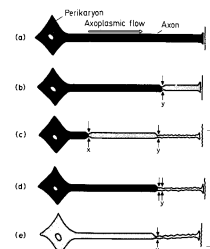
Axon susceptibility to compression

Ochoa J, Fowler TJ, Gilliatt 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

21

Double crush syndrome



22

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

23

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

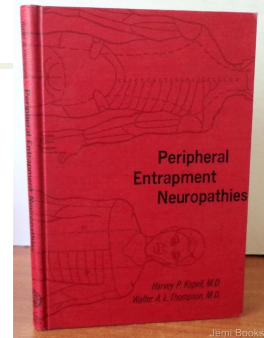
Diagnosis	Female		Male		Total		Chi-test
	N	%	N	%	N	% focal	
Lumbar radiculopathy	250	57	191	43	441	22,8	ns
Carpal tunnel syndrome	273	66	140	33	413	21,4	p<0.01
Ulnar nerve lesion	56	36	98	64	154	8,0	p<0.01
Cervical radiculopathy	55	36	96	64	151	7,8	p<0.01
Brachial plexopathy	39	39	61	61	100	5,2	p<0.01
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

24

Entrapment neuropathies

25

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



26

Entrapment neuropathy

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

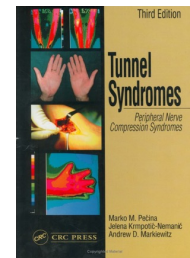
HP Kopell and VAL Thompson
Peripheral Entrapment Neuropathies
 The William and Wilkins Company
 Baltimore, 1963

"Chronic compressive neuropathy caused by surrounding anatomical structures"

27

55 syndromes! Neuromythology

All that shines is not gold!!!



28

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%)

29

Entrapments - upper extremities

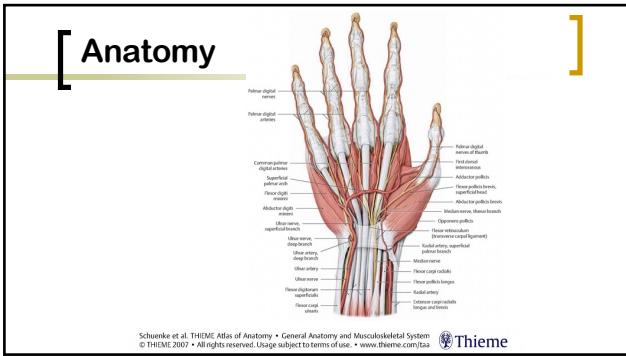
Common

- Carpal tunnel syndrome

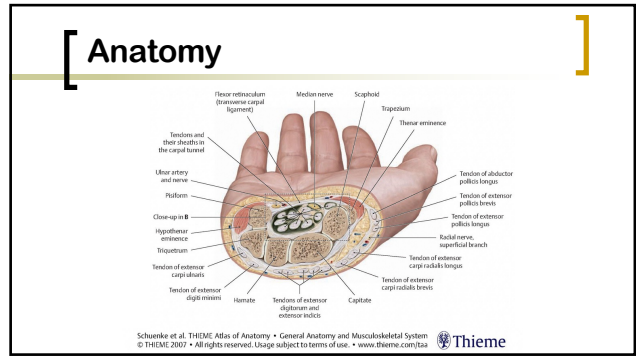
Rare

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

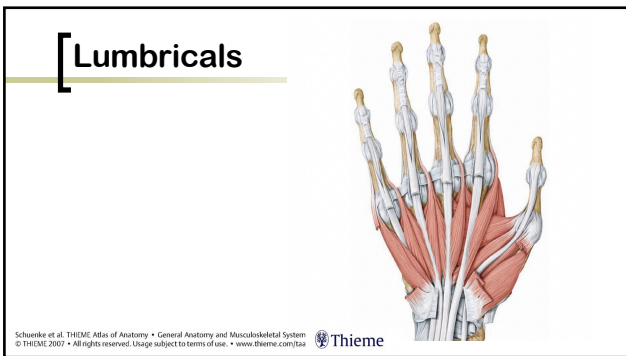
30



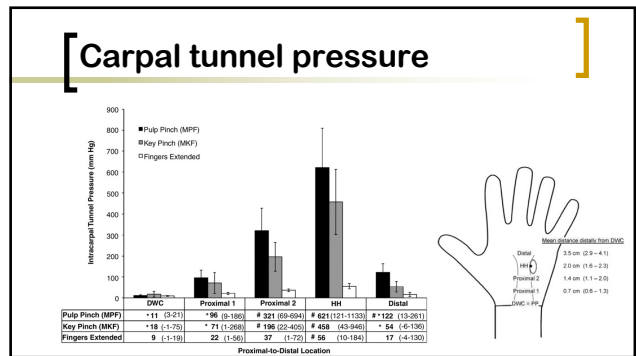
31



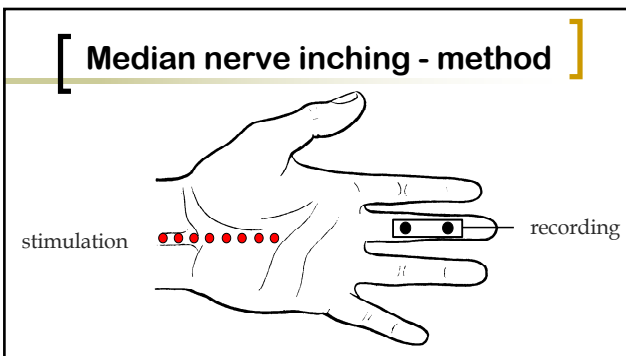
32



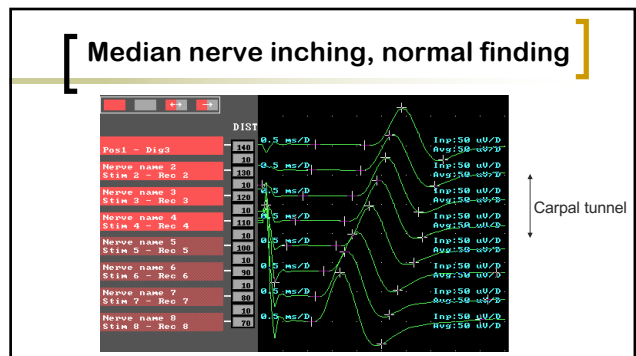
33



34

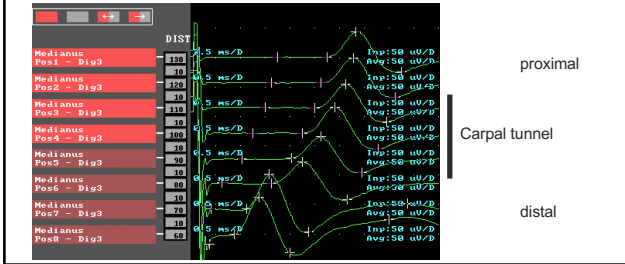


35



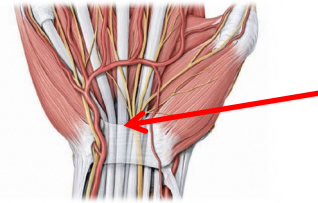
37

Inching in very mild CTS



38

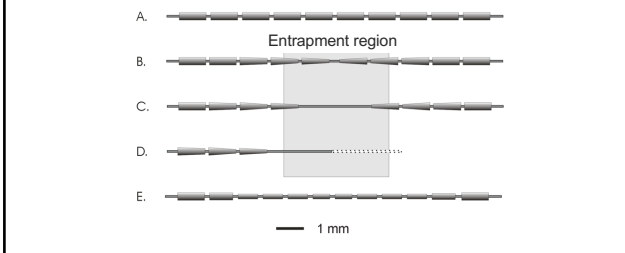
Entrapment site



Schaecke et al. THEME Atlas of Anatomy • General Anatomy and Musculoskeletal System
© THEME 2007 • All rights reserved. Usage subject to terms of use. • www.theme.com/ta
Thieme

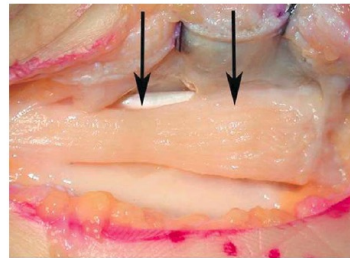
39

Pathophysiology



40

Surgical finding



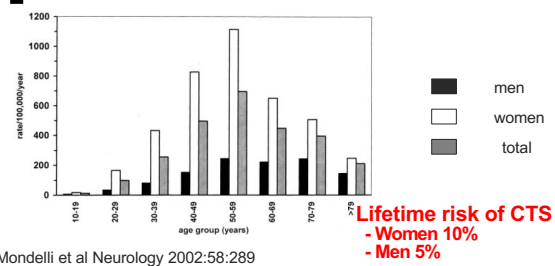
41

Predisposing factors for CTS

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

42

Annual incidence of CTS



43

Diagnosis

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

44

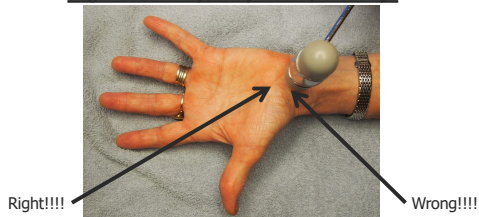
Symptoms

- 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!**

45

Tinel's sign – useless test in CTS

High sensitivity, very low specificity

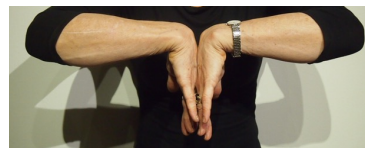


Tinel, Jean. Le signe du fourmillement dans les lésions des nerfs périphériques. Presse médicale, 1915;47: 388-389

46

Phalen's sign

- 1 min
- Numbness in fingers 1-4
- Positive in moderate and severe CTS
- Specific



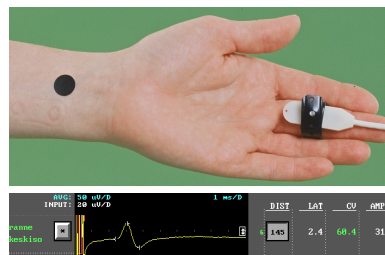
47

Different neurophysiological methods

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

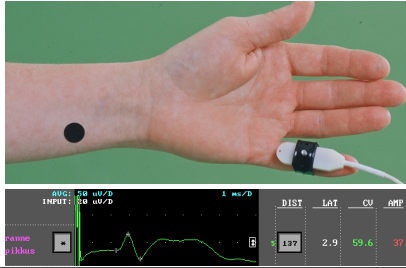
48

N.medianus – sensory neurography



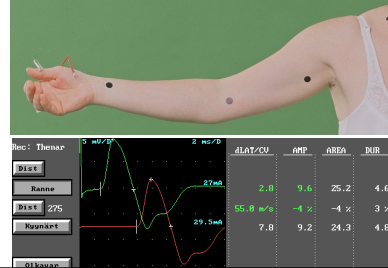
49

N. ulnaris – sensory neurography



50

N. medianus - motor neurography



51

EMG



52

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

53

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. Jablocki, MD; M.T. Andary, MD; M.K. Floeter, MD, PhD; R.G. Miller, MD; C.A. Quartly, MD; M.J. Vennix, MD; and J.R. Wilson, MD

54

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

55

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

56

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

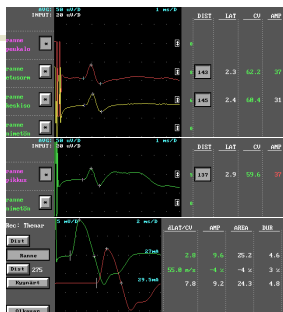
57

Normal finding

N.medianus, sens

N.ulnaris, sens

N.medianus, mot



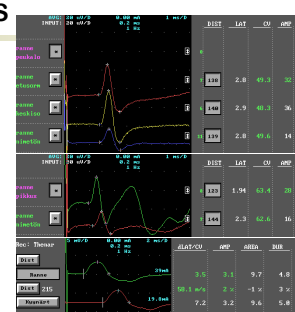
58

Very mild CTS

N.medianus, sens

N.ulnaris, sens

N.medianus, mot



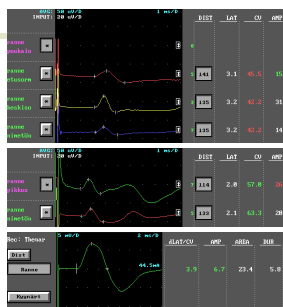
59

Mild CTS

N.medianus, sens

N.ulnaris, sens

N.medianus, mot



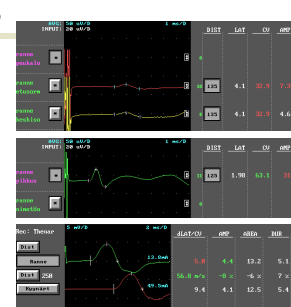
60

Moderate CTS

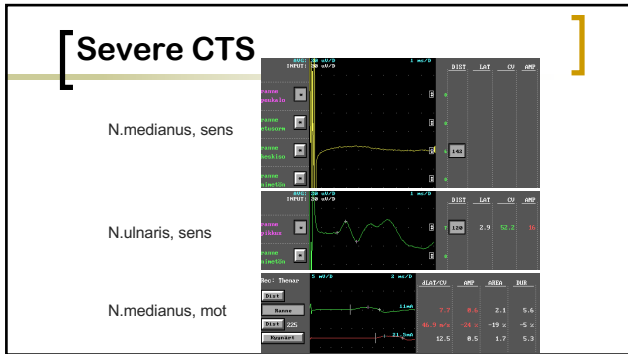
N.medianus, sens

N.ulnaris, sens

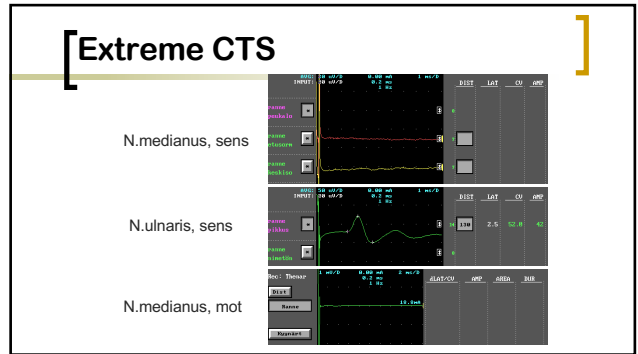
N.medianus, mot



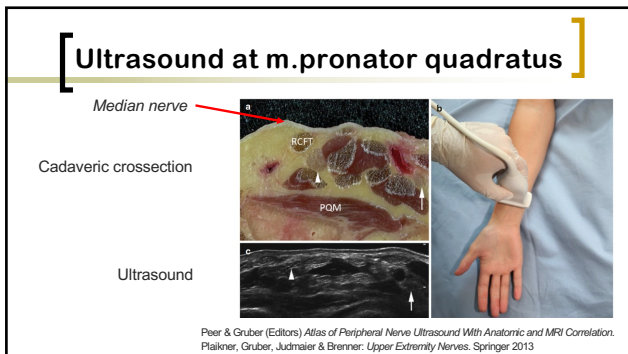
61



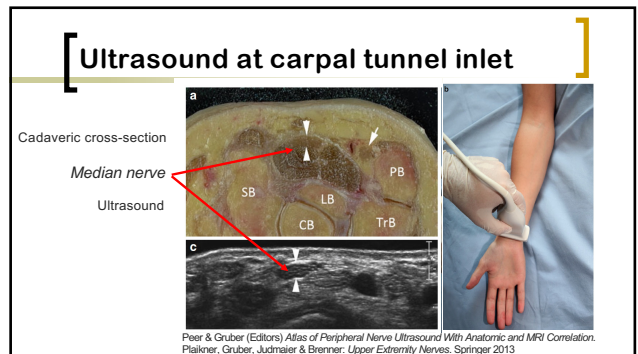
62



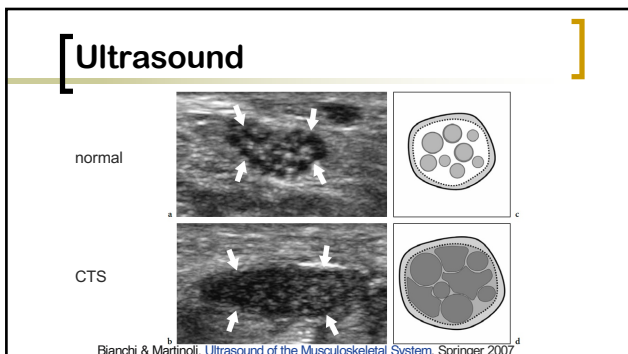
63



64



65



66

- ### [Ultrasound in CTS]
- 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

69

[Ultrasound]

- Structural information
- Identifies structural abnormalities
 - Lipoma
 - Ganglion
 - Aneurysm
 - Tumors
 - Scars
 - Inflammation

70

[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

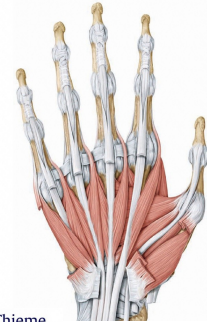
71

[Treatment]

- Before treatment evaluate causes (risk factors) 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

72

[Lumbricals]



Schenke et al. *THieme Atlas of Anatomy - General Anatomy and Musculoskeletal System*
© THieme 2007 • All rights reserved. Usage subject to terms of use • www.thieme.com/tae Thieme

73

[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

74

[Surgery]



75

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 59%. 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, Ethelbert Road, Canterbury, Kent, CT1 3NG, UK

Accepted 7 March 2001

76

Surgical outcome

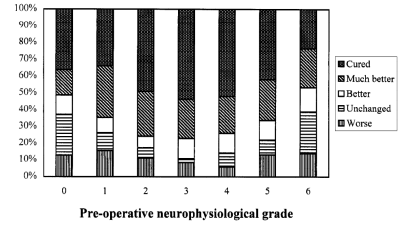


FIGURE 1. Subjective outcome of carpal tunnel decompression in relation to preoperative neurophysiological grade.

77

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

Annette A. M. Gerritsen, PhD
Henrica C. W. de Vet, PhD
Bob J. P. M. Schooten, MD, PhD
Frits W. Benda-Blijleven, MD, PhD
Mans C. T. F. M. de Krom, MD, PhD
Lex M. Beuter, PhD

CARPAL TUNNEL SYNDROME (CTS) is the most common entrapment neuropathy and is caused by compression of the median nerve at the wrist. The prevalence of electrophysiologically confirmed CTS in the adult general population in the Netherlands is 6.0% in men and 9.2% in women.¹ While CTS may be treated with conservative options such as wrist splints, injections with corticosteroids, or both, evidence for the efficacy of most conservative treatment options is limited.² A recent systematic review has shown that among the vari-

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

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). All 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%; $P < .001$). After 18 months, the success rates increased to 90% for the surgery group (61/68 patients) vs 75% for the splinting group (50/79 patients), which is a difference of 15% (95% CI, 3%–27%; $P = .02$). However, by that time 41% of patients (52/79) in the splint group had also received the surgery treatment.

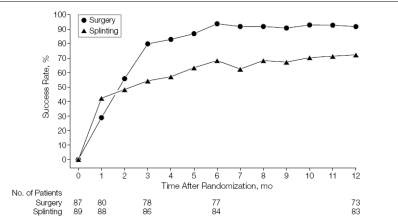
Conclusion Treatment with open carpal tunnel release surgery resulted in better outcomes than treatment with wrist splinting for patients with CTS.

DOI: 10.1002/ctm.1001

78

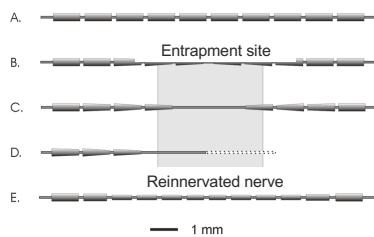
Surgery > splinting

Figure 2. Success Rates at Each Follow-up Measurement



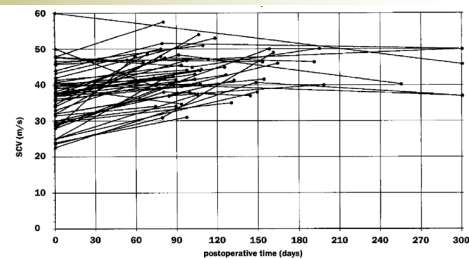
79

Pathophysiology



80

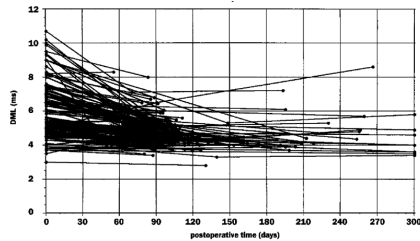
Sensory CV after surgery



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

81

Distal motor latency after surgery



82

US postoperatively

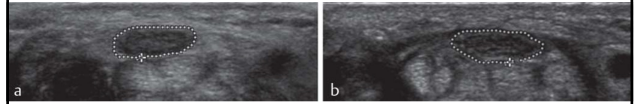


Fig. 4 CSA of the median nerve in a 72-year-old male patient a: preoperative, CSA 0.252 cm², VAS 7, b: 12 months postoperative CSA 0.276 cm², VAS 0.

- Thickening does not change after surgery

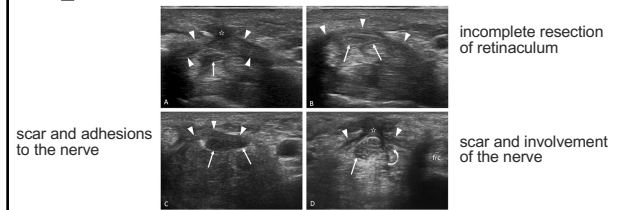
83

Problems following surgery

- Erroneous 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!!!

84

Ultrasound – failed surgery

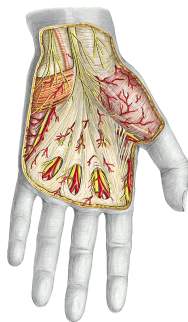


A. Gervasio et al· Carpal tunnel sonography Journal of Ultrasound (2020) 23:337–347

85

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

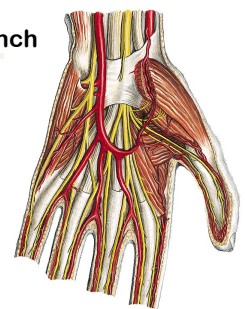


Putz and Pabst (ed) Sobotta, Atlas of Human Anatomy, 20th edition, Urban & Schwarzenberg

86

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

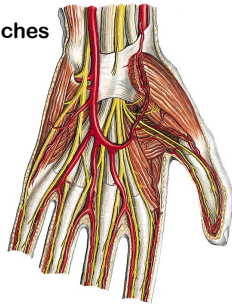


Putz and Pabst (ed) Sobotta, Atlas of Human Anatomy, 20th edition, Urban & Schwarzenberg

87

Damage to sensory palmar braches

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



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

88

Beware of overdiagnosis

Always consider: Do the ENG abnormalities explain the symptoms?

89

Neuromythology!

- 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

90

Odin – His ravens: Munin and Hugin

Hugin (hågen=tanken, "thought")



Munin =minnet, "memory"

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

91

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

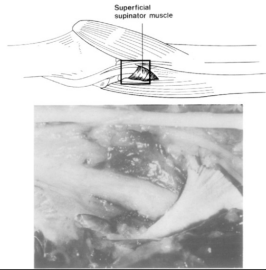
92

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

93

Posterior interosseus syndrome



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

94

Site of maximum pain

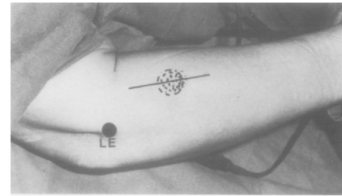


Fig. 4. Entrapment site and line of incision. The right forearm seen from the side. Dotted area: maximal tenderness over the nerve. LE: lateral epicondyle. Straight line: skin incision.

95

FFG journal 1980:50:125-133

NEUROPHYSIOLOGICAL INVESTIGATION OF POSTERIOR INTEROSSEOUS NERVE ENTRAPMENT CAUSING LATERAL ELBOW PAIN

INGMAR ROSÉN and CARL-OLOF WERNER

Departments of Clinical Neurophysiology and Orthopedic Surgery, University Hospital, S-221 85 Lund (Sweden)

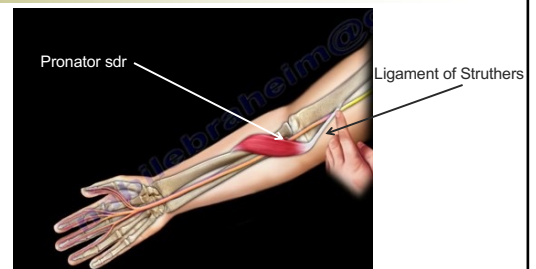
(Accepted for publication: March 27, 1980)

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; Gianetti 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-

crease 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 8. 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

96

Pronator syndrome



97

J Hand Surgery 2011:36:907-909

EVIDENCE-BASED MEDICINE

Pronator Syndrome

Steven Presciutti, MD, Craig M. Rodner, MD

Continuing Medical Education

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 antebrachial 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.¹⁻⁴ 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 fingers³⁻⁵ 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.⁶ 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-

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.

98

99

Alberto Brandolini's principle

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

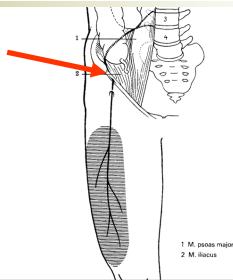
100

Entrapments – lower extremities

- Morton's metatarsalgia
- Meralgia paresthetica

101

N.cutaneus femoris lateralis



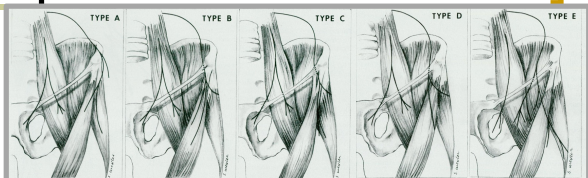
102

Meralgia paresthetica

- Numbness of the lateral side of the thigh
 - Standing
 - Walking
 - Lying prone with straight legs
 - Alleviated sitting
- Rarely pain
- **Severe obesity BMI >30 kg/m²**

103

Course of lateral cutaneous nerve



- | | | | | |
|---|---|---|--|---|
| A: 4%
Posterior to ASIS
Across iliac crest | B: 27%
Anterior to ASIS
Superficial to sartorius | C: 23%
Medial to ASIS
In tendon of sartorius | D: 26%
Medial to sartorius
Between tendon of sartorius and iliopectas | E: 20%
Medial, overlying iliopectas |
|---|---|---|--|---|

ASIS = anterior superior iliac spine

104

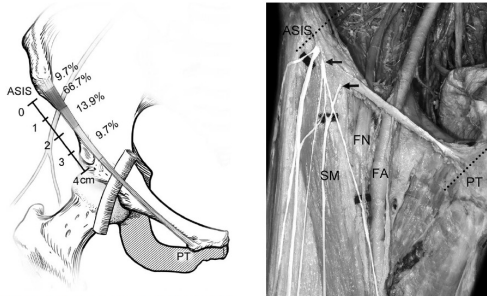
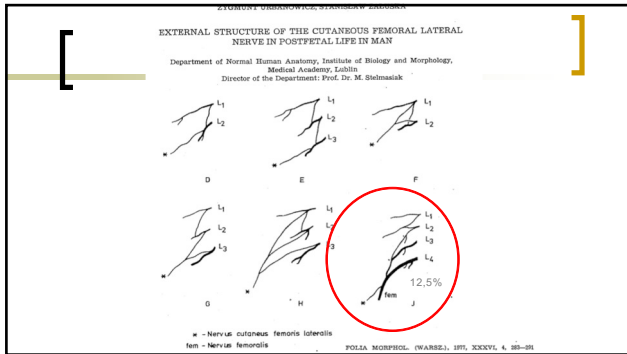


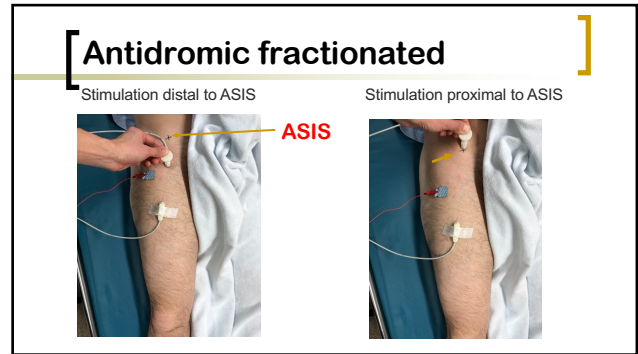
FIGURE 2. Significant areas where the LFCN is located. In approximately 70% of cases the LFCN was located <1 cm from the ASIS.

FIGURE 3. Multiple branches of the LFCN caused by intrapelvic ramification. Anomalous branches (arrow) arise medial to the LFCN and form a plexus in the proximal thigh.

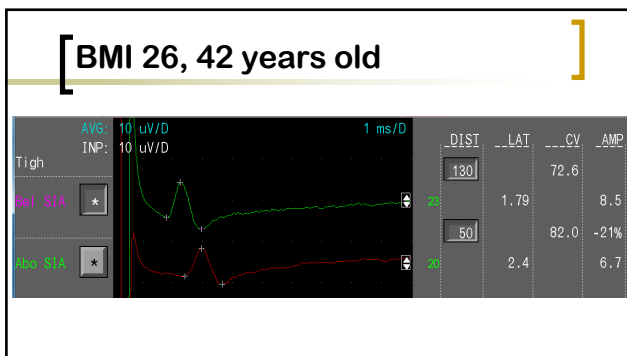
105



106



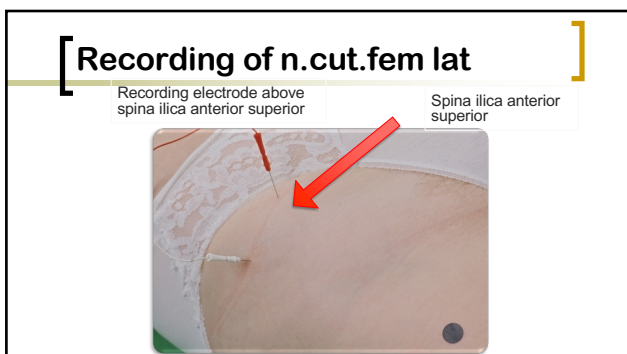
107



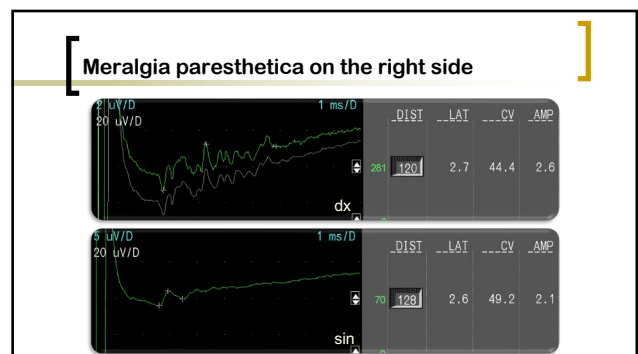
108

- ### Preliminary results – Jonathan Chu
- 60 subjects 33 male, 27 female
 - 19-80 years
 - BMI 24.33 (17-43)
 - Response with antidromic method for all except 1 (BMI 43)
 - 8 subjects no response above ASIS by antidromic
 - 6 subjects no response above ASIS by orthodromic
 - Mean below ASIS (Point A) amplitude 3.9, velocity 70 ± 6 m/s

109

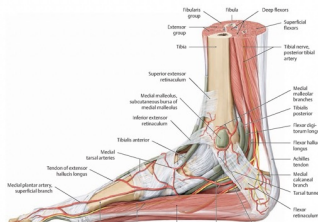


110



111

Tarsal tunnel syndrome?????



Schuenke et al. • *THIEME Atlas of Anatomy* • *Systema radiologicum et musculoskeletale system*
© THIEME 2007 • All rights reserved. Usage subject to terms of use. • www.thieme.com/taa

117

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

118

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%)

119

Temporary nerve compression

120

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 branches in the hand

121

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%)

122

Ulnar neuropathy

123

Ulnar neuropathies in the literature



124

124

Epidemiology

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

125

125

Confusing terminology

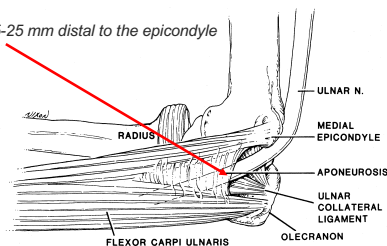
- Entrapment
 - Not synonymous with focal neuropathy
- Cubital tunnel syndrome!
 - Literature often uses term for any ulnar neuropathy at the elbow
- Tardy ulnar palsy
 - Arthrosis of the elbow
- Localization?
 - Retroepicondylar, cubital tunnel, diffuse
- Etiology
 - Temporary or repeated compression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

126

126

Ulnar nerve at the elbow

Aponeurosis 5-25 mm distal to the epicondyle



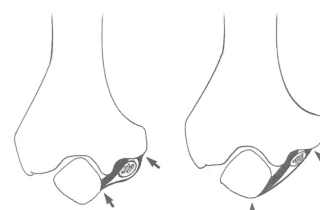
Kincaid JC. Muscle Nerve 1988;11:1005-1015

127

127

Cubital tunnel - rest and flexion

Elbow extended Elbow flexed



128

128

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, 5-10%

129

129

Ulnar neuropathy at the elbow 2

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

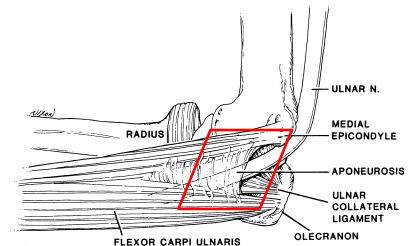
130

130

Entrapment at the elbow

131

Cubital tunnel



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

132

132

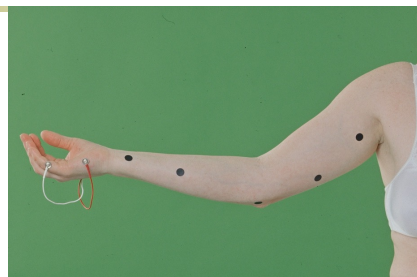
Cubital tunnel syndrome

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

133

133

Ulnar nerve



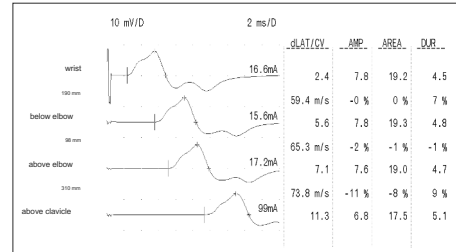
134

Ulnar nerve



135

Ulnar nerve



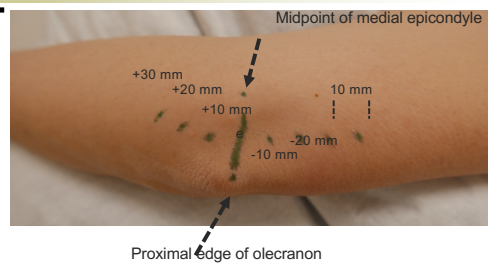
136

Ulnar nerve short segment study



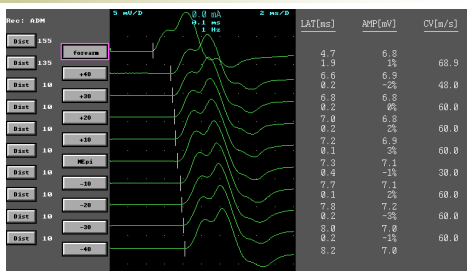
137

Reference line



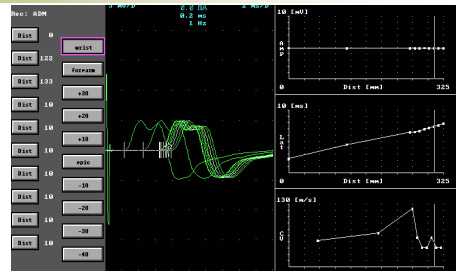
138

Ulnar nerve inching - normal



139

Ulnar nerve - superimposed



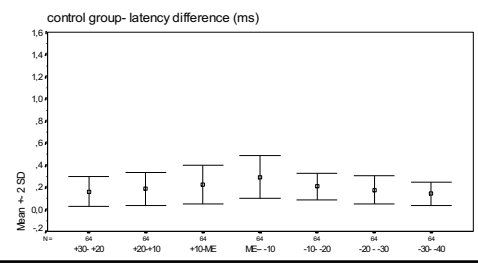
140

Basic facts

- Conduction velocity = 50 m/s
- Conduction time in 10 mm segment 0.2 ms

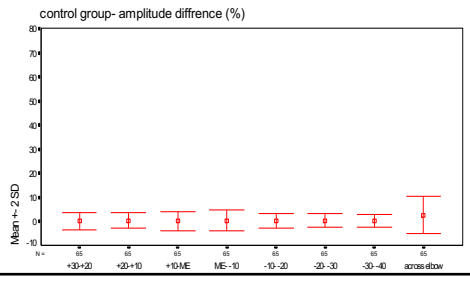
141

Ulnar nerve inching - controls



142

Ulnar nerve inching - decay



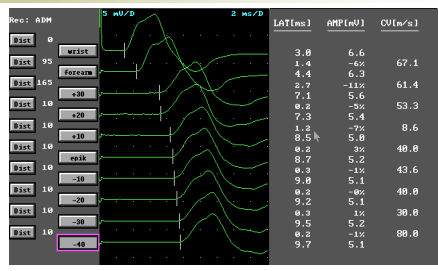
143

Reference limits

- Conduction time < 0.5 ms
- Amplitude decay < -5%

144

Mild cubital tunnel syndrome



145

Tardy ulnar palsy

Tardy ulnar palsy

146

[Arthrosis of the elbow]



147

[Tardy ulnar palsy]

- Deformity of the elbow joint
 - Previous supracondylar humerus fracture
 - Arthrosis of the elbow – age, rheumatoid arthritis
- 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

148

[]
Temporary compression

149

[The non-dominant side is exposed]



150

150

[The sofa may be dangerous..]



151

151

[Reading in chair is not good...]



152

152

[Mobile phone also problem.....]



153

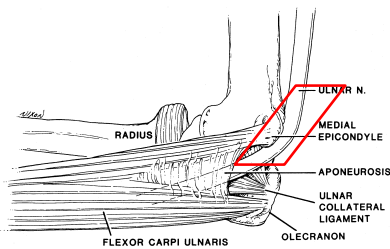
[Temporary compression]

- 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

154

154

[Retroepicondylar groove]

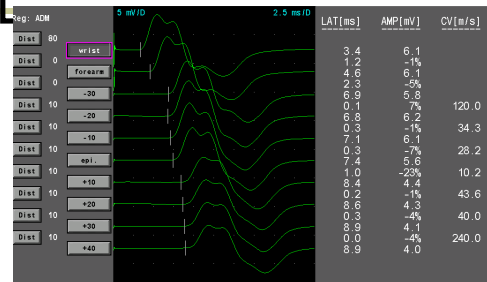


Kincaid JC. Muscle Nerve 1988;11:1005-1015

155

155

[Retroepicondylar ulnar nerve lesion]



156

[Ulnar numbness in the night]



Picture courtesy of Jesus Panigua

157

[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

158

158

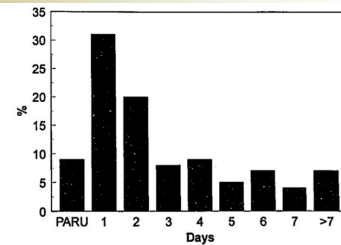
Perioperative ulnar neuropathy

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

159

159

Perioperative ulnar neuropathies do not originate on the operating table!

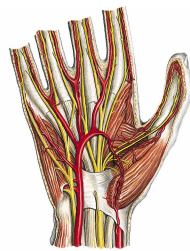


Warner MA. Et al Ulnar neuropathy. Incidence, outcome and risk factors in sedated or anesthetized patients. *Anesthesiology* 1994;81:1332-1340

160

160

Ulnar nerve at the wrist



Putz and Pabst (ed) Sobotta. Atlas of Human Anatomy, 20th edition, Lippincott & Williams & Wilkins

161

161

Ulnar nerve at the wrist

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

162

162

Cyclists palsy



163

163

STYRKEPRØVEN

TRONDHEIM - OSLO

537 KM



164

164

Acta Neurol Scand 1997; 95: 233-240
Printed in UK - all rights reserved

Copyright © Munksgaard 1997
ACTA NEUROLOGICA
SCANDINAVICA
ISSN 0001-6314

Impotence and nerve entrapment in long distance amateur cyclists

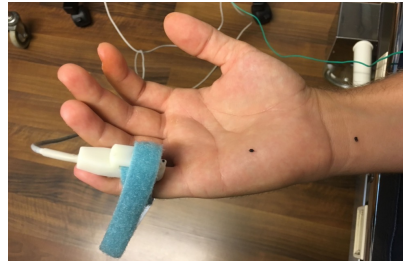
Andersen KV, Bovim G. Impotence and nerve entrapment in long distance amateur cyclists. Acta Neurol Scand 1997; 95: 233-240. © Munksgaard 1997.

Kjeld V. Andersen, Gunnar Bovim¹
Laboratory of Clinical Neurophysiology, Department of Neurology, Trondheim University Hospital, Norway

- 13% had numbness of the ulnar fingers
- Never pain
- 5 % men had impotence due to pudendal neuropathy
- In most participants symptoms lasted 1-3 months

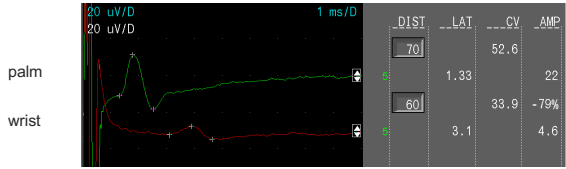
165

Fractionated neurography at wrist



166

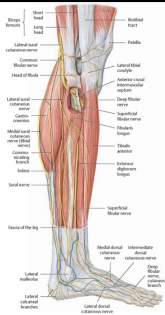
Fractionated neurography



	DIST	LAT	CV	AMP
palm	70	1.33	52.6	22
wrist	60	33.9	-79%	4.6

167

Peroneal nerve- knee



Schuenke et al. THIEME Atlas of Anatomy • General Anatomy and Musculoskeletal System
© THIEME 2007 • All rights reserved. Usage subject to terms of use. • www.thieme.com/taa

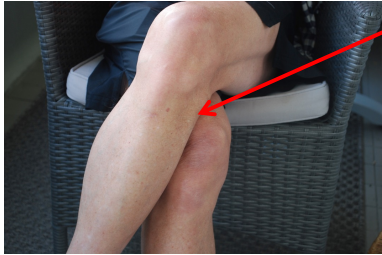
168

Peroneal nerve at the knee

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

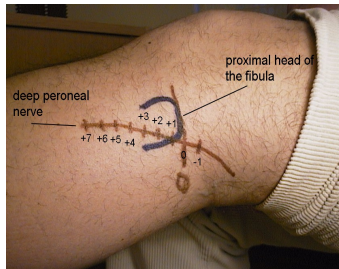
169

Peroneal nerve compression



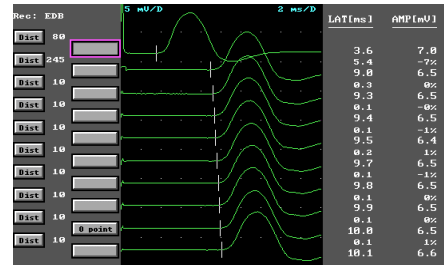
170

Stimulation sites



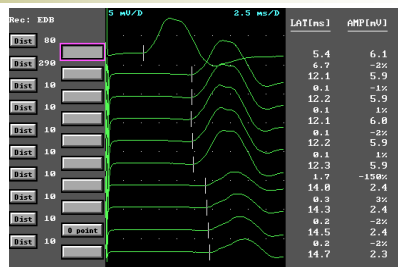
171

Peroneal nerve inching-normal



172

Slimmer's palsy



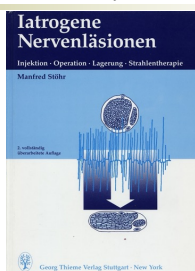
173

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

174

Iatrogenic neuropathies



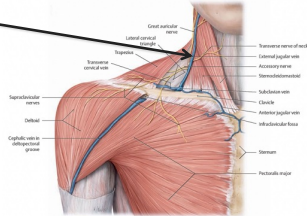
175

Iatrogenic

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

176

[Accessory nerve]

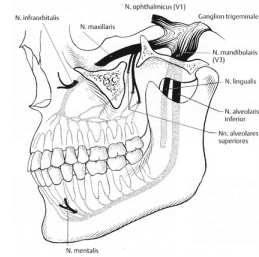


Schuenke et al. THIEME Atlas of Anatomy • General Anatomy and Musculoskeletal System
© THIEME 2007 • All rights reserved. Usage subject to terms of use. • www.thieme.com/taa



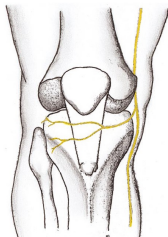
177

[Inferior alveolar nerve]



178

[Inferior patellar nerve]



37/60

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

179

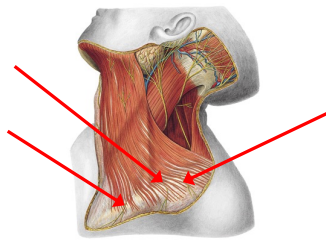
[Sural nerve]



Sobotta: Atlas of human Anatomy
UrbanSchwarzenberg

180

[N.supraclaviculares]



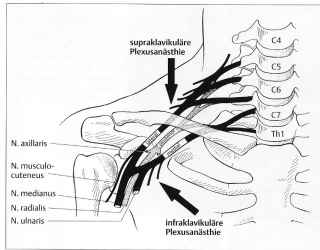
181

[Direct injury during surgery]

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

182

[Plexus anesthesia]



183

[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

184

[Goals of electrodiagnosis]

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

185



Facebook or Skype neuropathy?

186

Woman 73 years, right-handed

187

[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

188

History

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

189

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

190

Differential diagnosis?

- ?

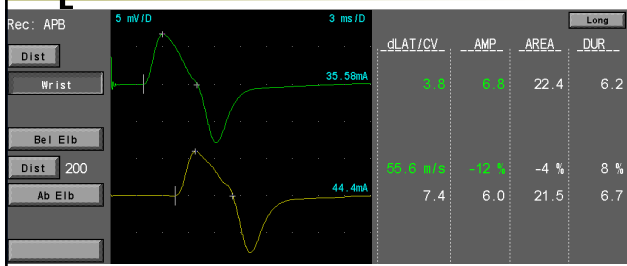
191

Differential diagnosis?

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

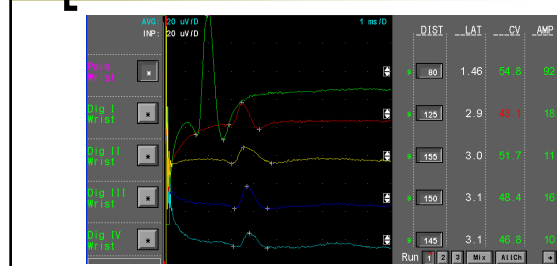
192

N.medianus sin - motor



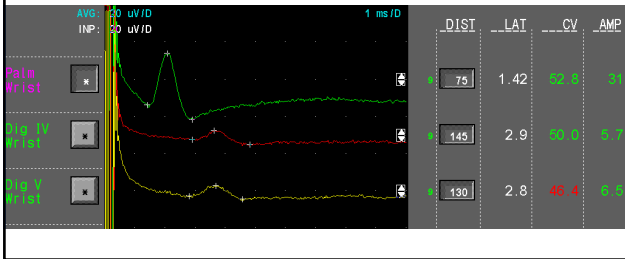
193

N.medianus sin - sensory



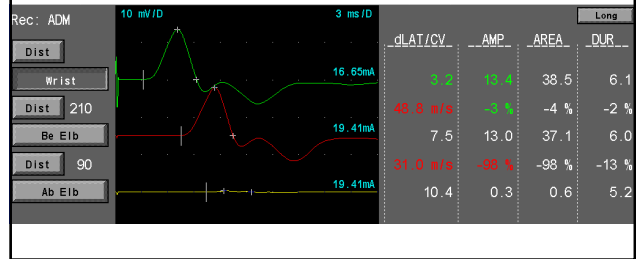
194

[N.ulnaris sin - sensory]



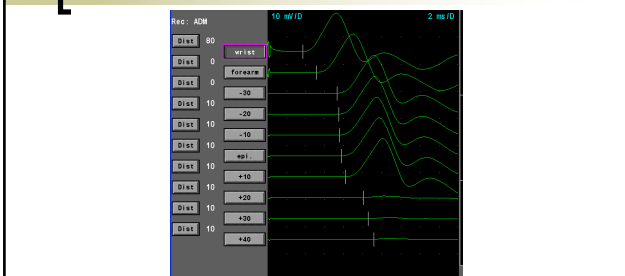
195

[N.ulnaris sin – motor]



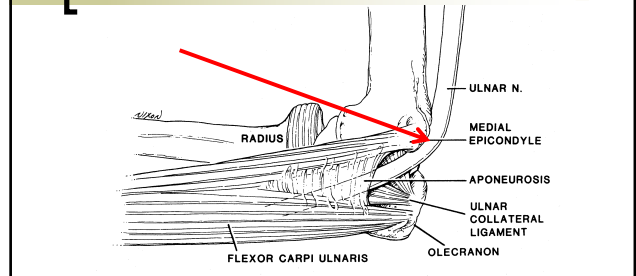
196

[N.ulnaris sin – short segment study]



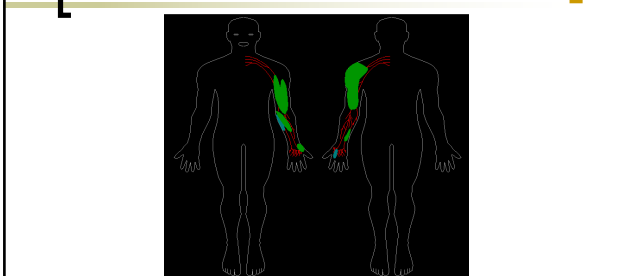
197

[Site of the lesion]



198

[EMG]



199

[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?

200

[Additional information]

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

201

[Grandmother with facebook]



202

[Etiology]

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

203

[Treatment and outcome]

- Conservative treatment
- Explanation of injury mechanism
 - Avoid static flexion of the elbow
- Symptomfree 10 weeks after the onset

204

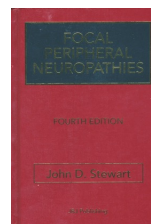
[Take home messages]

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

205

[Stewart Focal Peripheral Neuropathies]

Stewart
JBJ Publishing, 2010



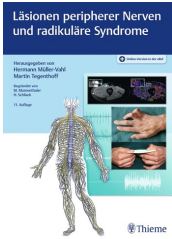
- The textbook on focal neuropathies.
- A must in the bookshelf of every EMGer

Available from AANEM

206

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

11. Überarbeitete Auflage, Thieme, 2020



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

207

Game over

Frank and Ernest by Thaves



208