

Special neurography techniques

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No disclosures

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Goals

- Neurography with surface electrodes
 - Some unusual nerves
- Neurography with near nerve electrodes
 - Technique
 - Examples
- Cases

2

Outline 45 min

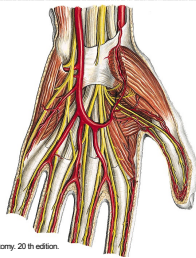
- Surface electrodes
 - Palmar digital nerves
 - Supraclavicular nerves
 - Phrenic nerve
- Neurography with near nerve electrodes
 - Plantar digital nerves
 - Infrapatellar nerve
 - Inferior alveolar nerve
- Patients

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Palmar digital nerves

4

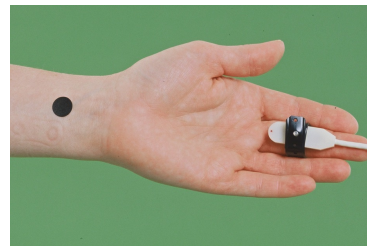
Palmar digital nerves



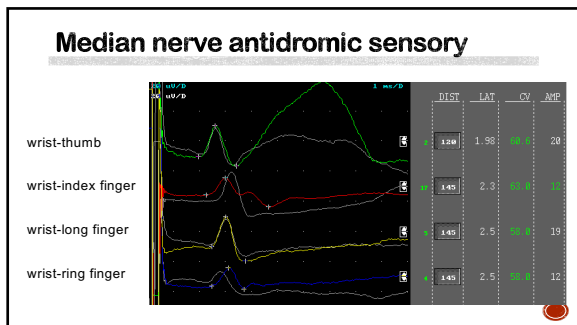
Putz and Pabst (ed) Sobotta, Atlas of Human Anatomy, 20th edition, Urban & Schwarzenberg

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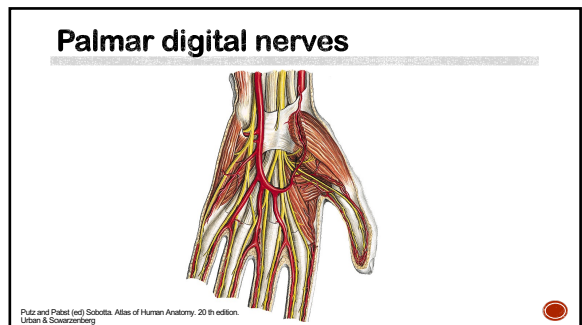
Median nerve - antidromic



6



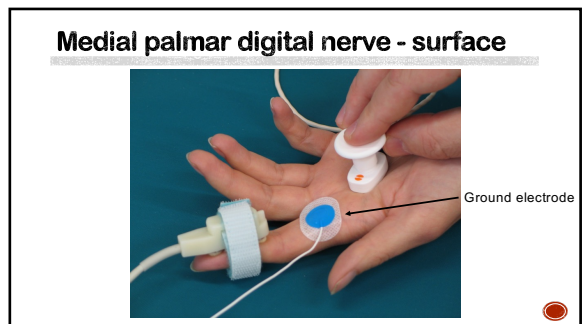
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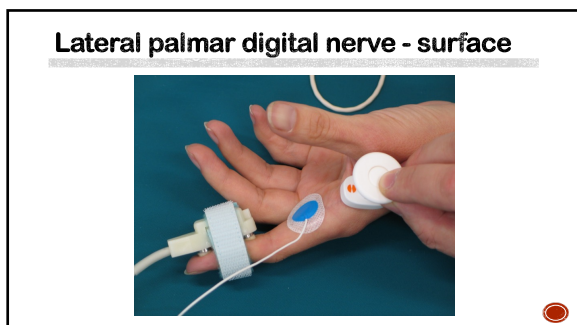
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- ### Palmar digital nerves – surface electrodes
- Reliable separation of individual digital nerves in each finger is difficult with surface electrodes
 - False negative findings

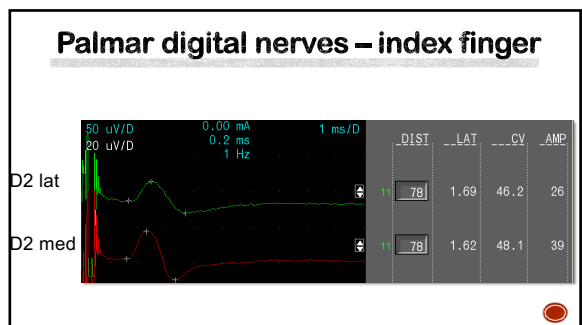
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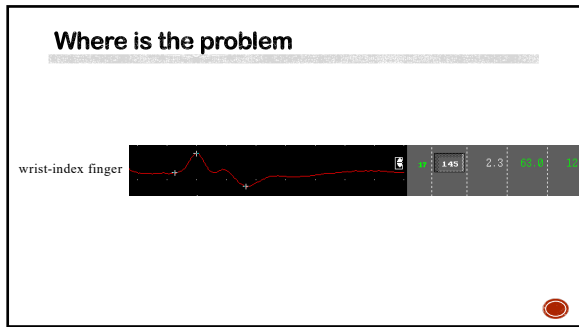
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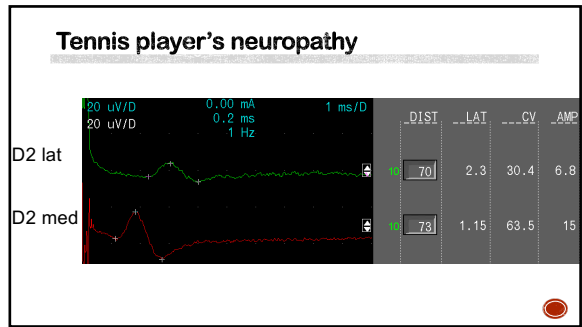
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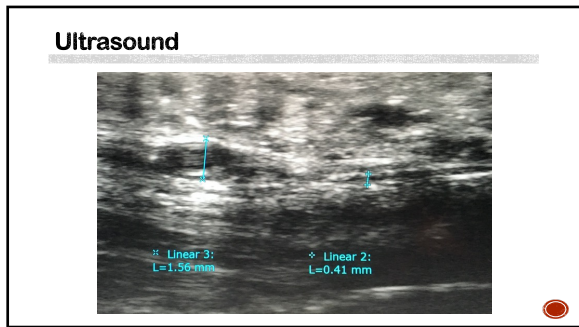
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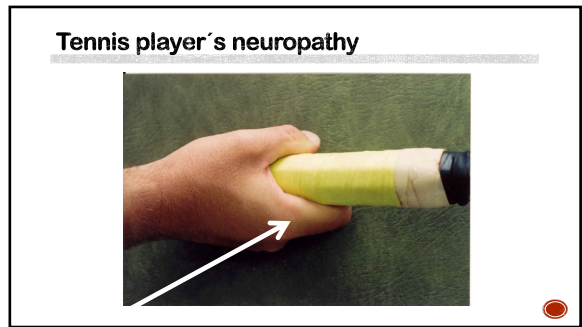
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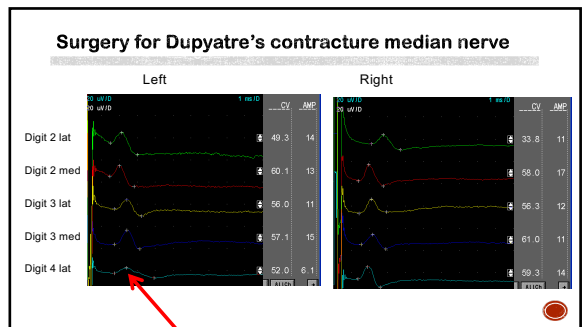
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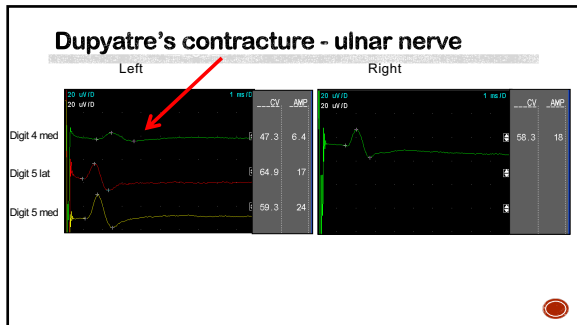
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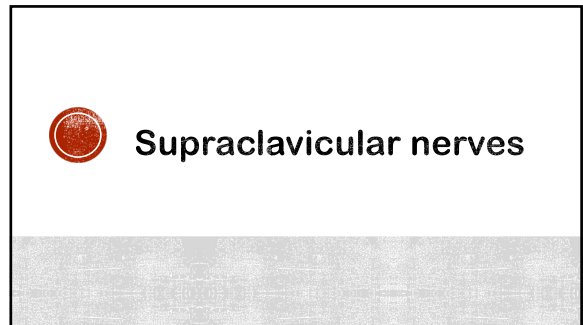
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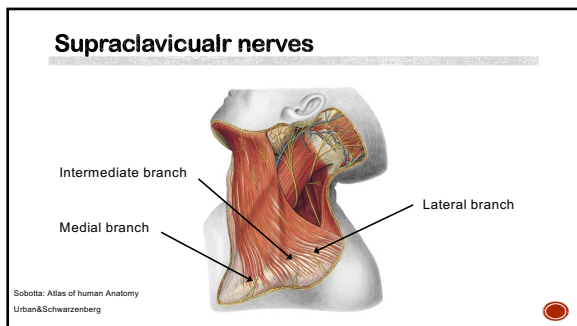
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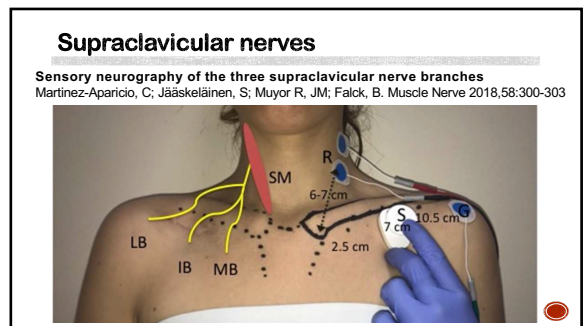
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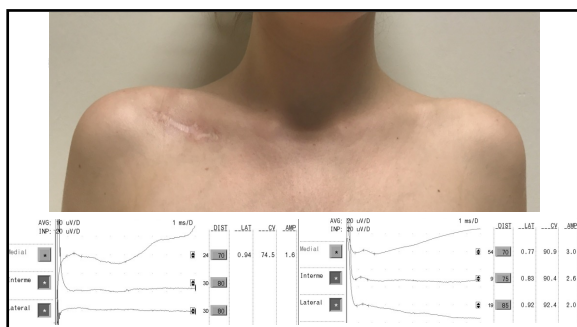
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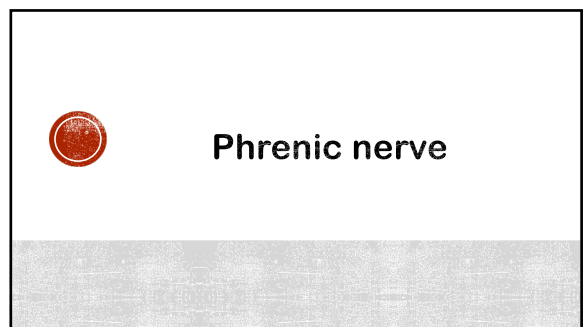
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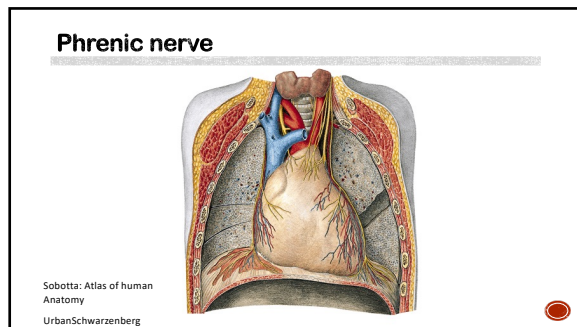
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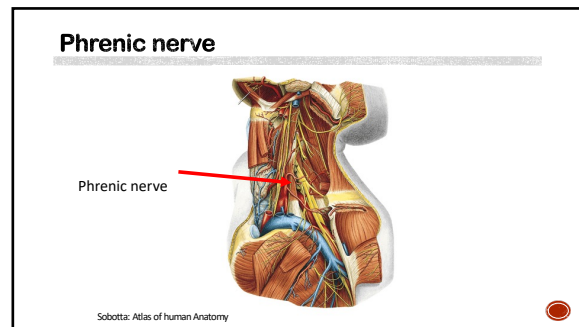
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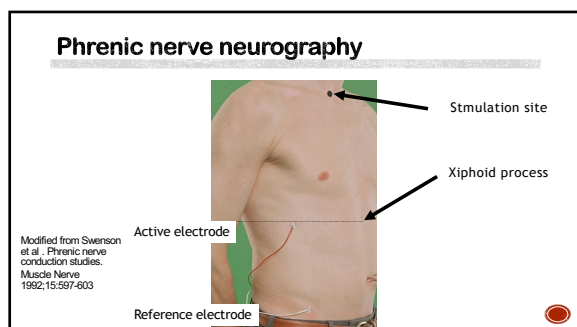
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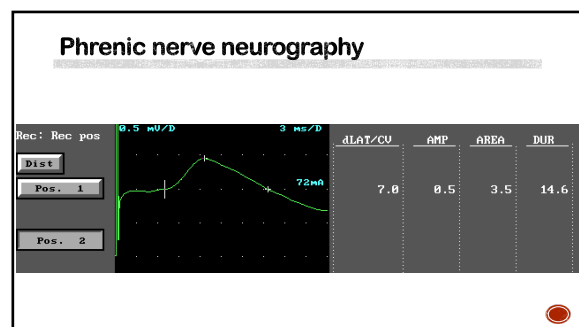
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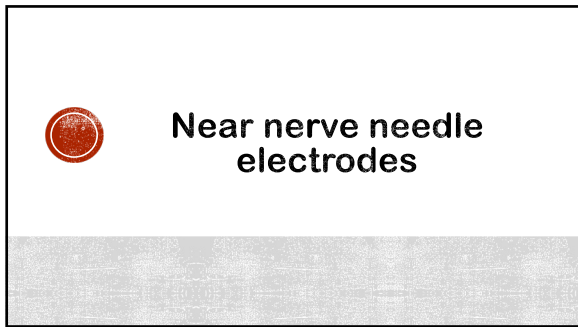
36

- ### Phrenic nerve neurography
- High stimulus intensities required
 - 70-100mA, 0.2-0.5 ms
 - Painful
 - Difficult to obtain responses in obese subjects
 - M-wave amplitude varies with respiration
 - Study during expiration if possible
 - EKG artifact may be considerable
 - Avoid stimulation of the brachial plexus

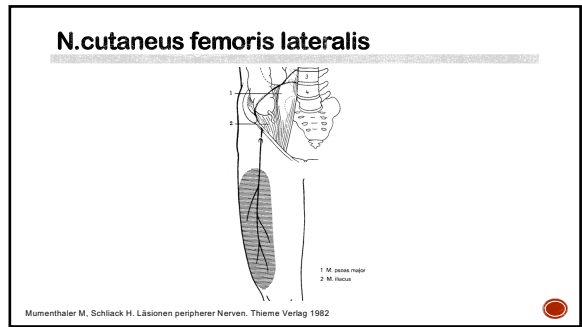
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- ### Phrenic nerve – reference values
- Latency 6,6 +/- 1,4 ms
 - Amplitude >200 uV
 - Amplitude side difference large (>100%) even in healthy subjects

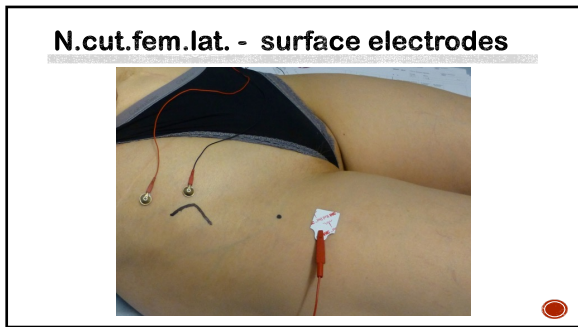
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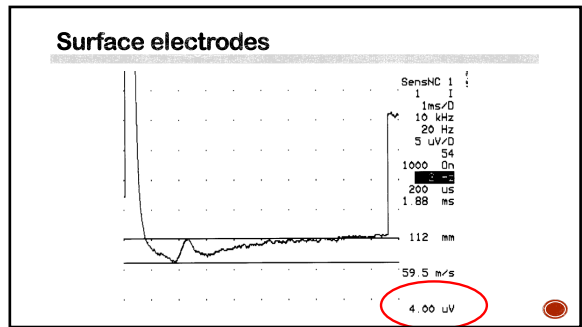
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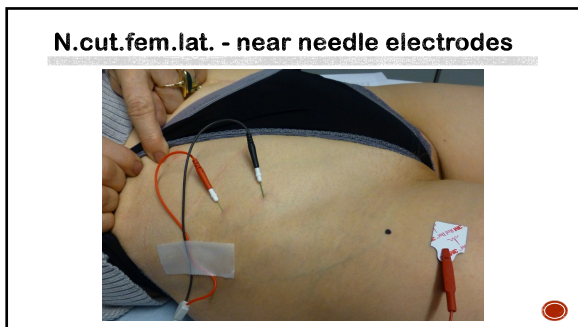
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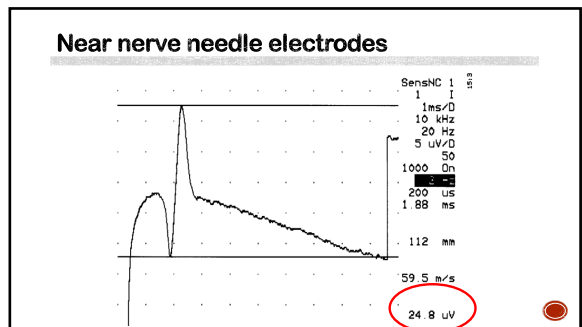
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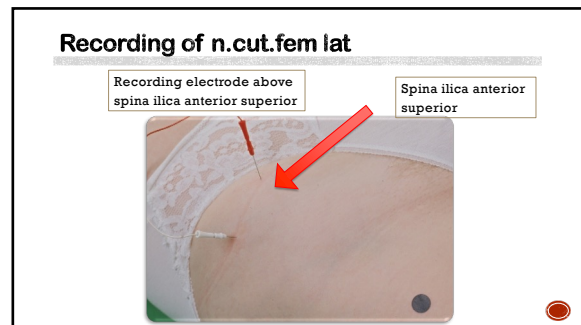
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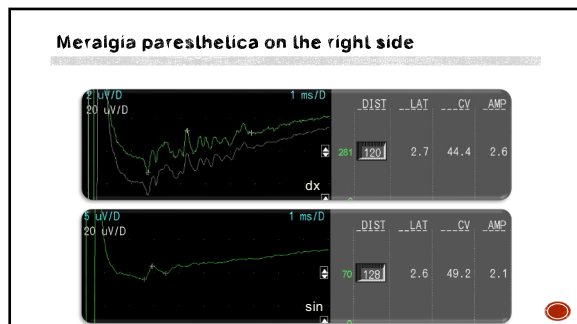
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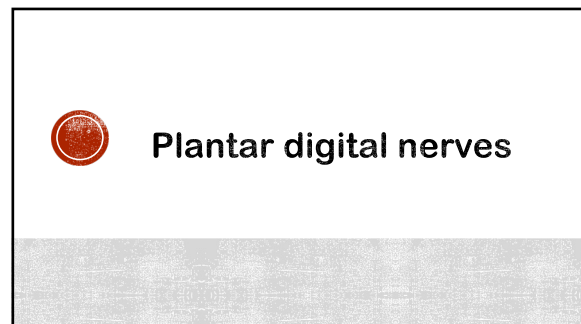
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- ### Plantar digital nerves lesions
- Metatarsal entrapment neuropathy (Morton's metatarsalgia)
 - Temporary compression due to long periods of toe flexion
 - Surgery for hallux valgus may damage the digital nerve to the lateral side of the great toe
 - Trauma

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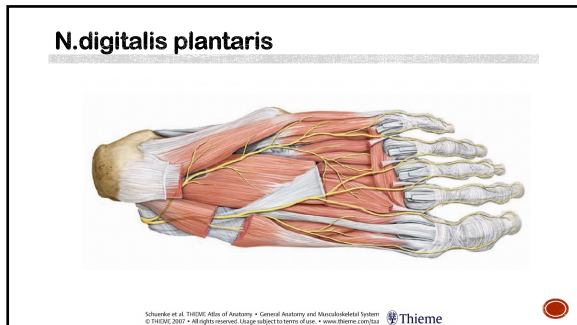
Sensory conduction velocity of plantar digital nerves in Morton's metatarsalgia

Article abstract—The orthodromic sensory conduction velocity of the plantar interdigital nerves were measured with needle electrodes in 28 healthy subjects. The stimulating needle electrodes were placed close to the shaft of the proximal phalanx of the toe, and the recording needle electrode was placed behind the medial malleolus. We examined six subjects with clinical symptoms of entrapment of the common plantar digital nerve (Morton's metatarsalgia). Five of the subjects later had surgery. The conduction velocities of the affected interdigital nerves were abnormally slow. The method is technically simple, but more painful than conventional conduction studies.

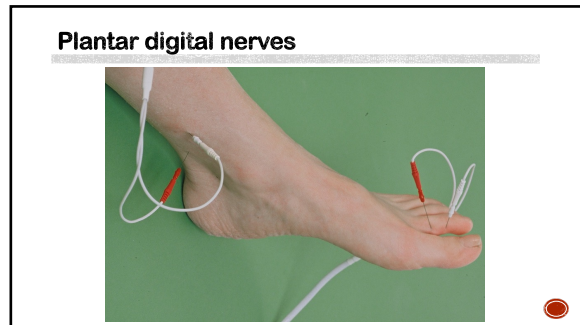
NEUROLOGY (Cleveland) 1984;34:698-701

Björn Falck, MD; Matti Hurme, MD; Seppo Hakkarainen, MD; and Pertti Aarnio, MD

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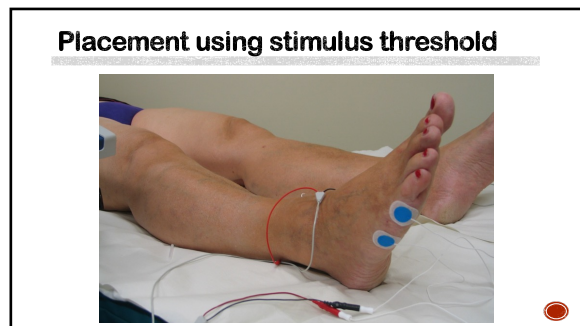


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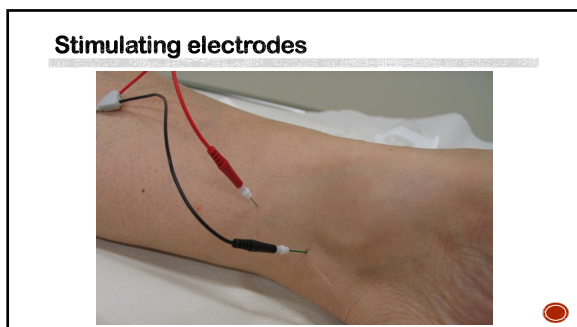
Placement of recording electrodes

- Stimulation threshold for motor response
 - Can only be used for mixed motor and sensory nerves
 - Close to nerve with thresholds at < 1.0 mA (0.2 ms)
- Stimulation - guided by patient sensations
 - Unreliable in patients
 - N.cutaneus femoris lateralis
- Ultrasound

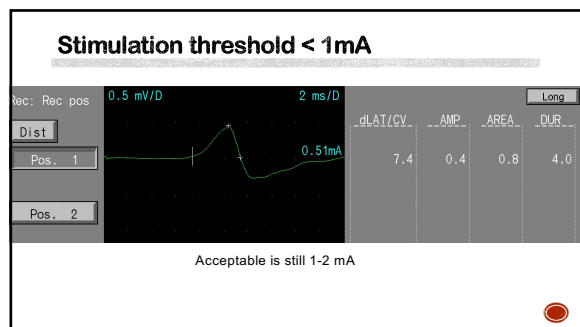
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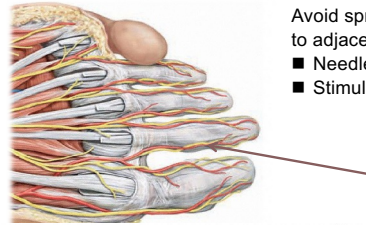
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Recording electrodes



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Stimulation



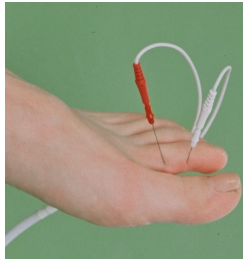
Avoid spreading of stimulus to adjacent digital nerve.
 ■ Needle electrode
 ■ Stimulus intensity > 5 mA

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

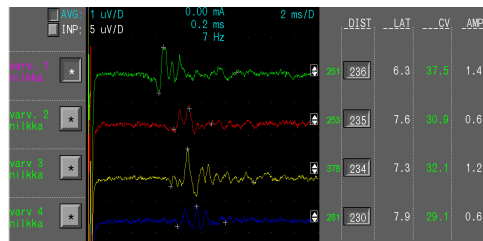


Intensity < 5 mA
 Frequency 7 Hz



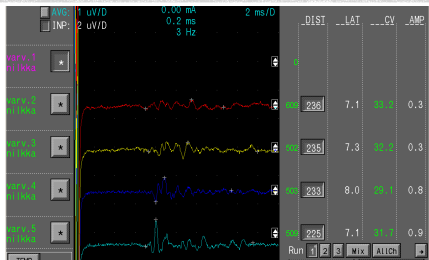
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N.digitalis plantaris lateralis



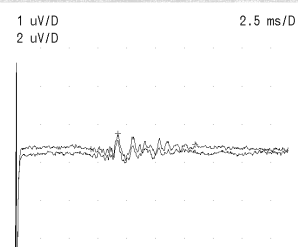
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N.digitalis plantaris medialis



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Normal responses are polyphasic



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Reference values

	Conduction velocity (m/s)				R ²
	N	mean	sd	Regression equation	
Dig plant later 1	37	38,3	4,3	38,2 + 0,01 * age sd=4,3	ns
Dig plant later 2	37	35,0	4,7	36,8 - 0,03 * age sd=4,6	ns
Dig plant later 3	37	36,4	4,5	37,9 - 0,03 * age sd=4,5	ns
Dig plant later 4	37	36,4	4,3	35,9 + 0,01 * age sd=4,3	ns
Dig plant med 2	60	37,4	4,7	42,9 - 0,12 * age sd=4,4	0,15
Dig plant med 3	61	36,1	4,7	42,9 - 0,12 * age sd=4,2	0,13
Dig plant med 4	62	36,9	4,5	43,2 - 0,16 * age sd=3,9	0,21
Dig plant med 5	58	37,8	4,3	44,7-0,18 * age sd=3,7	0,28

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Reference values

- Conduction velocity difference between adjacent nerves < 8 m/s

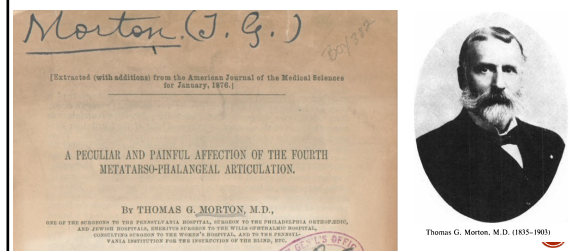
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University hospital of Turku focal neuropathies 2005

Lumbar radiculopathy	441 (23%)
CTS	413 (21%)
Ulnar nerve lesion (elbow)	154 (8%)
Cervical radiculopathy	151 (8%)
Brachial plexopathy	100 (5%)
Morton's metatarsalgia	97 (5%)
Peroneal nerve lesion	93 (5%)
Radial nerve lesion	78 (4%)
Facial nerve lesion	70 (3%)
Median nerve lesion	68 (3%)

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Thomas G Morton 1835-1903



83

T. G. Morton. *A peculiar and painful affection of the fourth metatarso-phalangeal articulation.* American Journal of the Medical Sciences, Philadelphia, 1876, 71: 37-45.

- Describes 12 patients in detail and 3 patients without details
- 13 women and 2 men
- Age at onset 11-50 years, mean 30 years, median 30 years
- In 8 the pain started acutely following a trauma to the foot
- In 4 the pain was associated with shoes
- Severe neuralgic pain around 4th metatarsophalangeal joint
- No abnormalities of the foot

84

T. G. Morton. *A peculiar and painful affection of the fourth metatarso-phalangeal articulation.* American Journal of the Medical Sciences, Philadelphia, 1876, 71: 37-45.

- 3 patients were treated with surgery: Excision of the 4th metatarsophalangeal joint and the surrounding soft tissue including nerves.
- Excised tissue no macroscopic evidence of disease.
- In one surgical sample microscopic analysis of nervous structures were healthy. A small abrasion was seen on the articular surface
- Surgical results were good

85

Plantar digital nerve entrapment

- Lewis Durlacher (1792-1864, surgeon chiropodist to Queen Victoria): *A treatise on corns, bunions, the disease of nails, and the general management of the feet*. Simpkin, Marshall & Co, 1845.
- Civigni F. *Su d'un nervoso gangliare rigonfiament alla pianta del piede*. Lettera anatomica al Dr. Salomone Lampronti. Pistoia, Tip, Bracali 1835
- T. G. Morton: *A peculiar and painful affection of the fourth metatarsophalangeal articulation*. American Journal of the Medical Sciences, Philadelphia, 1876, 71: 37-45.

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Filippo Civigni 1805-1844



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Morton's metatarsalgia - Etiology

- Entrapment of the plantar digital nerves between the distal metatarsal heads
- Usually the digital nerves II and III (between the II/III and III/IV metatarsal heads)

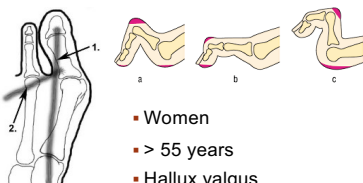
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Morton's metatarsalgia - Clinical features

- Common in > 50-year-old women
- Sometimes younger persons, youngest 16 years
- Pain in the forefoot when walking, symptoms are alleviated at rest
- On palpation painful area between affected metatarsal heads
- Associated with *hallux valgus*, *hammertoes* and *rheumatoid arthritis*
- Plantar digital nerve to interspaces II/III and III/IV may be affected

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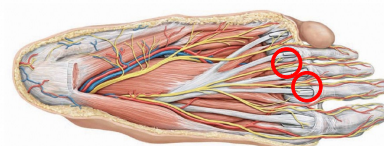
Predisposing factors



- Women
- > 55 years
- Hallux valgus
- Hammertoes

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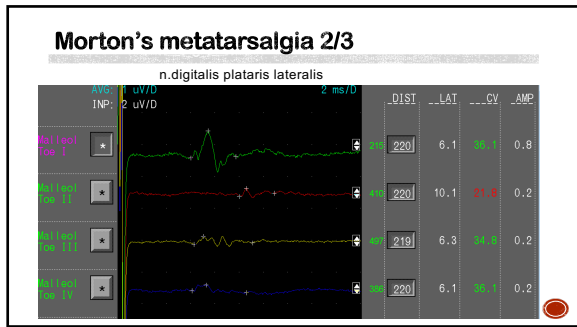
Plantar nerves



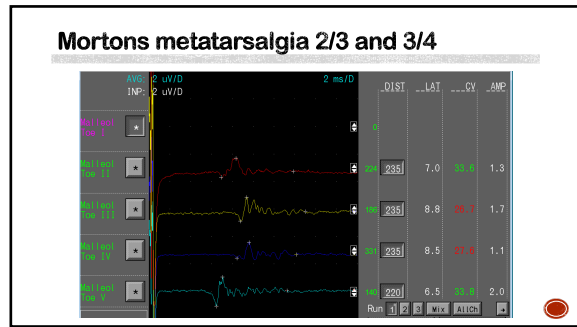
plantar digital nerve entrapment between II/III or III/IV metatarsals

Schuenke et al. *THiEM Atlas of Anatomy - General Anatomy and Musculoskeletal System*
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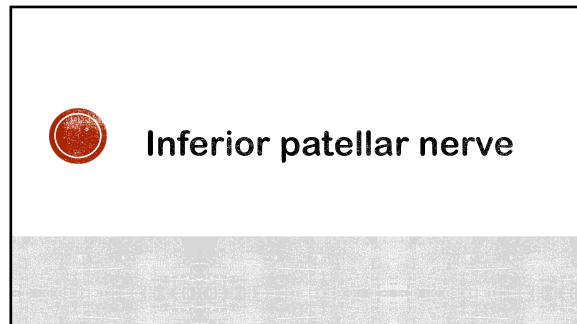


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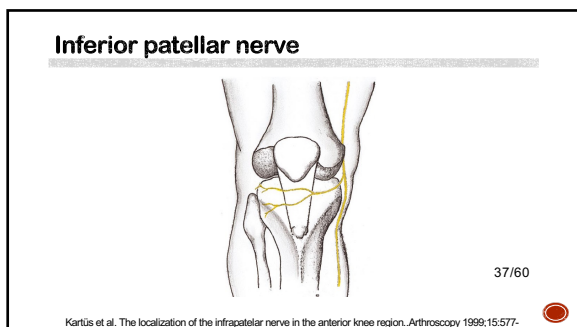
Affected interspace

Interspace	Number	%
2/3	14	21
3/4	12	17
2/3 and 3/4	41	62

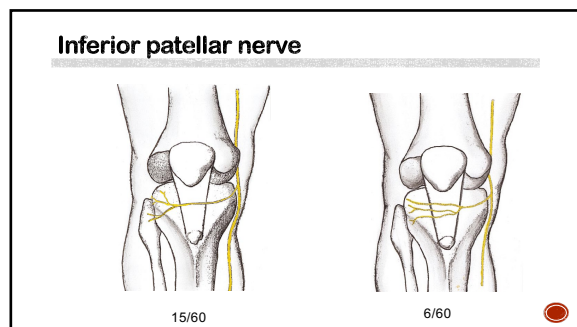
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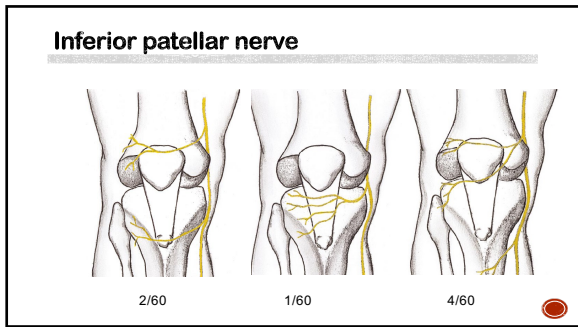
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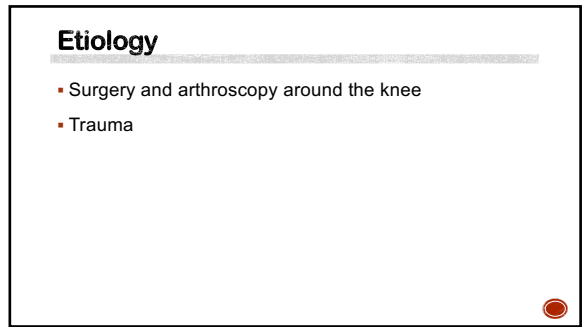
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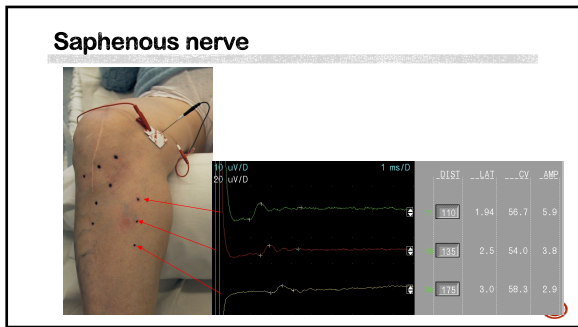
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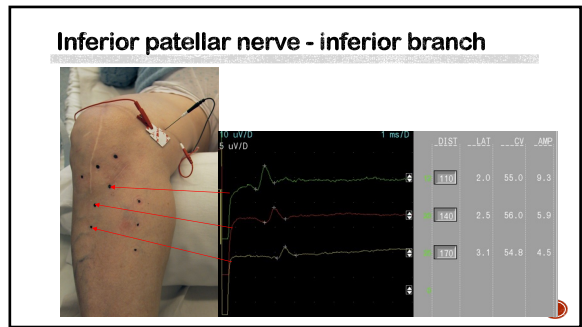
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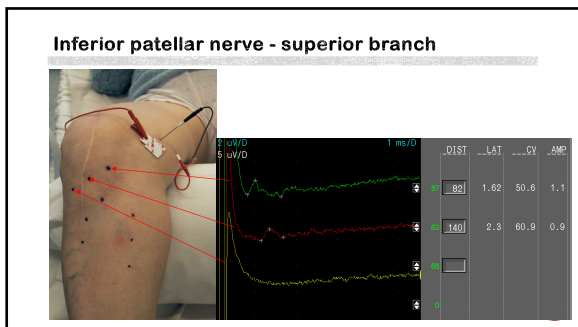
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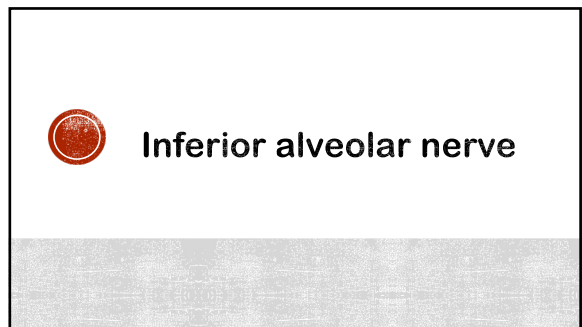
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Muscle & Nerve 1999;22:455-459

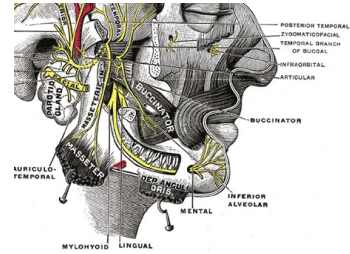
A NEW TECHNIQUE FOR RECORDING SENSORY CONDUCTION VELOCITY OF THE INFERIOR ALVEOLAR NERVE

SATU K. JÄÄSKELÄINEN, MD, DMSc

Department of Clinical Neurophysiology, Turku University Central Hospital, PL-52, FIN-20521, Turku, Finland

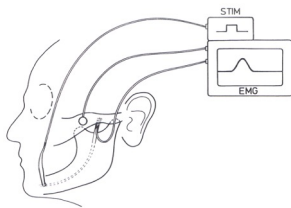
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Inferior alveolar nerve



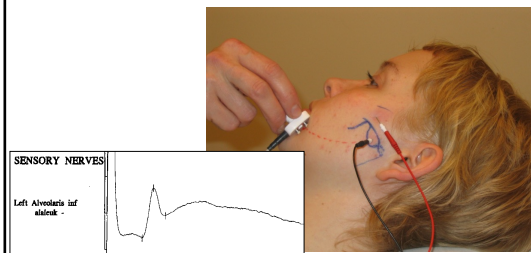
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Inferior alveolar nerve



106

Inferior alveolar nerve



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Reference values

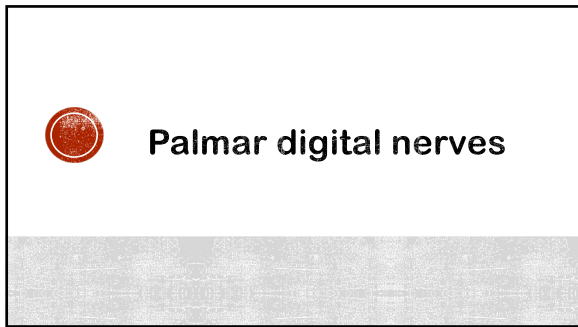
- CV m/s= 64.1 sd=3.9,
- Amplitude 6.3 sd=1.6

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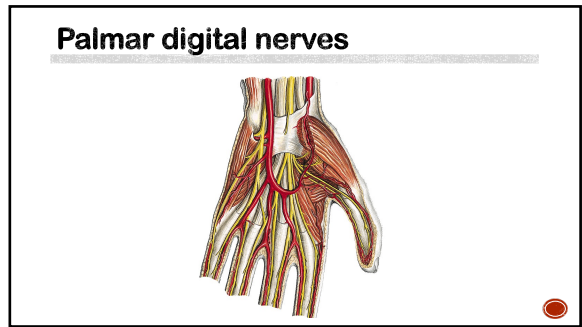
Etiology

- Extraction of wisdom teeth
- Split mandibular osteotomy
- Trauma

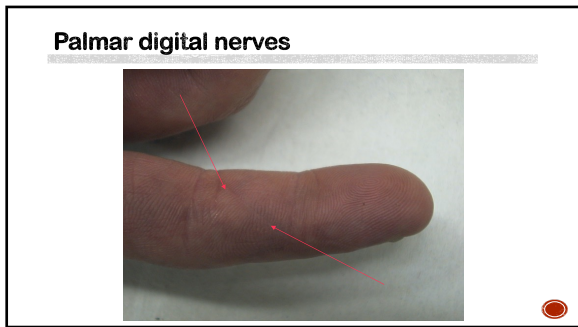
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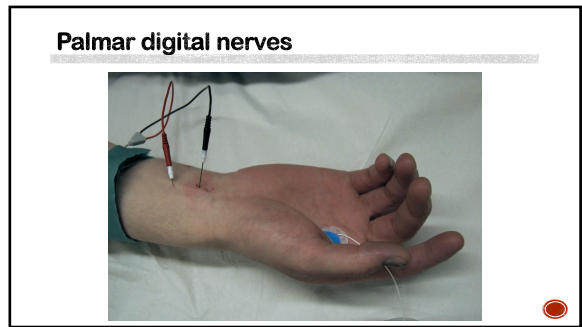
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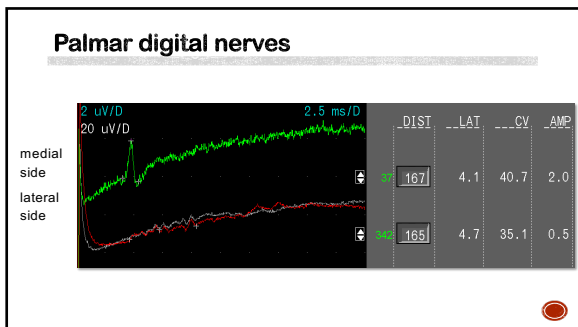
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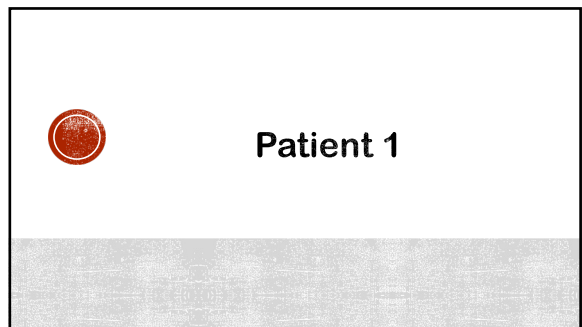
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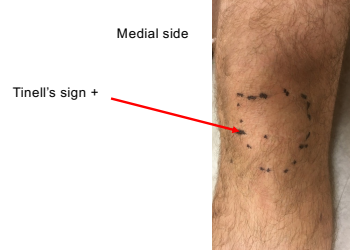
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Patient

- 46 year old man
- One year ago fell in stairs while carrying a refrigerator
- Hit his patella on the stair
- Pain on the medial side of the patella
- No fractures
- Allodynia over the patella (NRS 7-8/10)

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Skin area with allodynia – left knee

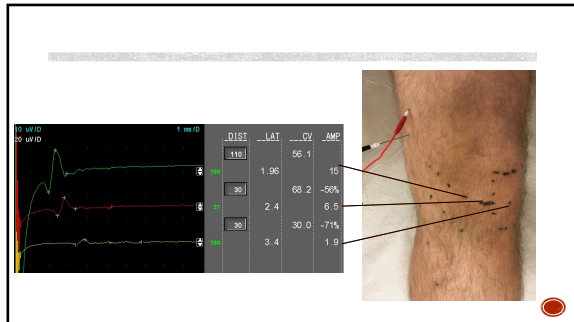


117

Recording set up



118



119

Patient 2

History

- 10 weeks ago to injury to forefinger while repairing his car
- Sharp metal edge cut on dorsal side of the index finger MCP joint
- Lost immediately finger extension
- Acute surgery to repair of the extensor tendon
- No nerve injury was observed intraoperatively
- Altered sensation on the dorsal side of the forefinger
- Allodynia over the dorsal side of the index finger, NRS 8/10

120

121

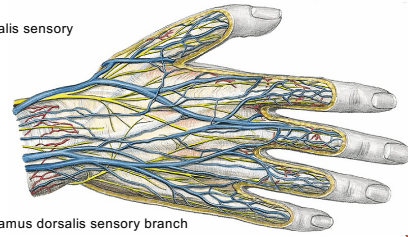
Scar



122

Innervation of dorsum of the hand

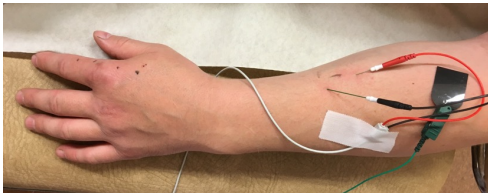
N. radialis sensory



N. ulnaris ramus dorsalis sensory branch

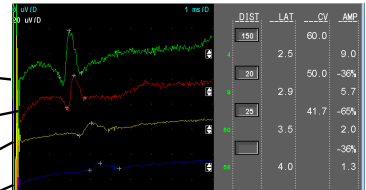
123

Recording setup



124

Neurography



125

Finding

- Partial injury to sensory branch of radial nerve to the forefinger
- Sharp object has probably cut some fascicles

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Patient 3

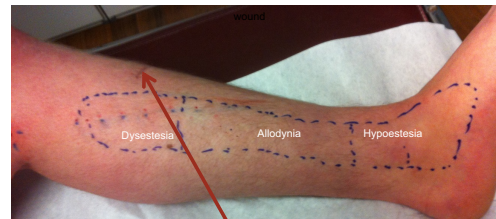
127

History

- Attempted robbery of the the patient sitting in a car
- Knife penetrated the medial side of the left leg
- Allodynia of the medial side of the leg

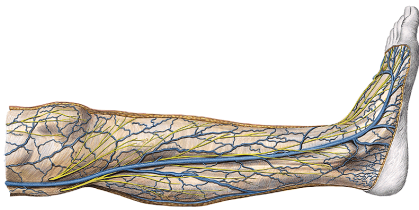
128

Patient



129

Saphenous nerve



Sobotta: Atlas of human Anatomy, UrbanSchwarzenberg

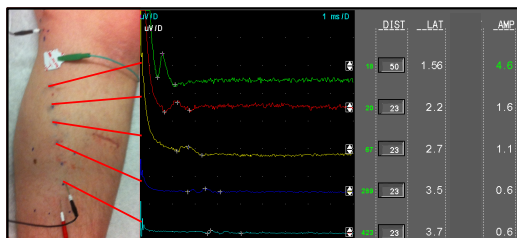
130

Recording setup



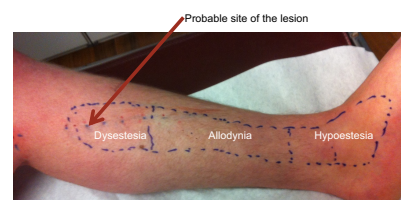
131

Neurography

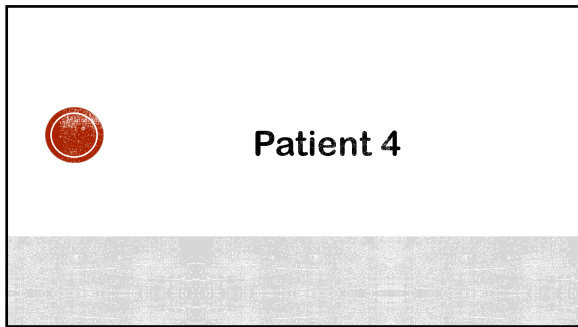


132

Patient



133



134

History

- 58 year old healthy woman
- Surgery for callus on the lateral side of 4th toe
- After surgery allodynia over the lateral side of 4th toe

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Sensory abnormality

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Differential diagnosis

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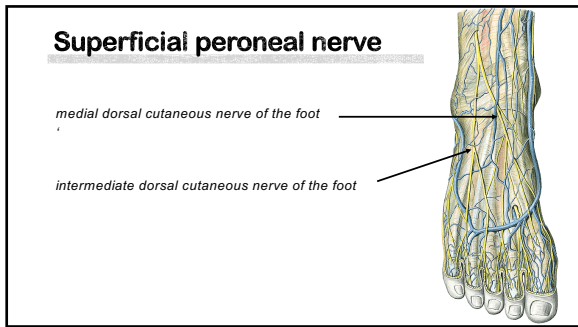
Plantar digital nerves

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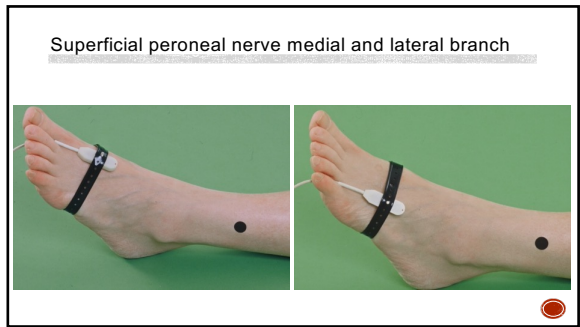
Plantar digital nerves

	1 UWD	5 UWD	2.5 ms/D	Q1	SI	LAT	CV	AMP
Dig 4 medial side - ankle	333	283		7.6	30.7	0.9		
Dig 4 lateral side - ankle	516	235		7.5	31.1	0.5		
Dig 5 medial - ankle	1040	235		7.9	29.7	0.4		

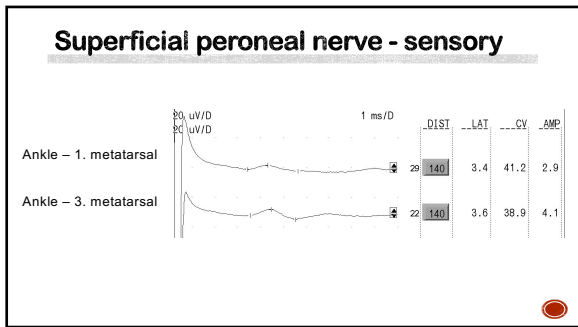
139



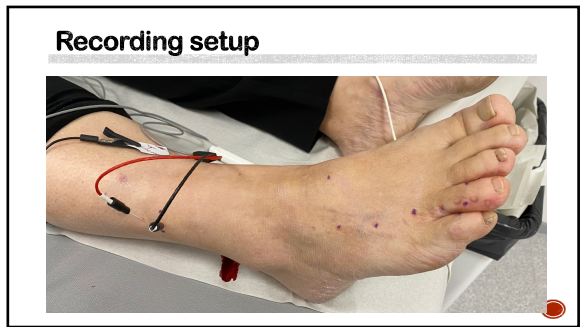
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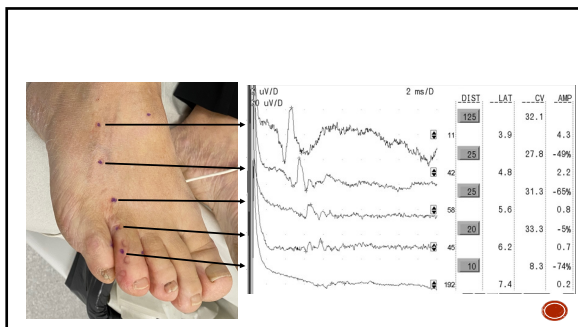
141



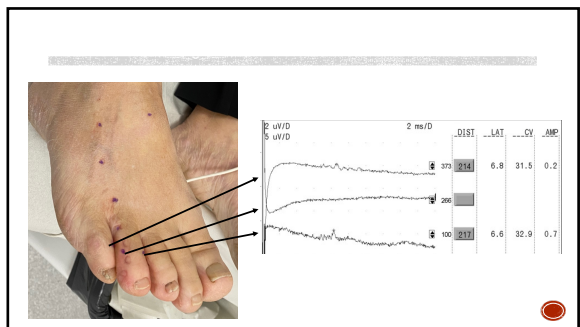
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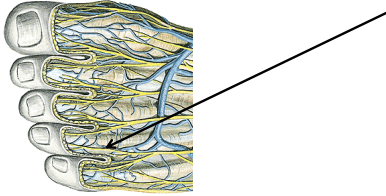


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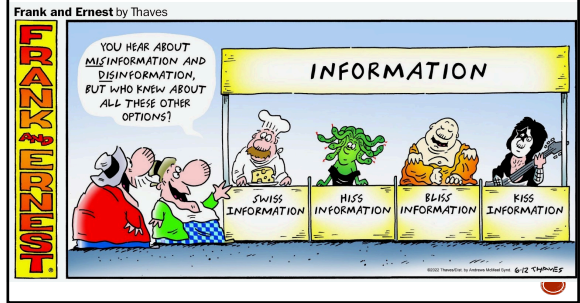
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Conclusion



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