

# Special neurography techniques

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No disclosures

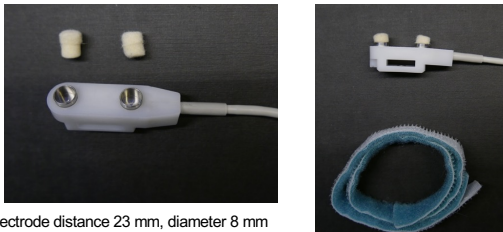
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## Outline 45 min

- Surface electrodes
  - Palmar digital nerves
  - Supraclavicular nerves
  - Phrenic nerve
  - Sural nerve in the foot
  - Superficial peroneal nerve
  - Deep peroneal nerve sensory branch
  - Radial motor nerve
- Neurography with near nerve electrodes
  - Plantar digital nerves
  - Infrapatellar nerve
  - Inferior alveolar nerve
- Patients

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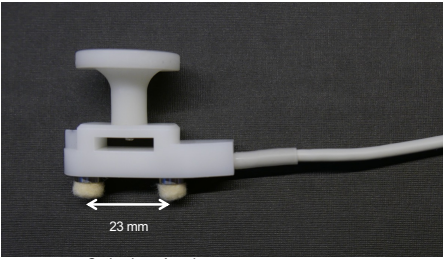
### Fixed bar electrode



Interelectrode distance 23 mm, diameter 8 mm  
Nihon Kohden NM-420S

3

### Stimulating electrode

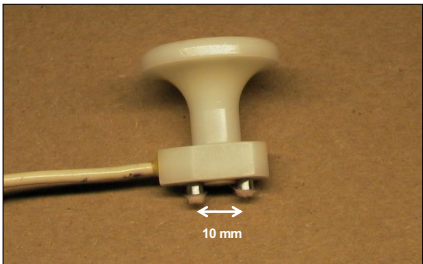


23 mm

Cathode Anode

4

### Stimulating electrode - small

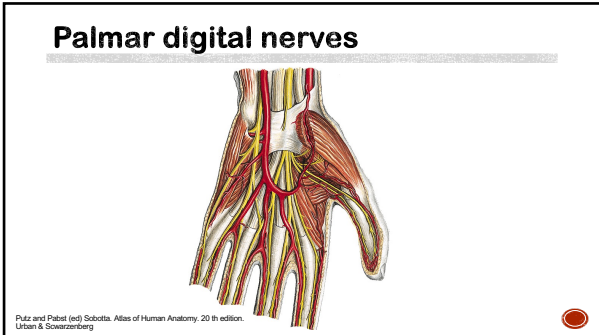


10 mm

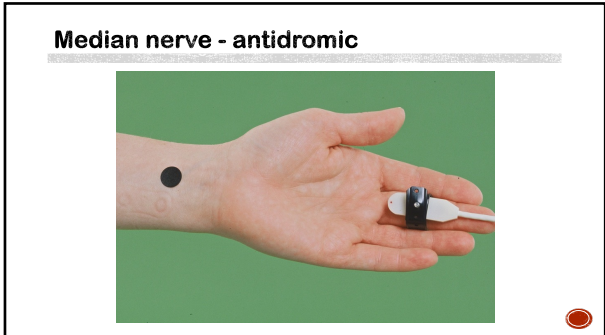
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## Palmar digital nerves

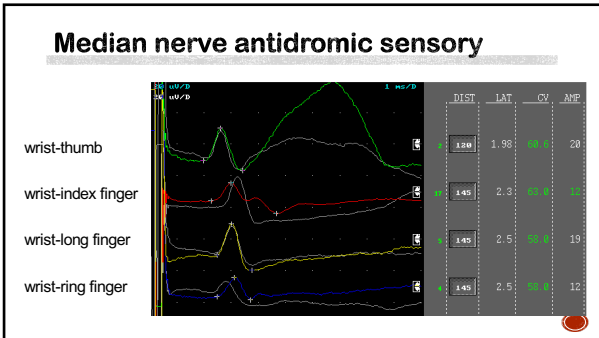
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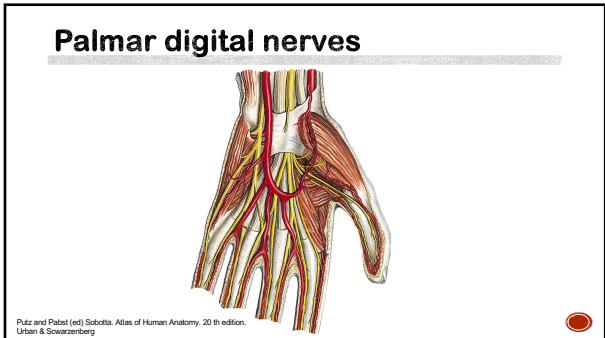
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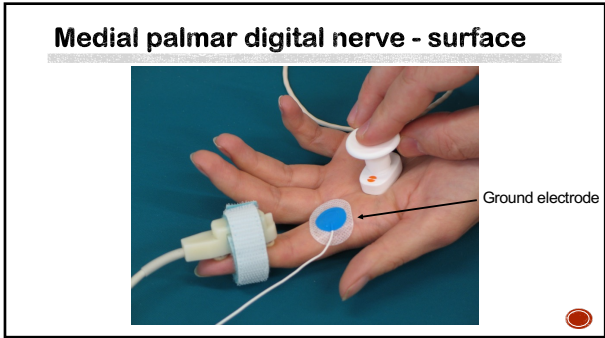
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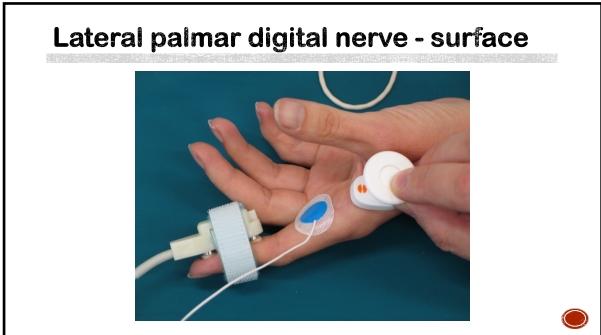
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- ### Palmar digital nerves – surface electrodes
- Reliable separation of individual digital nerves in each finger is difficult with surface electrodes
  - False negative findings

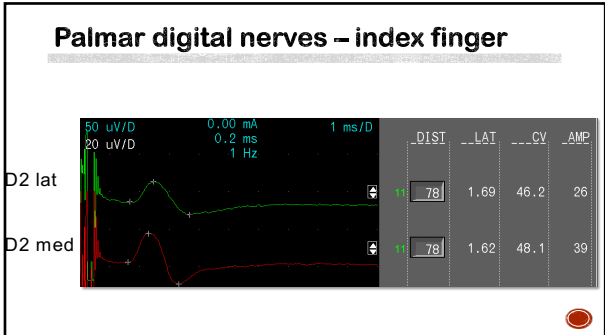
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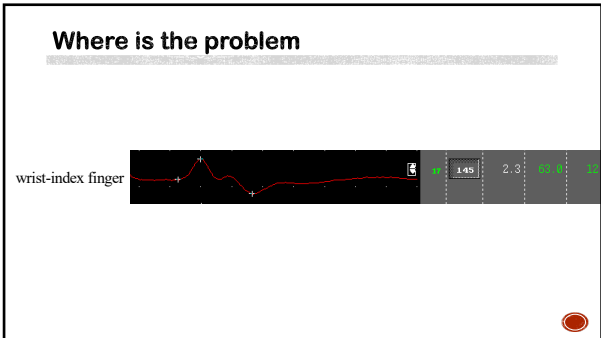
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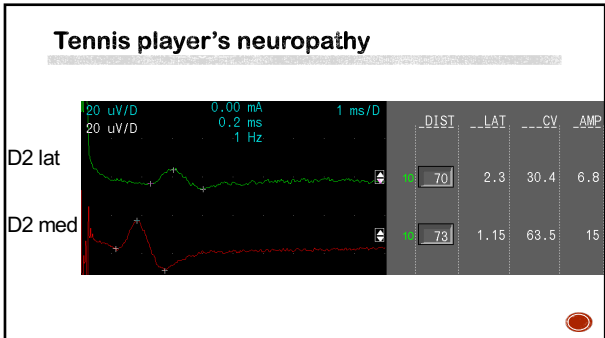
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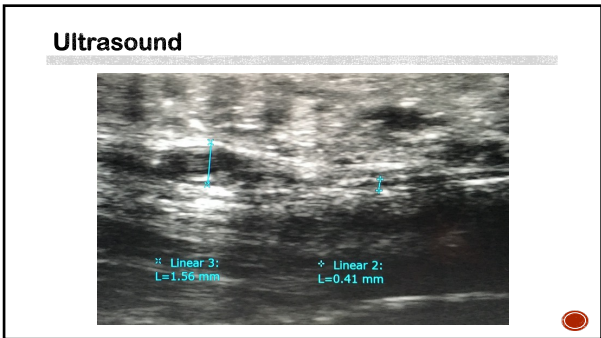
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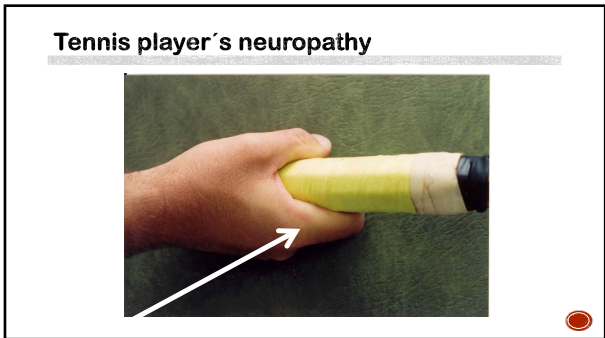
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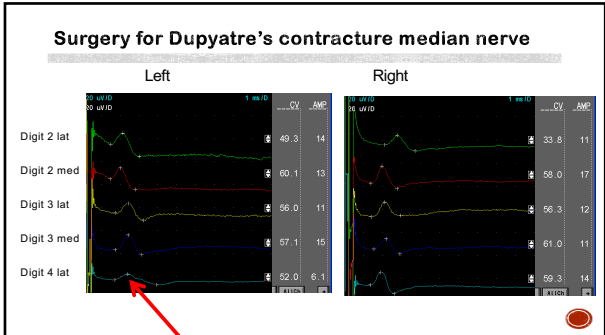
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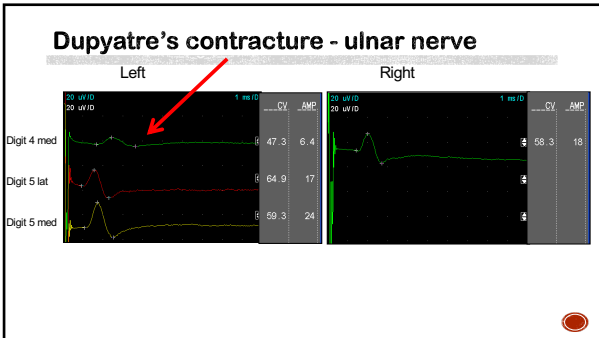
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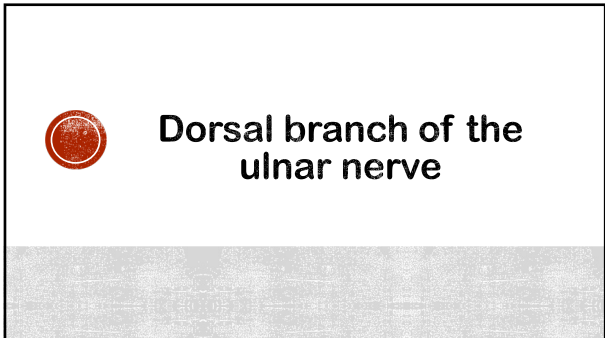
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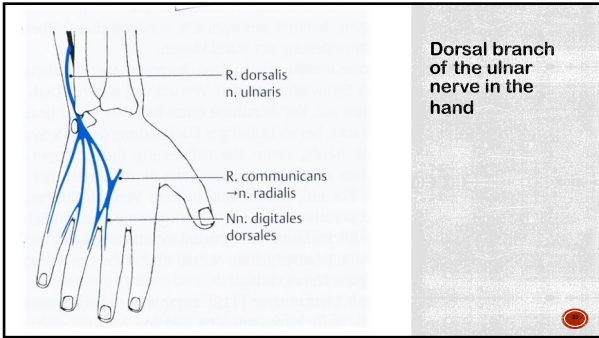
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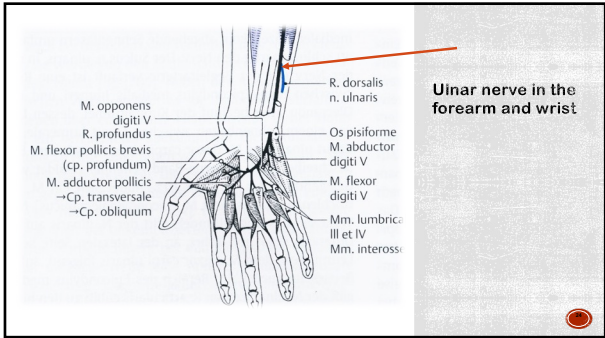
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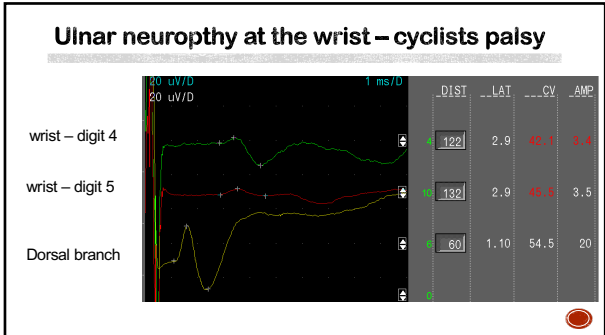


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- ### Clinical utility of ulnar dorsal branch
- Localization of ulnar nerve neuropathies
    - Normal in ulnar neuropathies at the wrist
    - Abnormal in ulnar neuropathies at the elbow
  - Sometimes also focal neuropathies in the hand

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### Anomalous innervation

CASE OF THE MONTH

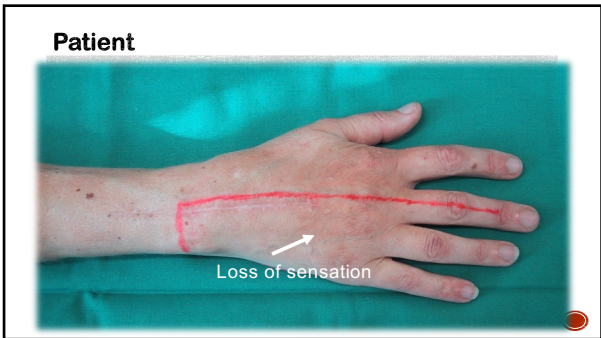
ABSTRACT: The sensory symptoms due to lesions of the superficial branch of the radial nerve are usually limited to the dorsolateral area of the hand. We describe a 40-year-old woman who presented with numbness of the dorsomedial aspect of the right hand following attrition of the wrist. Clinically, the sensory loss suggested a lesion of the dorsal branch of the ulnar nerve. However, nerve conduction studies showed that the sensory loss was due to a lesion of a branch of the superficial branch of the radial nerve. The patient had bilateral, anomalous innervation of the dorsum of the hand—the dorsal branch of the ulnar nerve could not be demonstrated with nerve conduction techniques and the superficial branch of the radial nerve innervated most of the dorsum of the hand. Antidromic stimulation of the dorsal branch of the ulnar nerve and superficial branch of the radial nerve with paired surface recording of sensory nerve action potentials from the dorsolateral (radial side) and dorsomedial (ulnar side) hands is useful for evaluating this anomaly. Our patient had two children, one of them with a similar anomaly. This suggests an autosomal dominant inheritance of the anomaly.

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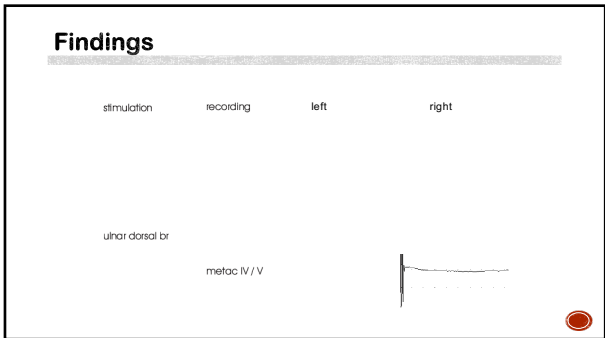
#### ANOMALOUS SUPERFICIAL RADIAL NERVE: A PATIENT WITH PROBABLE AUTOSOMAL DOMINANT INHERITANCE OF THE ANOMALY

ABRAHAM KURUVILLA, MD, SATU LAAKSONEN, MD, and BJÖRN FALCK, MD, PhD  
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 Accepted 25 June 2002

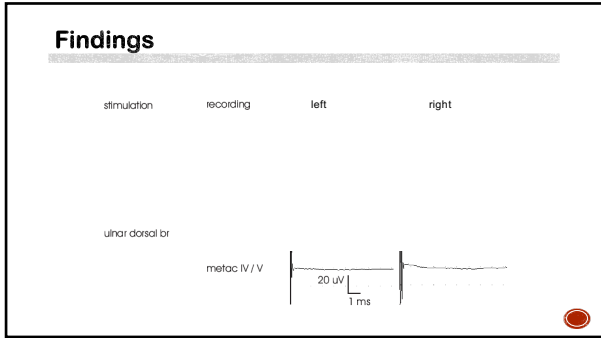
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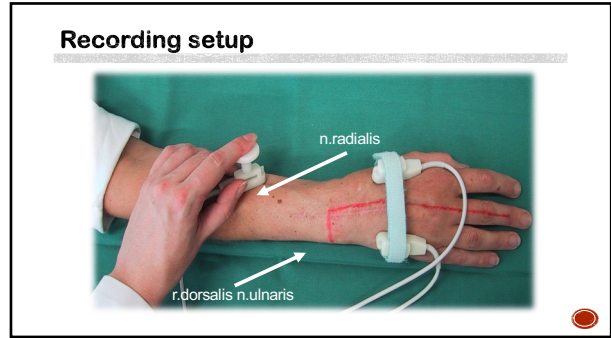
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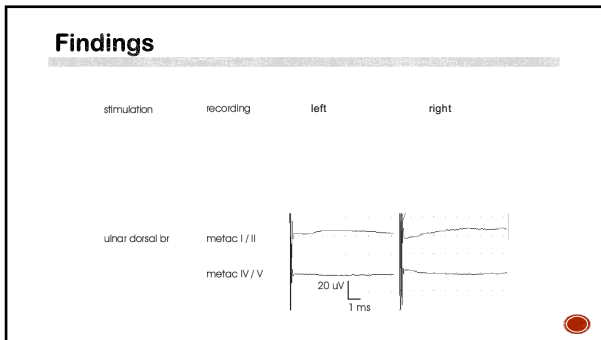
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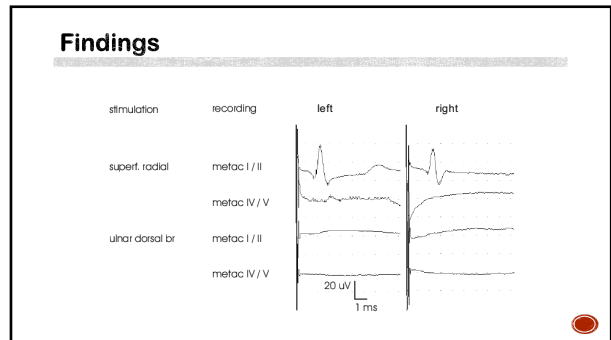
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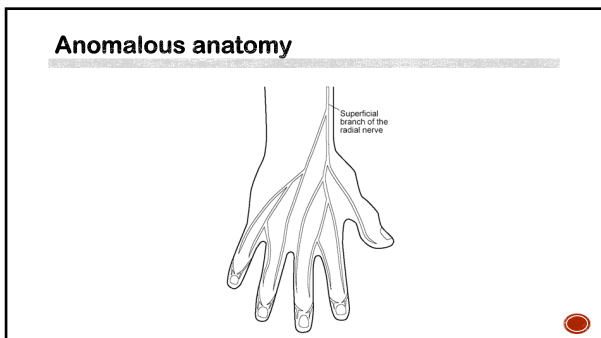
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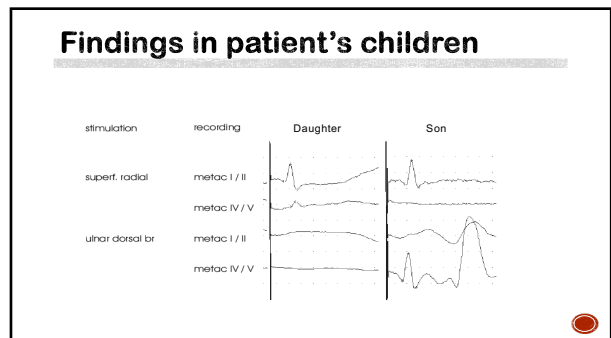
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### Occurrence of this anomaly

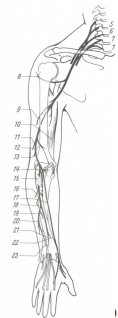
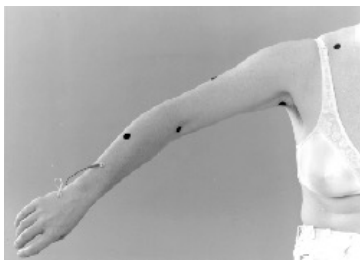
- Encountered in 1-2% of the population
- Usually bilateral, but not always

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### Radial nerve

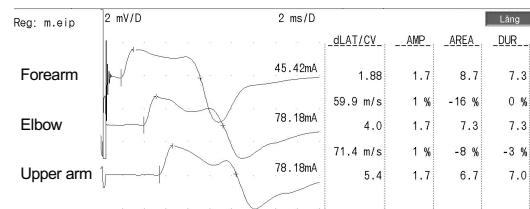
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### Radial nerve motor



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### Radial nerve motor



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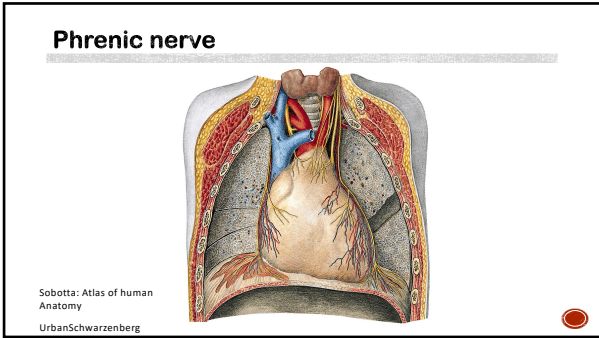
### Utility

- Saturday night palsy
  - In the middle of the upper arm
- Posterior interosseus neuropathy
  - Parsonage – Turner syndrome (neuralgic amyotrophy)
  - Entrapment exists only in textbooks

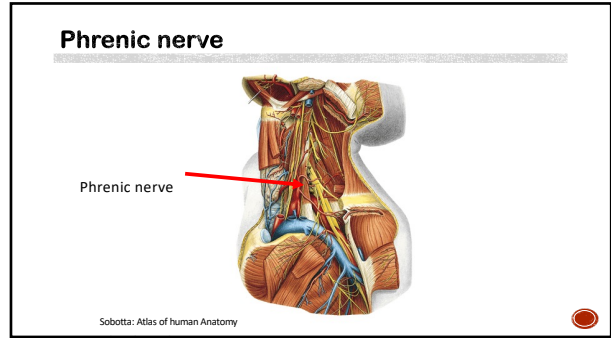
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### Phrenic nerve

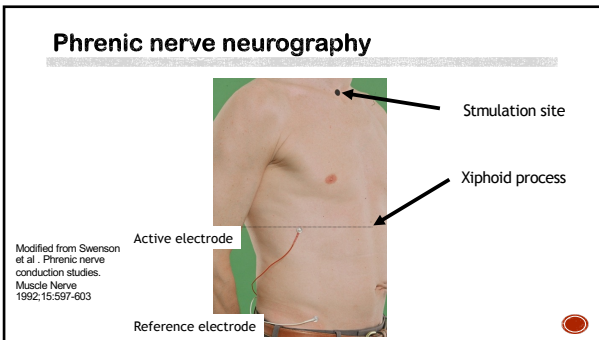
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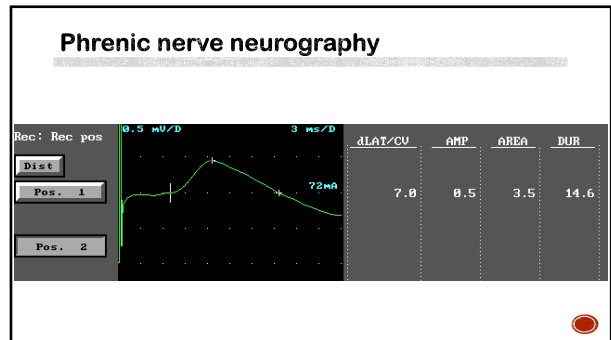
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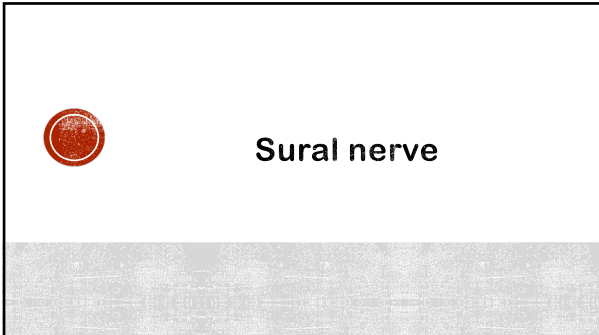
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- ### Phrenic nerve neurography
- High stimulus intensities required
    - 70-100mA, 0.2-0.5 ms
    - Painful
  - Difficult to obtain responses in obese subjects
  - M-wave amplitude varies with respiration
    - Study during expiration if possible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

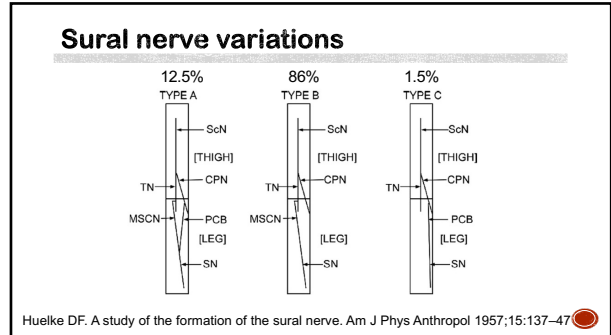
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- ### Phrenic nerve – reference values
- Latency 6,6 +/-1,4 ms
  - Amplitude >200 uV
  - Amplitude side difference large (>100%) even in healthy subjects

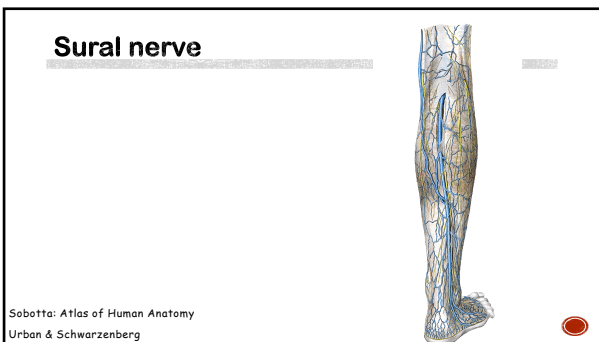
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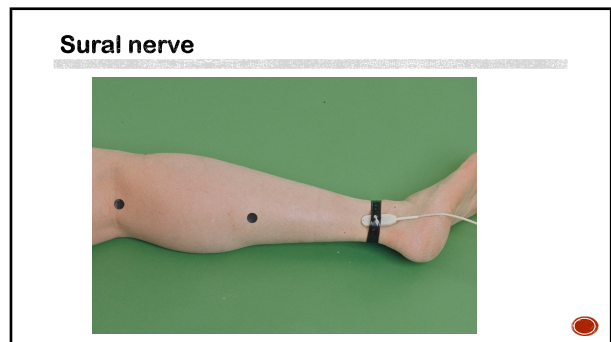
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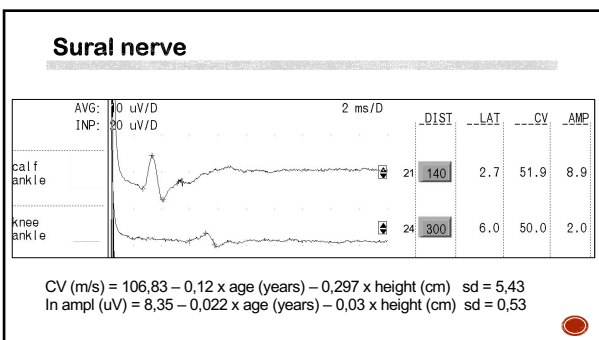
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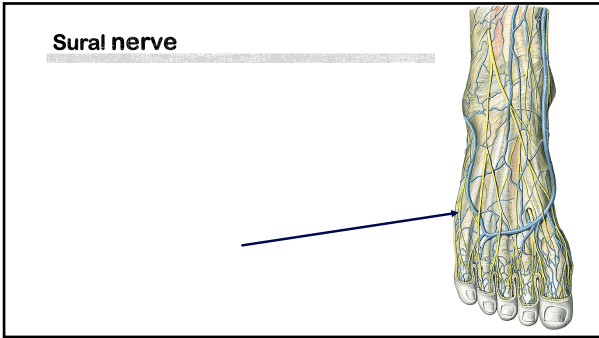


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- ### Utility
- Diagnosis of polyneuropathy
  - Local nerve lesions
    - Surgery to the achilles tendon
    - Compression by ski boots in the leg (mostly women)

54

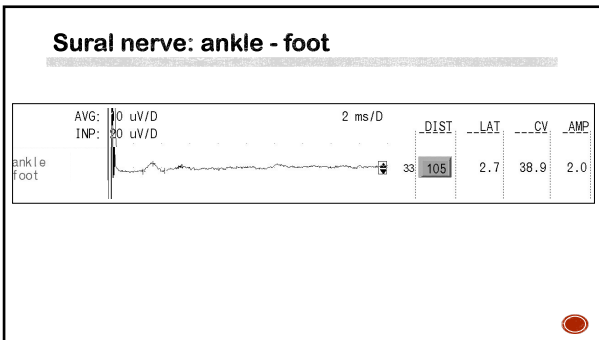




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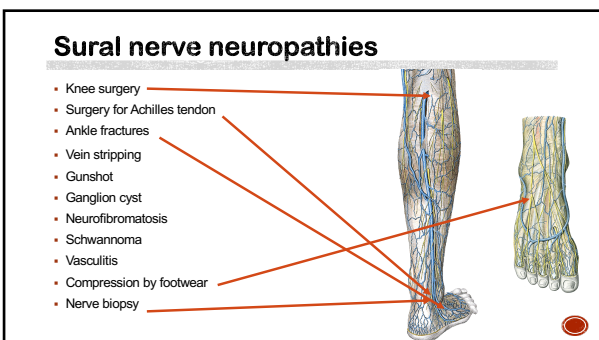
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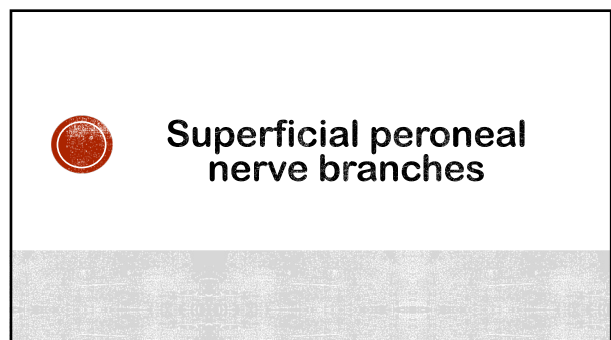
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- ### Utility
- Diagnosis of polyneuropathy in young
  - Local nerve lesions
    - Surgery to the ankle, especially ligaments
    - Compression on the foot by ski boots or shoes

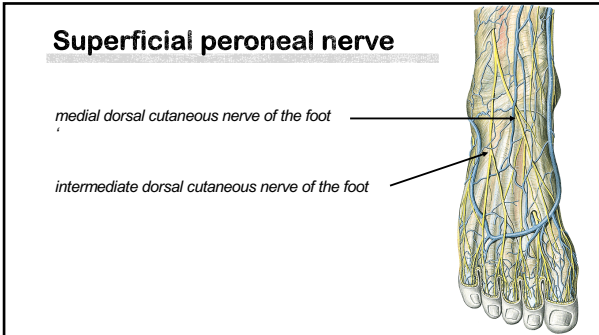
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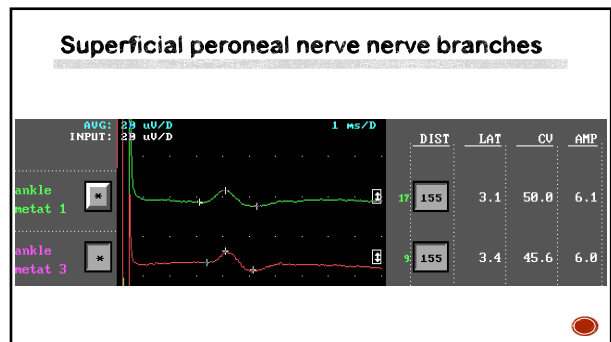
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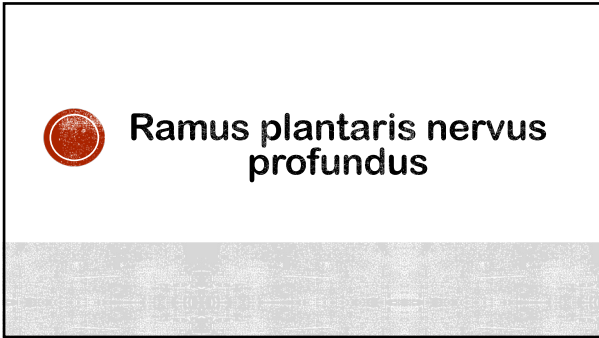
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- ### Utility
- Diagnosis of polyneuropathy in young adults
  - Local nerve lesions
    - Surgery to the ankle, especially ligaments
    - Compression by ski boots or shoes

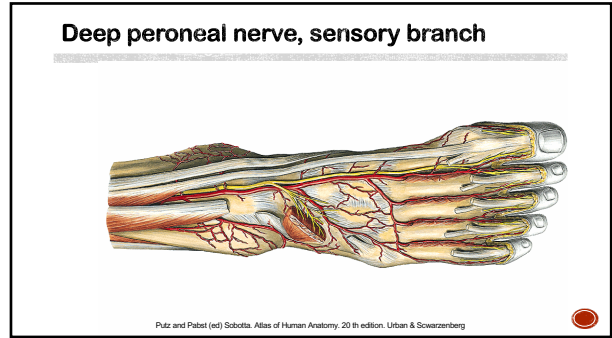
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- ### Bevare
- Ageing affects the nerve considerably
    - Even in healthy 75 year old subjects there may be no response
  - The branching of the into two branches is not constant

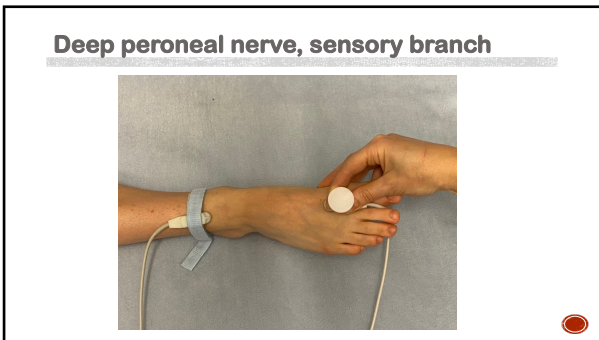
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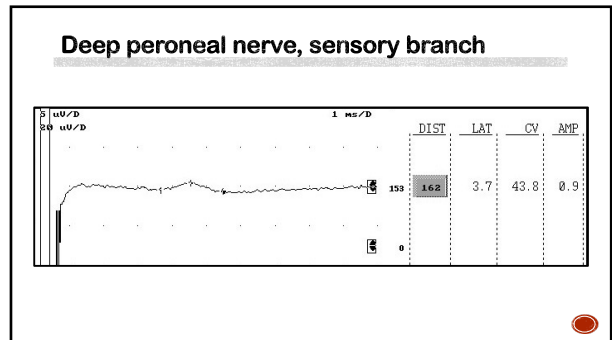
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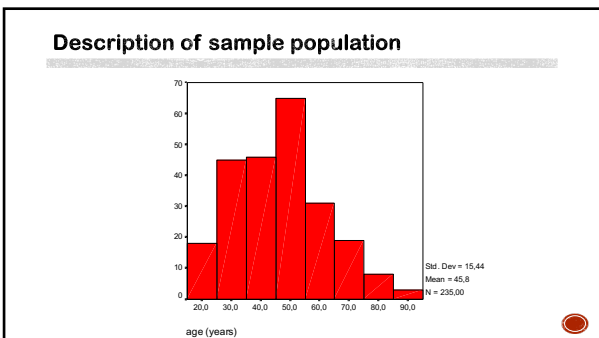
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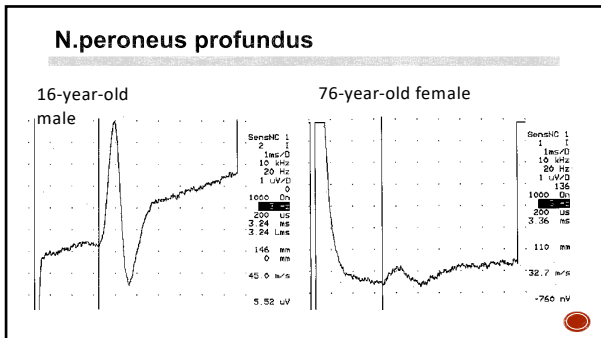


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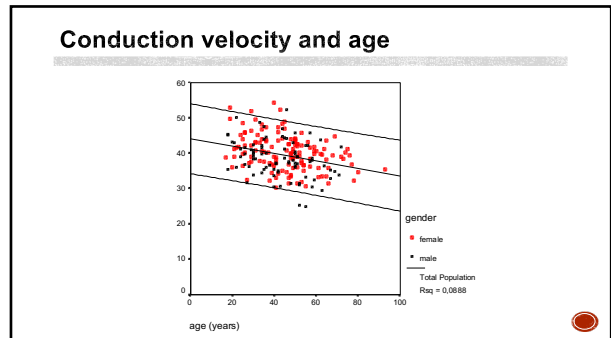
**Descriptive statistics**

	N	mean	sd
Cv (m/s)	219	39.5	5.1
Ampl (uV)	235	1.2	1.1

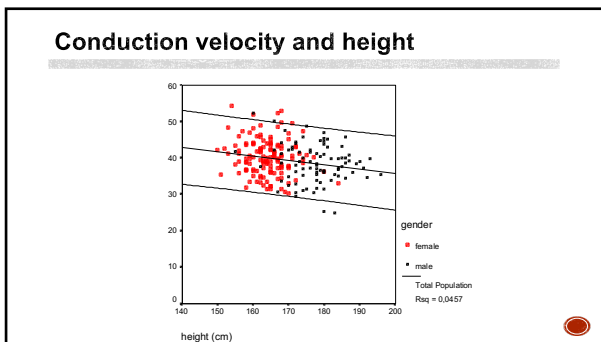
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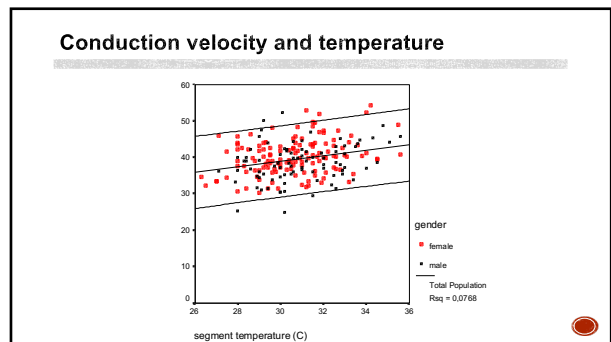
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### Regression model for CV

CV = 48.92 - 0.16\*age + 1.02\*seg.temp - 0.19\*height sd=4.2 R<sup>2</sup>=0.32

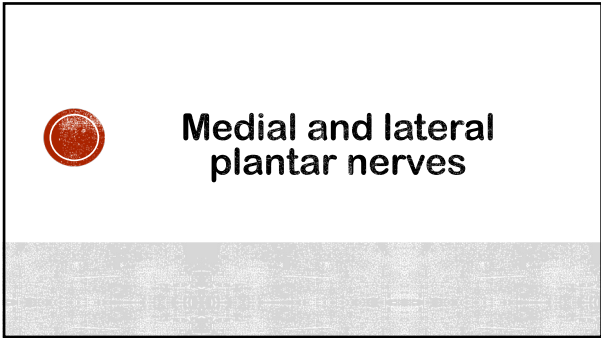
SQR AMPL = 5.97 - 0.17\*age + 0.13\*seg.length - 0.01\*height sd=0.3 R<sup>2</sup>=0.41

77

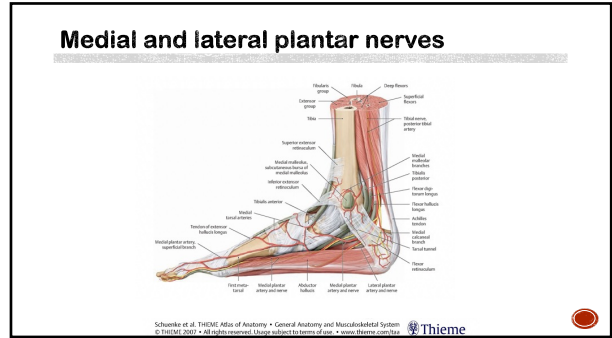
### Utility

- Diagnosis of polyneuropathies
- Focal neuropathies in the foot

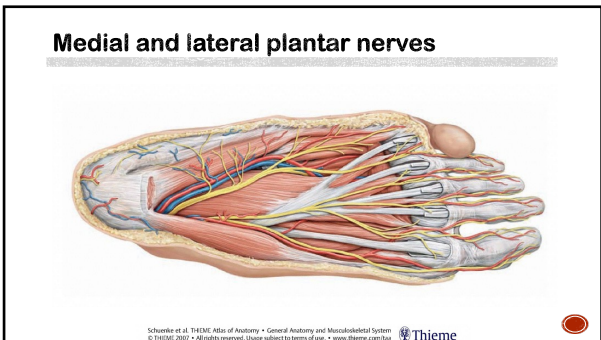
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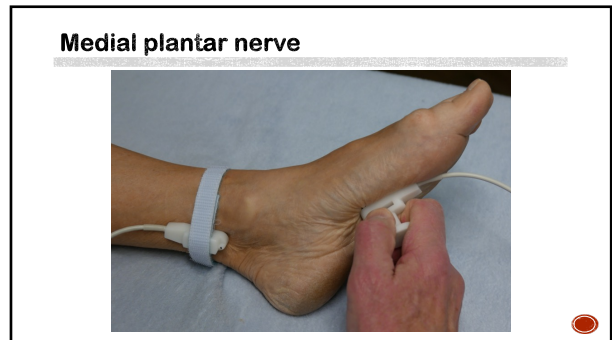
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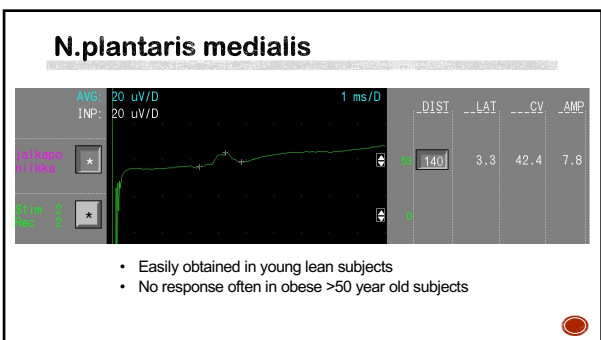
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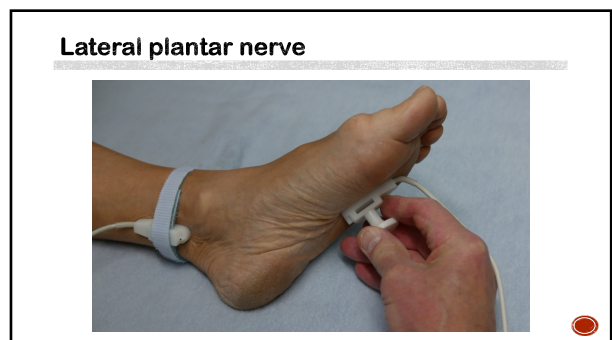
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84



### N.plantaris lateralis

DIST	LAT	CV	AMP
170	3.9	43.6	7.2

- Easily obtained in young lean subjects
- No response often in obese >50 year old subjects

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### Utility

- Diagnosis of neuropathies around ankle
- Tarsal tunnel syndrome
  - Neuromyography

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### Posterior cutaneous nerve of the thigh

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### Posterior cutaneous of the thigh

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### Posterior cutaneous of the thigh

89

### Posterior cutaneous of the thigh

DIST	LAT	CV	AMP
16	2.5	3.4	3.4

90

## Utility

- Focal neuropathies in the thigh
- Surgery for hamstring muscle injuries

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## Nervus saphenus

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## Saphenous nerve

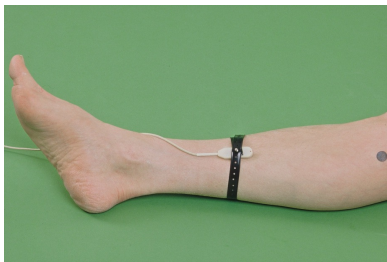
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## Saphenous nerve

Sobotta: Atlas of human  
Anatomy  
UrbanSchwarzenberg

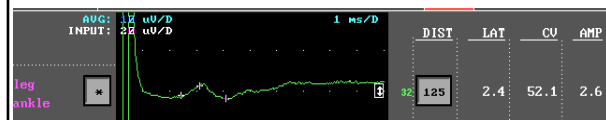
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## Saphenous nerve



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## Saphenous nerve



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## Reference values

- CV (m/s) = 56,6, sd = 5,7
- In ampl ( $\mu\text{V}$ ) = 1,3, sd = 0,6



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## Saphenous nerve lesions

- Commonly, lesions are caused by surgery for varicose veins
  - Difficult to exactly localize the lesion
  - Rarely severe symptoms
- Grafts for coronary by-pass surgery
- Entrapment i Hunter' s canal ???
  - Neuromythology



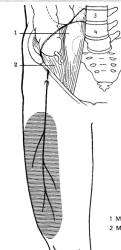
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## Near nerve needle electrodes

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## N.cutaneus femoris lateralis

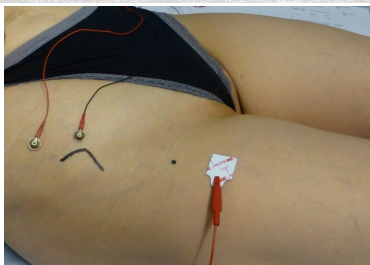


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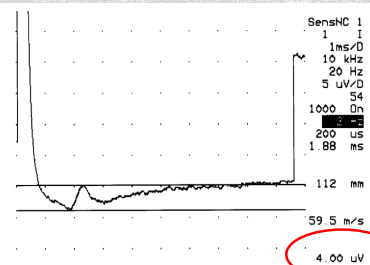
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## N.cut.fem.lat. - surface electrodes

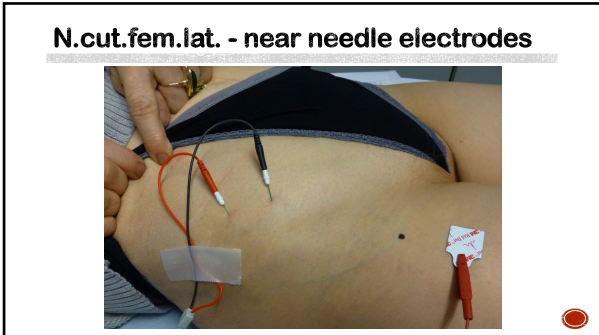


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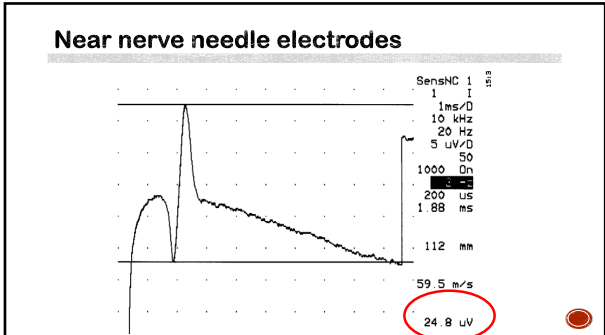
## Surface electrodes



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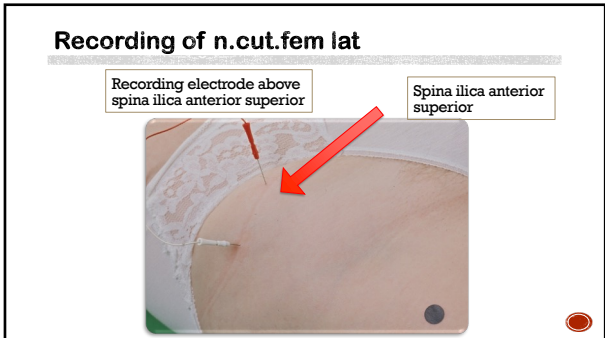
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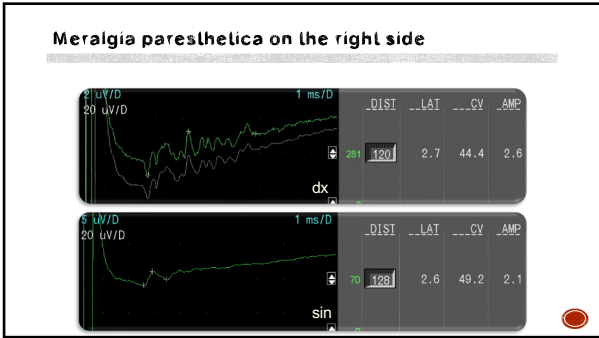
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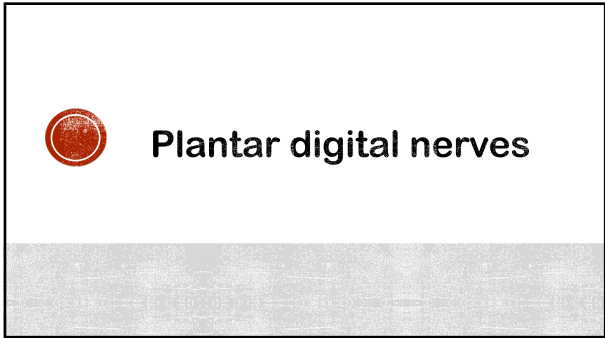
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## Plantar digital nerves lesions

- 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

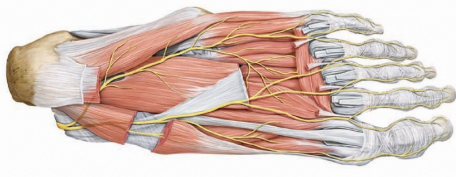
**Article abstract**—The orthodromic sensory conduction velocity of the plantar interdigital nerves were measured with needle electrodes in 28 healthy subjects. The stimulating needle electrodes were placed close to the shaft of the proximal phalanx of the toe, and the recording needle electrode was 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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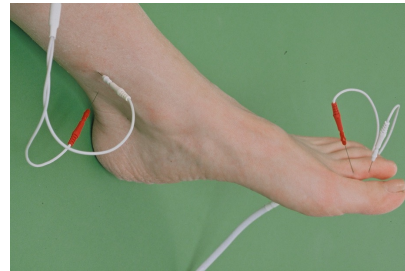
## N.digitalis plantaris



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## Plantar digital nerves



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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

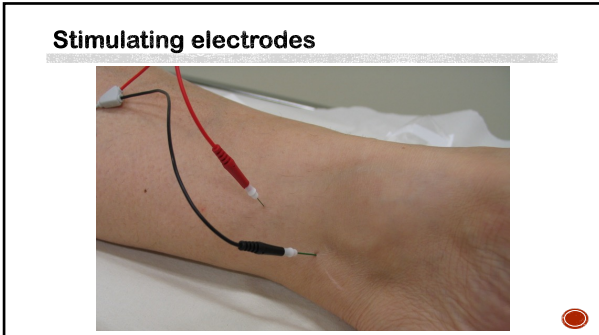
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## Placement using stimulus threshold

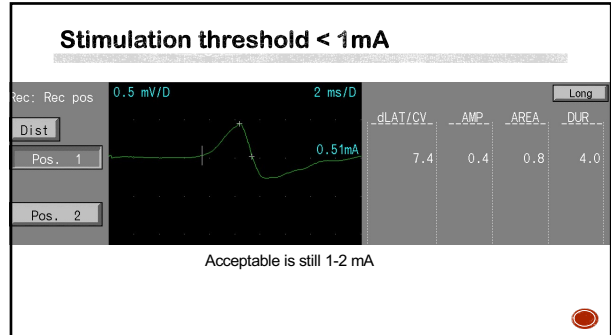


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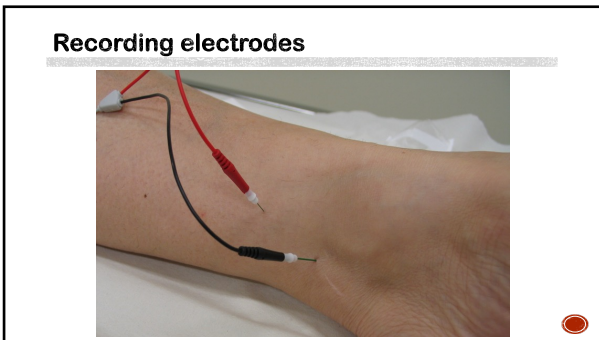




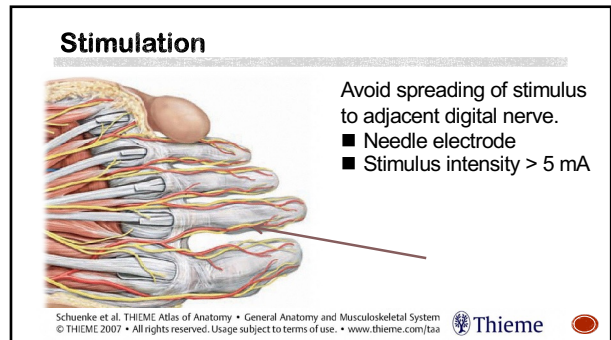
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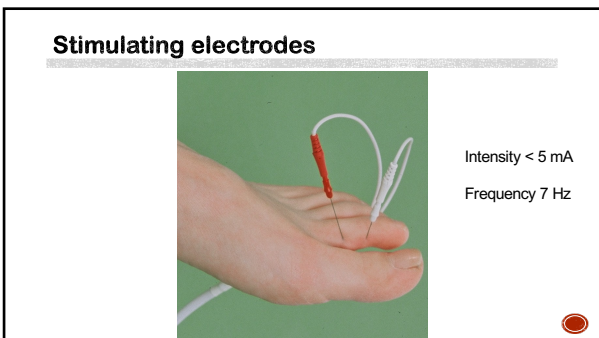
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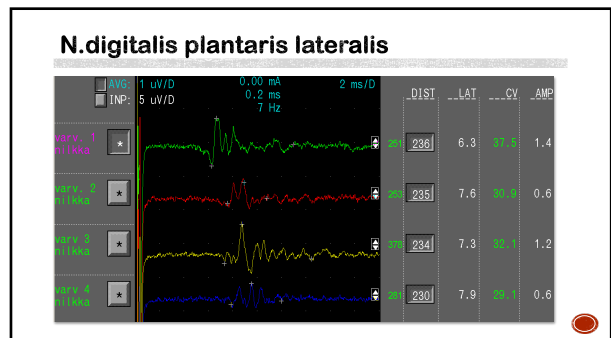
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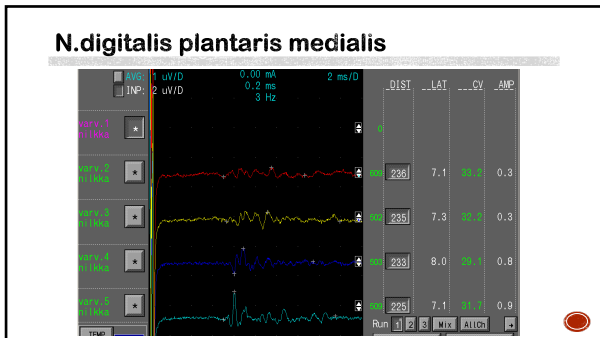
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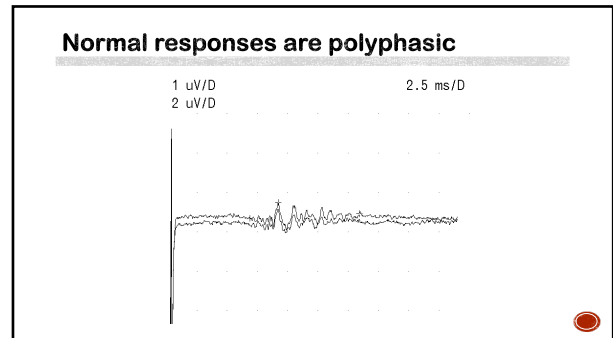
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### Reference values

	Conduction velocity (m/s)				
	N	mean	sd	Regression equation	R <sup>2</sup>
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

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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

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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

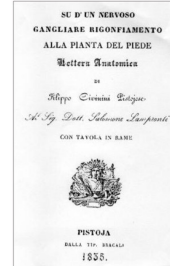
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### Plantar digital nerve entrapment

- 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 rigonfiamento 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 metatarso-phalangeal 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

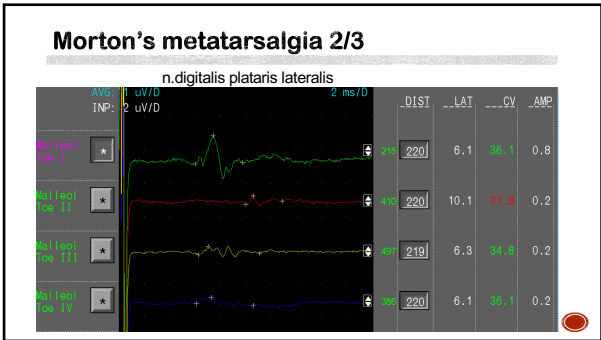
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### Plantar nerves

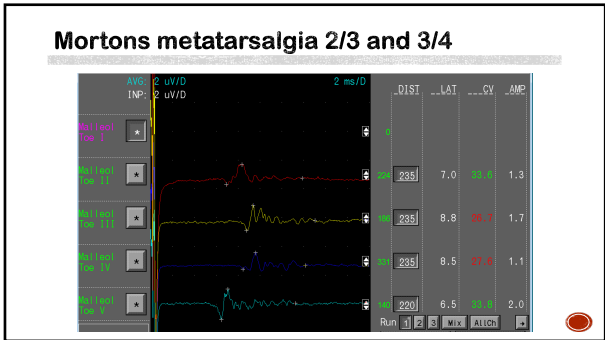
plantar digital nerve entrapment between II/III or III/IV metatarsals

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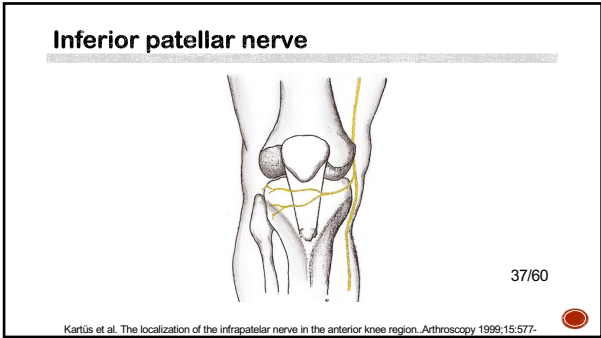
### Affected interspace

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

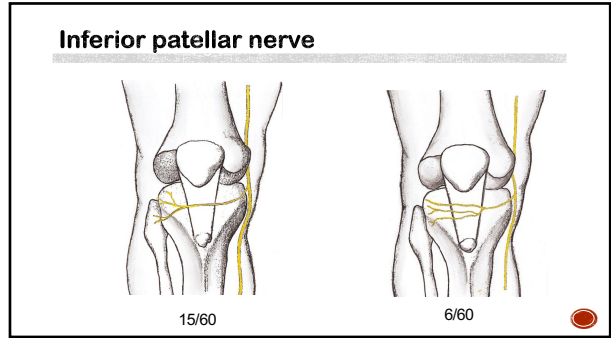
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### Inferior patellar nerve

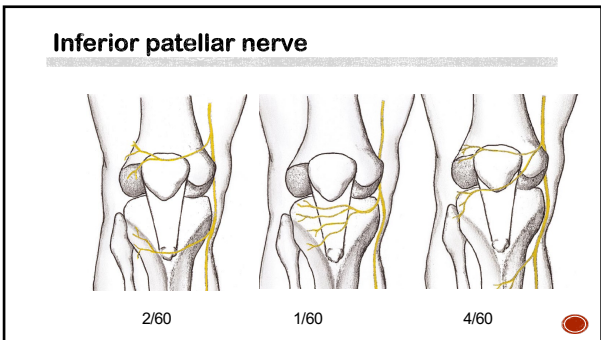
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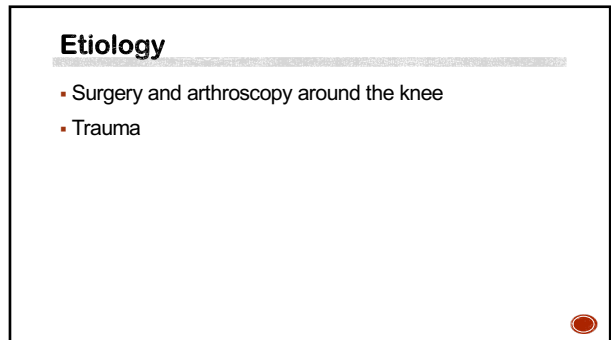
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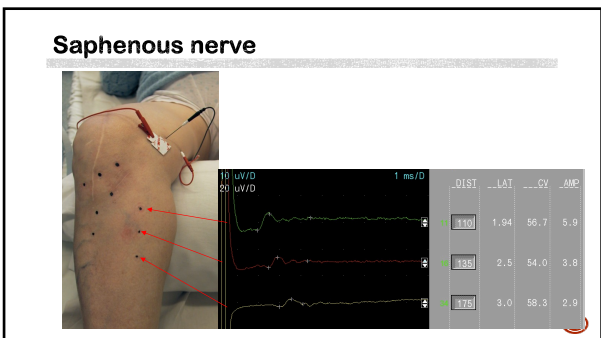
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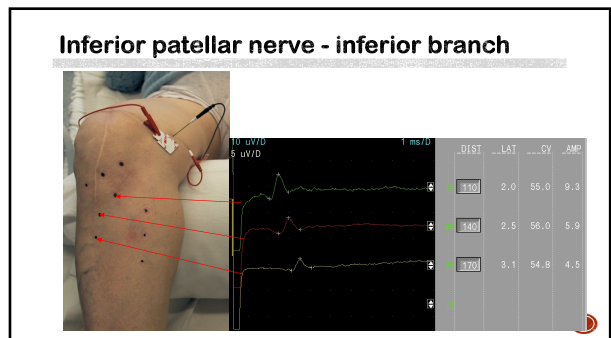
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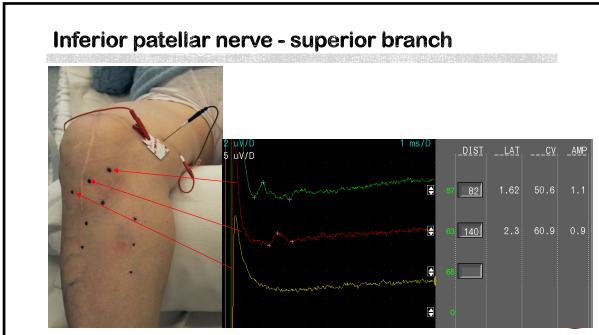


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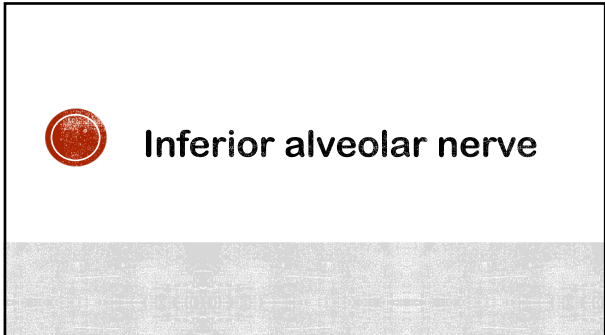


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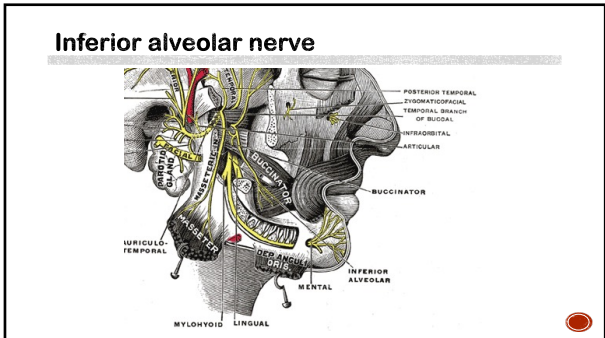
### Muscle & Nerve 1999:22:455-459

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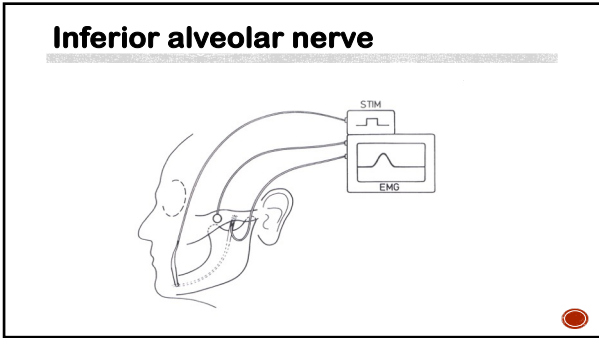
#### A NEW TECHNIQUE FOR RECORDING SENSORY CONDUCTION VELOCITY OF THE INFERIOR ALVEOLAR NERVE

SATU K. JÄÄSKELÄINEN, MD, DMSc  
 Department of Clinical Neurophysiology, Turku University Central Hospital, PL-52, FIN-20521, Turku, Finland

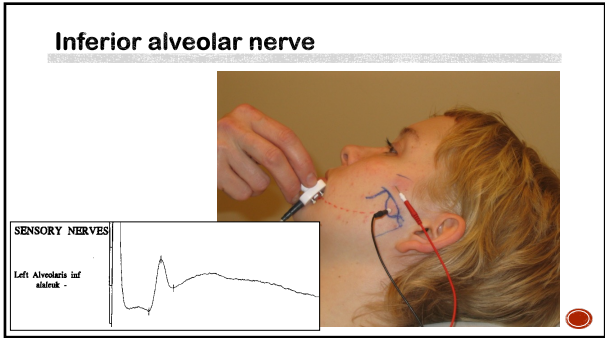
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### Reference values

- 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



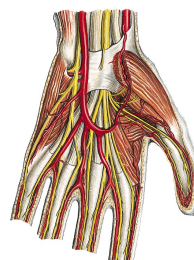
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### Palmar digital nerves

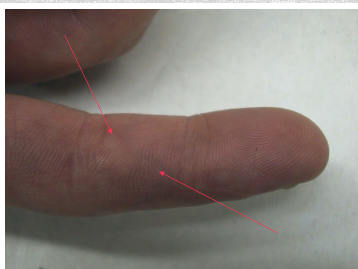
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### Palmar digital nerves



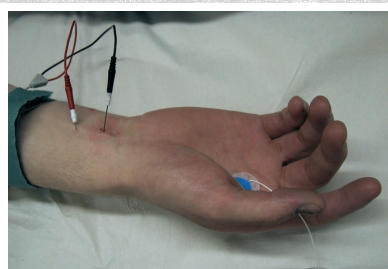
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### Palmar digital nerves

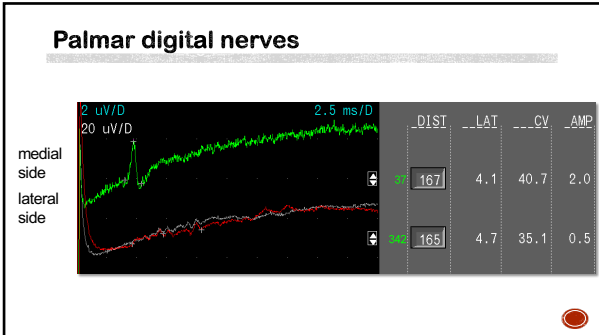


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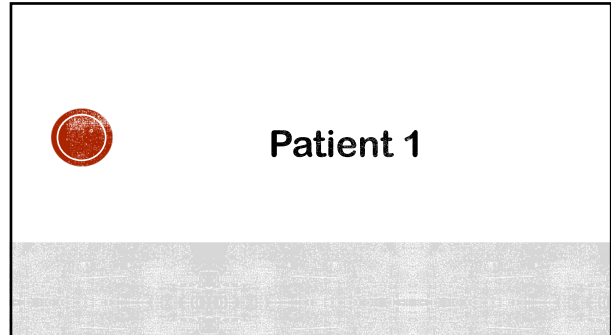
### Palmar digital nerves



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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)

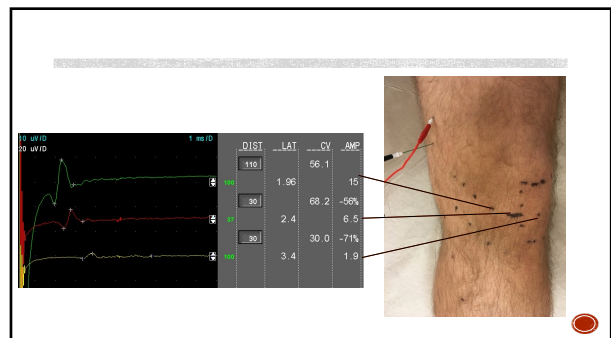
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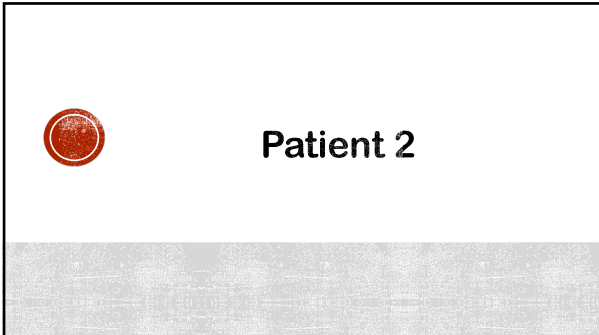
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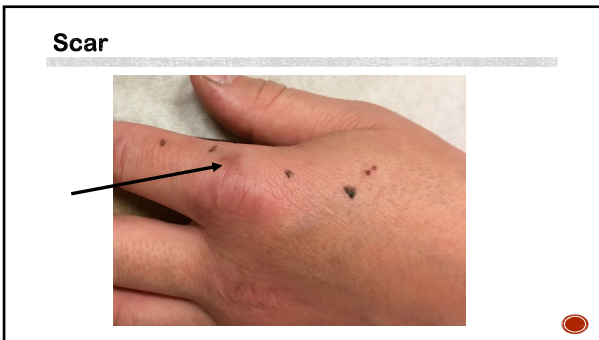


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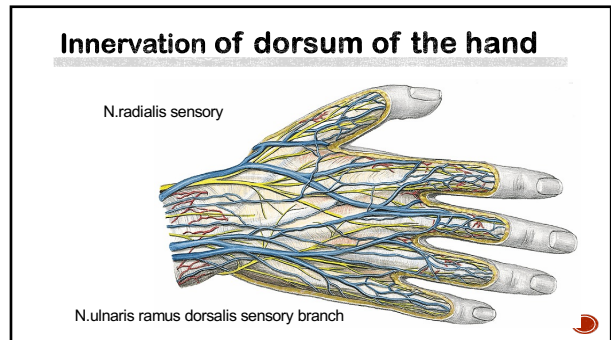
### History

- 10 weeks prior to EMG 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

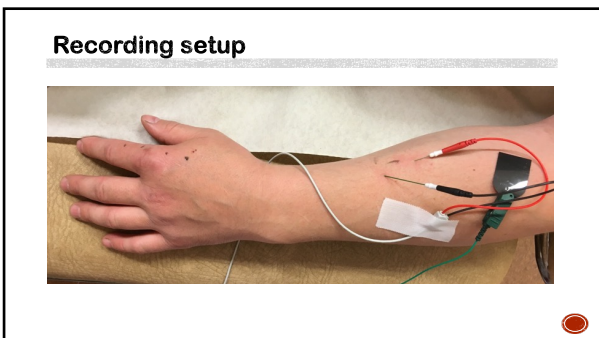
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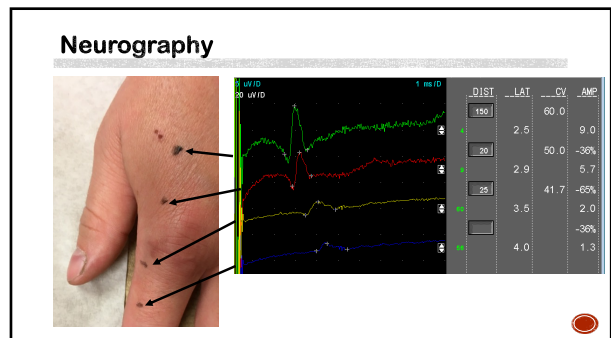
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### Finding

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

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### Patient 3

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### 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

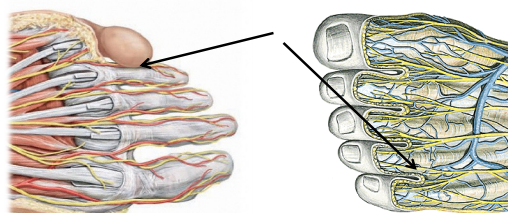
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### Sensory abnormality



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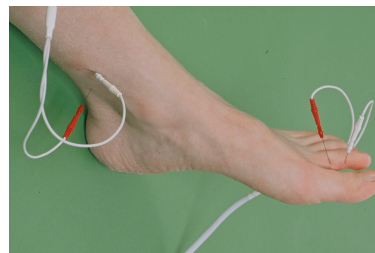
### Differential diagnosis



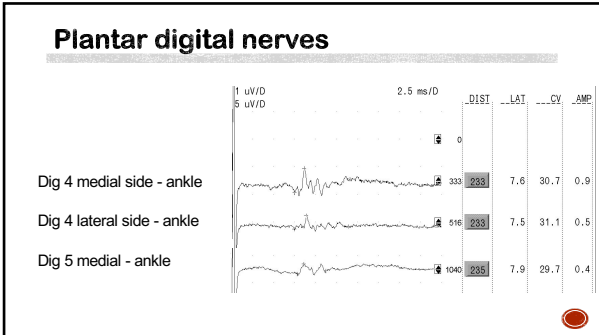
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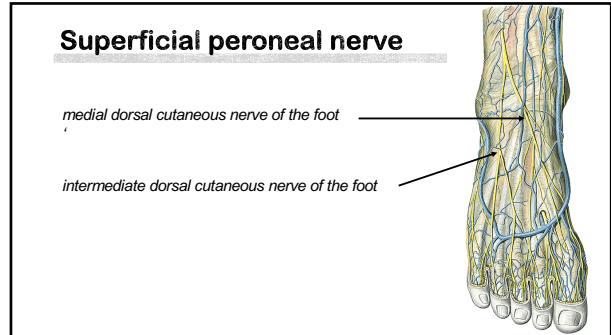
### Plantar digital nerves



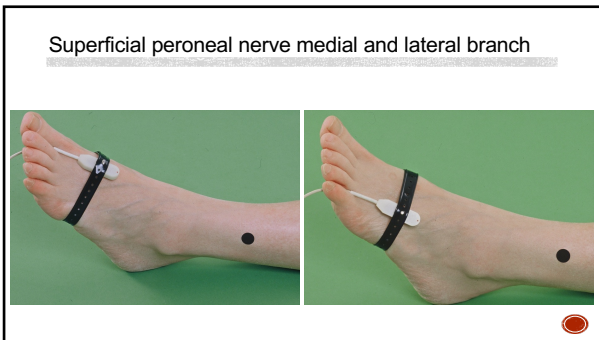
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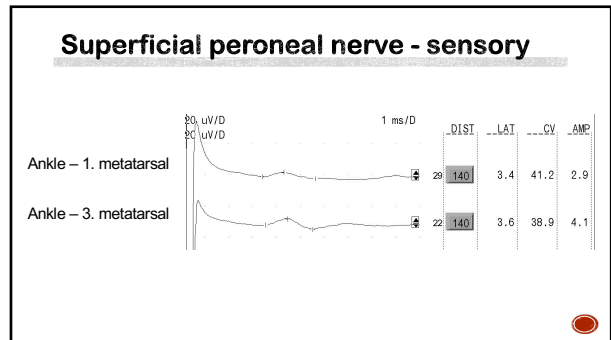
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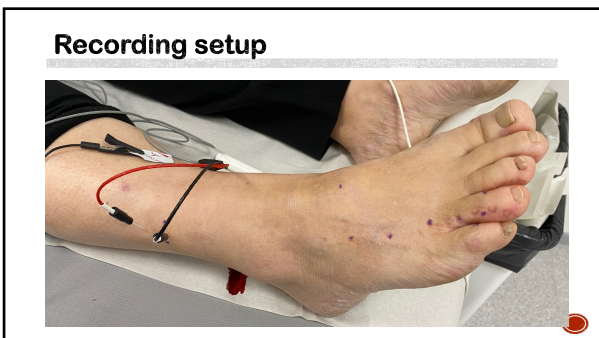
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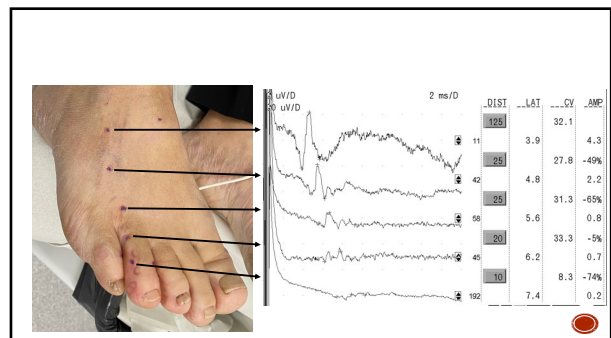
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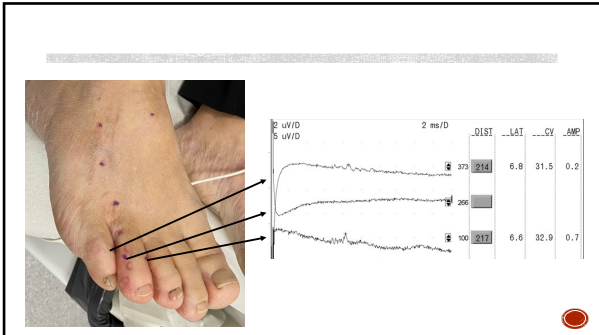


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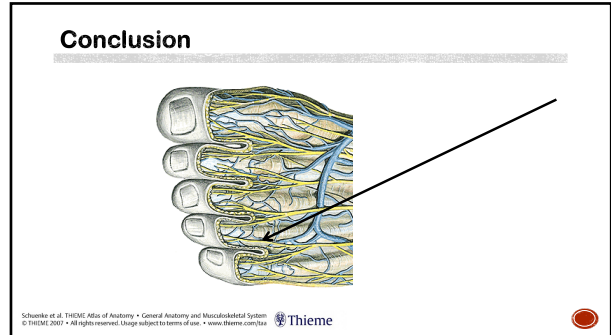


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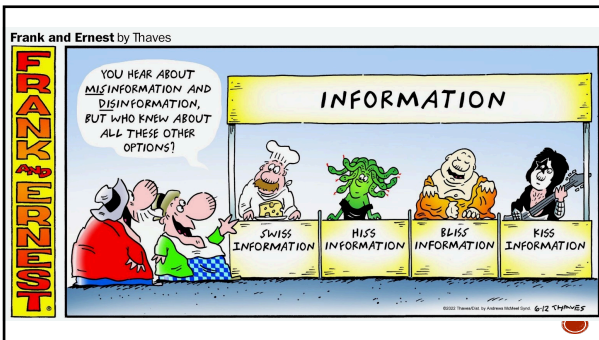




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