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Vojenská fakultní nemocnice  
Praha

# **Surgical treatment of the peripheral nerve injuries**

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First Faculty of Medicine and Military University Hospital Prague

# Types of nerves' injuries

- Traction – radial or peroneal n.



- Laceration



- Compression – combination of pressure and ischaemia, „Saturday night palsy“ or „Honeymoon palsy“

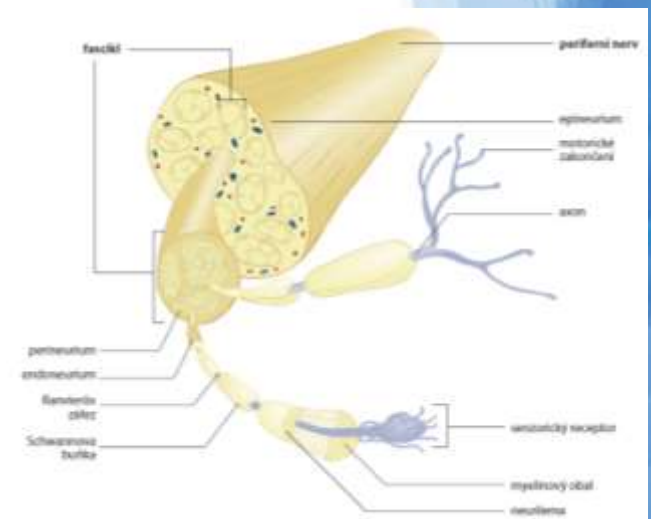
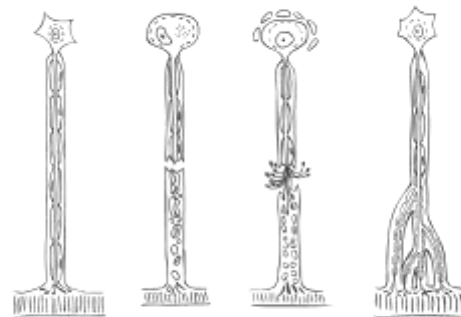
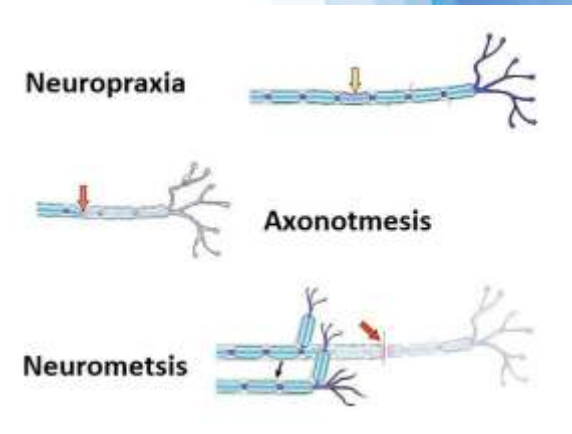


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# Classification

- Seddon (1943)
  - **Neurapraxia** – functional block
  - **Axonotmesis** – injury of axons (fibers) or fascicles
  - **Neurotmesis** – transection of the nerve
- 
- → Waller's degeneration
  - → +- Waller's regeneration



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# Timing of surgery

## Rule of 3x3

- Acutely, or within 3 days – clean cut wounds
- In three weeks – dirty lacerated wounds (GSWs, bites, extensive open injuries with vessels reconstruction..)
- In 3 – 6 months – closed (traction) injuries with EMG proven complete denervation



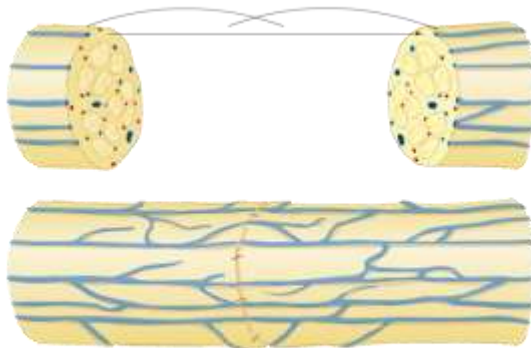
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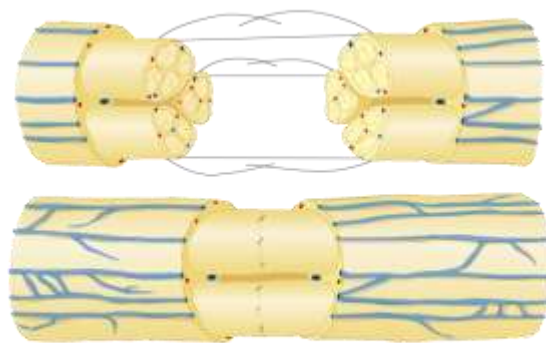


# End-to-end neurorrhaphy

- Acute surgery with minimal retraction of nerve stumps



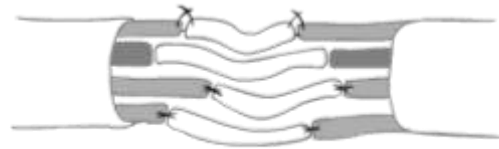
epineurial  
suture



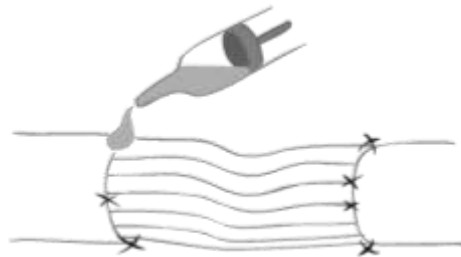
Group-fascicular  
suture



# Reconstruction with nerve grafts

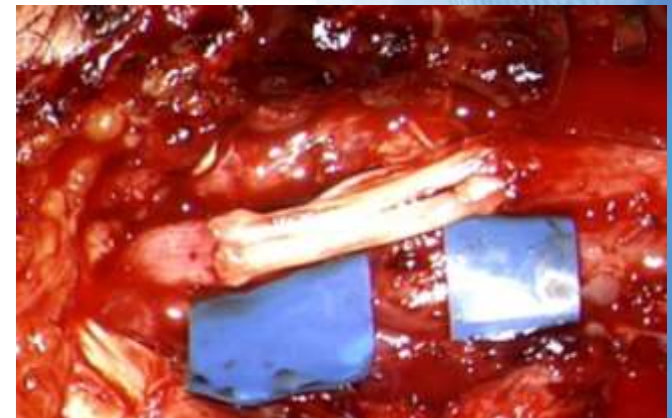


interfascicular reconstruction



Cabeliform technique +- glueing with tissue plasminogen

Salami slicing technique to cut out terminal neuroma

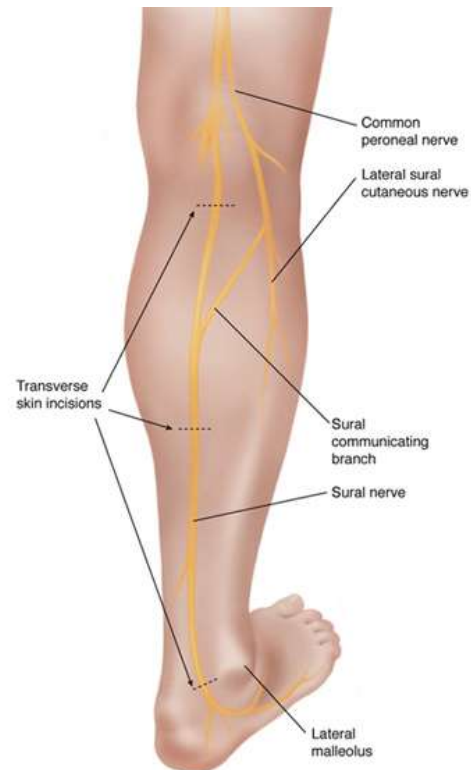
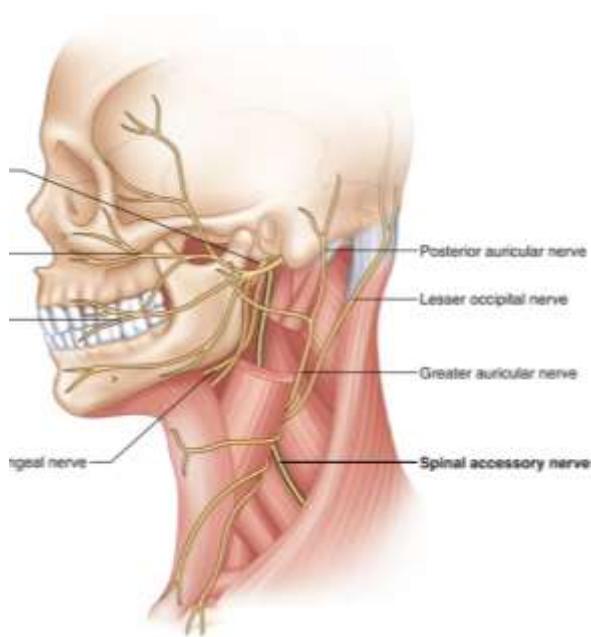


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# Nerve grafts

- **Sural nerve** – most often
- Lateral or medial antebrachial cutaneous nerve
- Great auricular nerve – n. VII



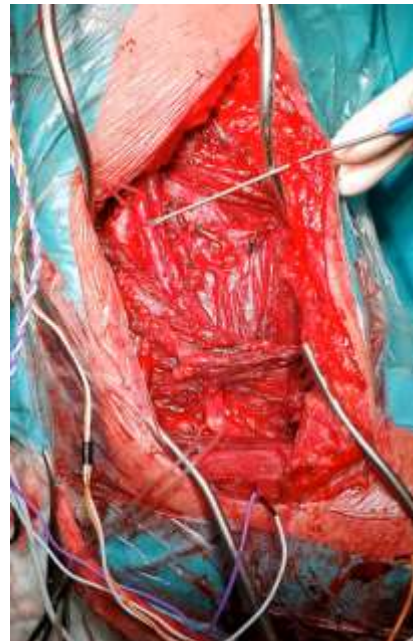
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# Closed injuries

- Typically traction lesions
- In cases with preserved function (conduction – positive NAP) – only neurolysis (releasing the nerve from the scar tissue)
- Negative neurogram – excision of neuroma-in-continuity and grafting



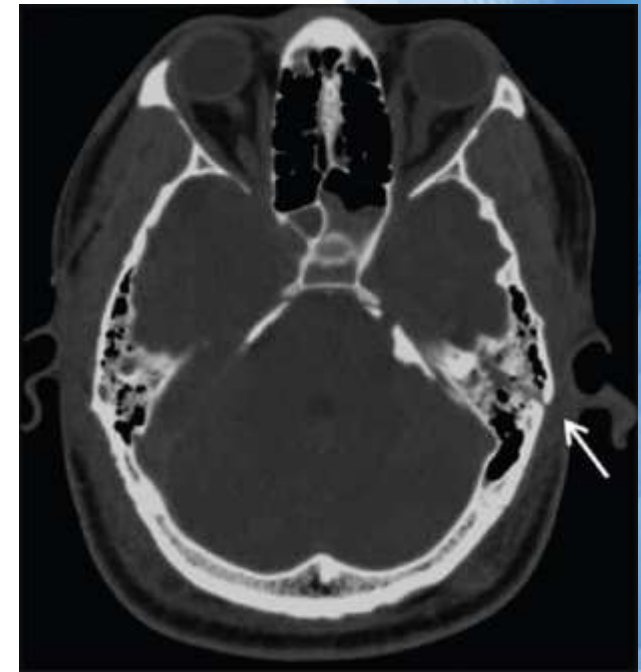
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# Facial nerve (VII)

- Traumatic lesions – temporal bone (pyramid) fractures
- Iatrogenic lesions – most common, surgery of ponto-cerebellar angle – VIIIth nerve schwannoma..., parotidectomy

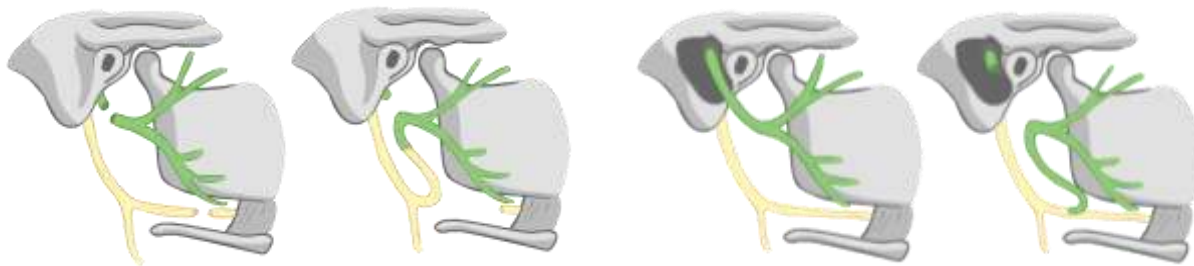
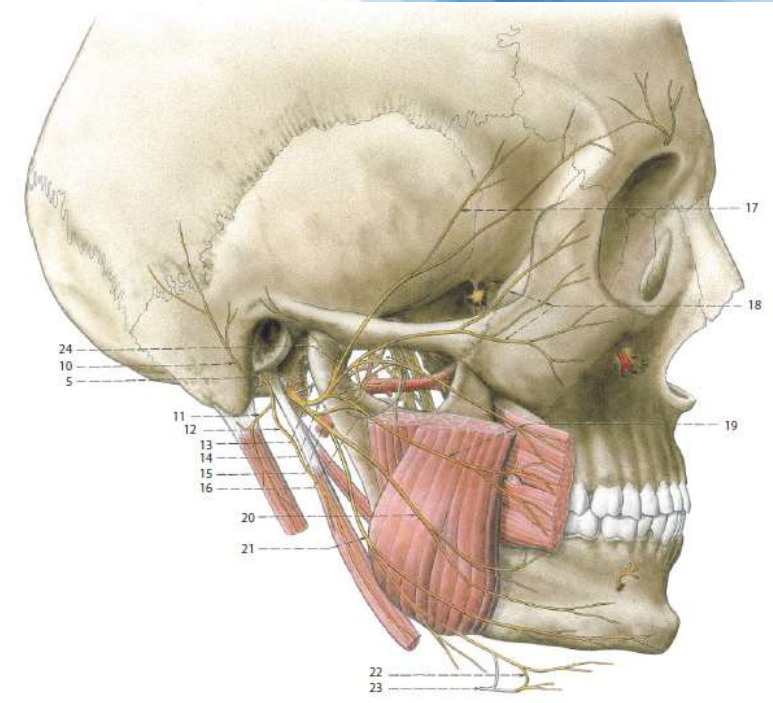


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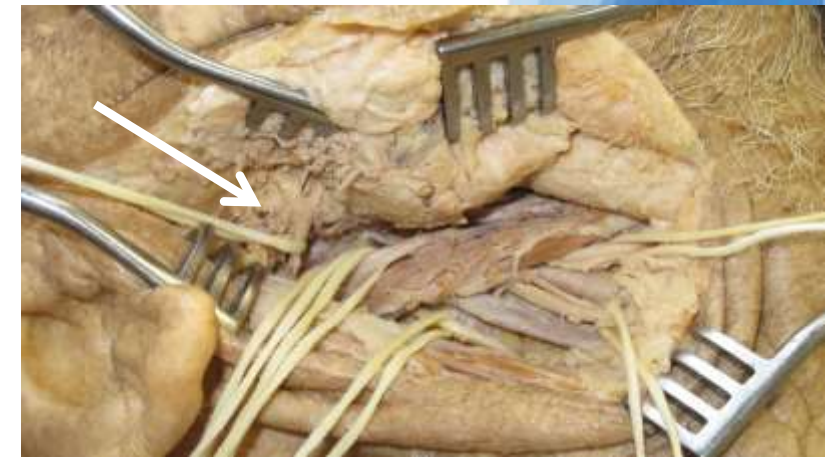
# Surgical treatment

- Decompression – pyramidal fractures
- End-to-end – iatrogenic lesions
- Reconstruction
  - With nerve grafts (Dott's technique)
  - Nerve transfer – hypoglossal-facial anastomosis



classical HFA

Partial (Darrouzet)



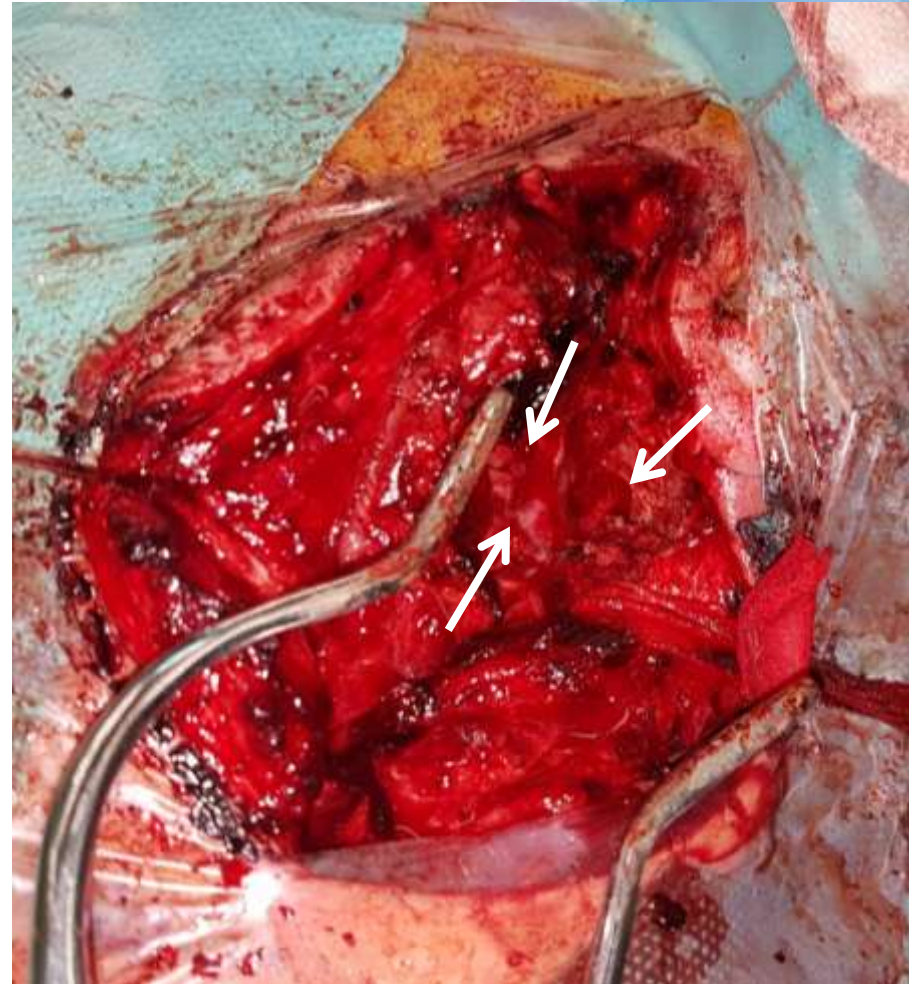
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# Facial nerve injury - grafting

Acute reconstruction of lacerated injury after resection of VIIth nerve schwannoma (missinterpreted as parotid gl.TU)

Reconstruction with 2 grafts from great auricular n.

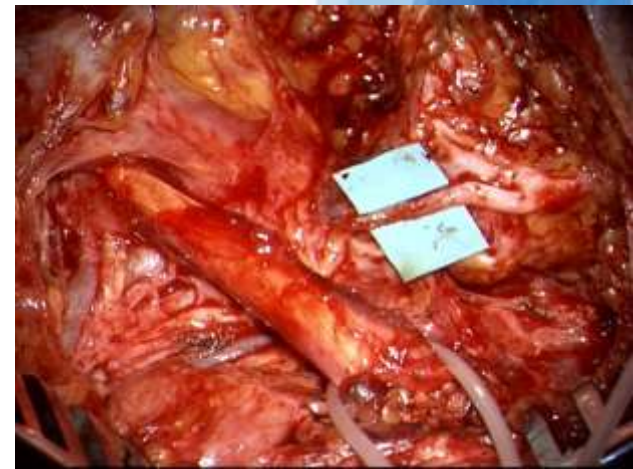
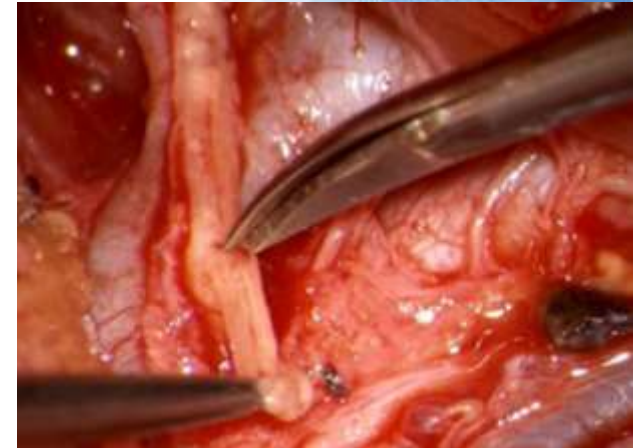


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# Facial nerve injury – nerve transfer



Cusimano and Sekhar, 1994

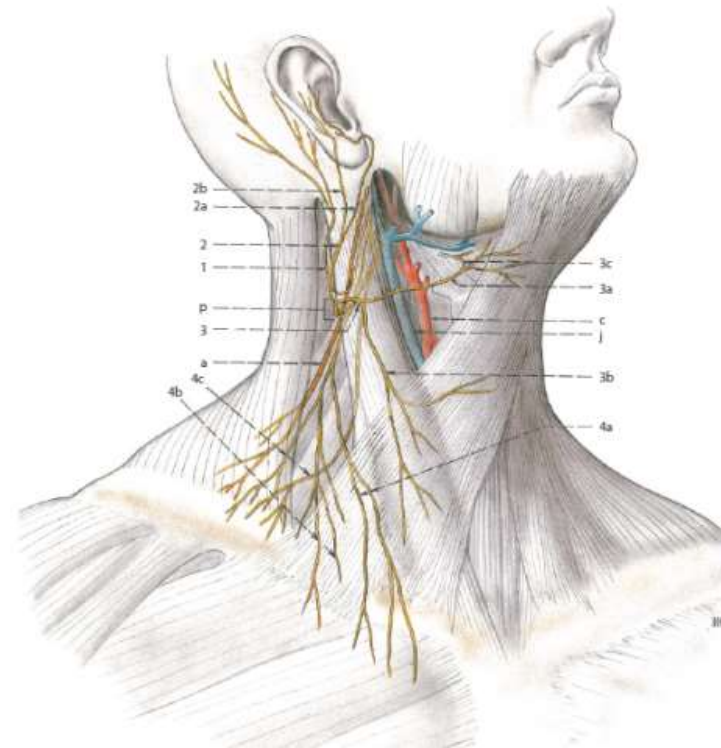


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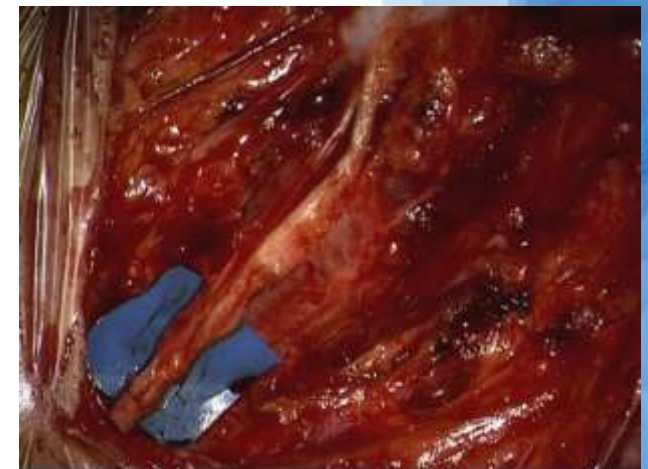
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# Spinal accessory n. (XI)

- Presentation: palsy of shoulder elevation, abduction, ventral fl.
- Iatrogenic – 3-10% in cerv lymph nodes resection



- Laceration of the nerve during lipoma resection
- 2 grafts from supraclavicular and lesser occipital nn.



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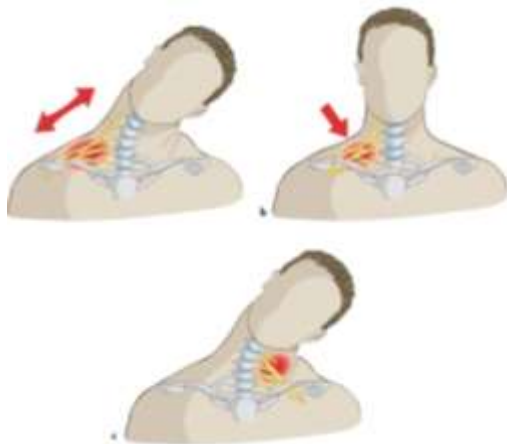
# Brachial plexus palsy

Typically closed lesions (93%) - traction:

- 81 % traffic injuries
- 63 % car or motorcycle crashes
- 19 % others – fall of the object onto the shoulder (tree branch, ice..)



Upper and complete lesions



Lower lesions

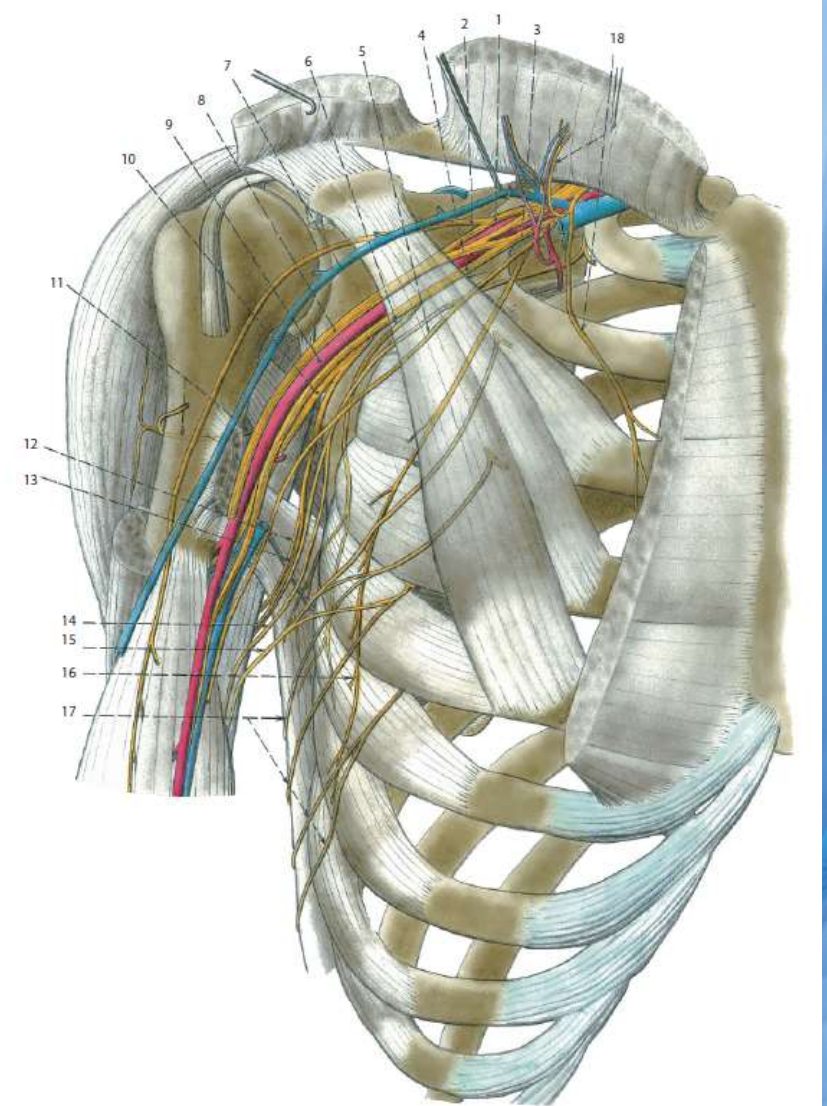
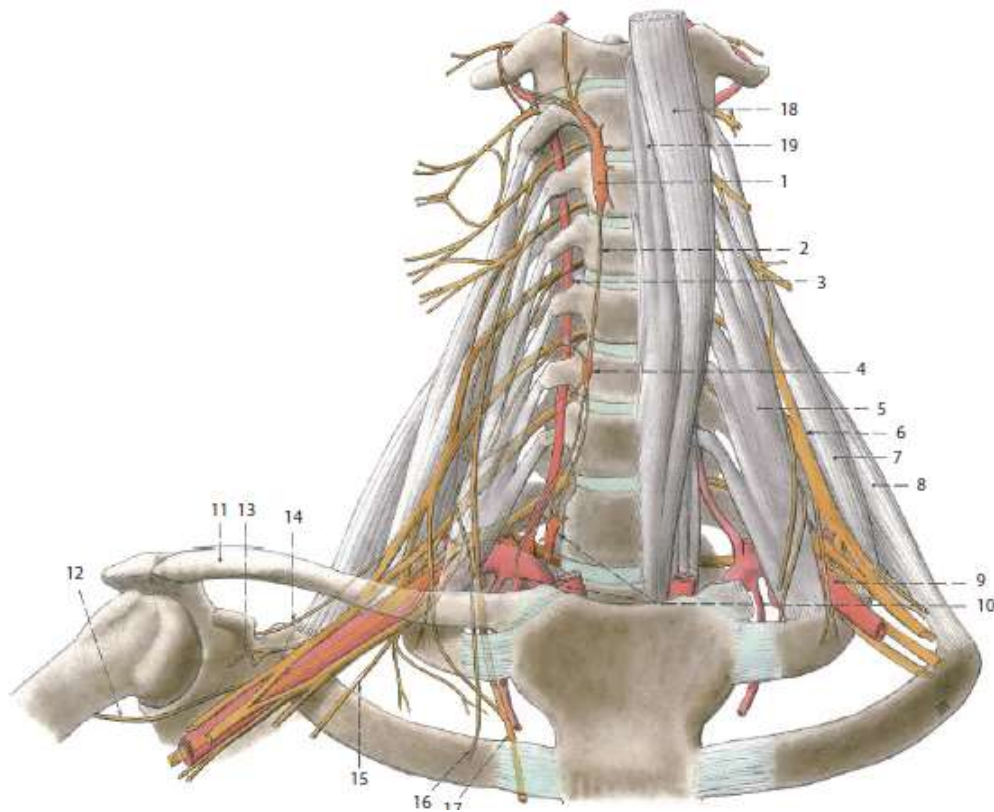


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# Brachial plexus anatomy



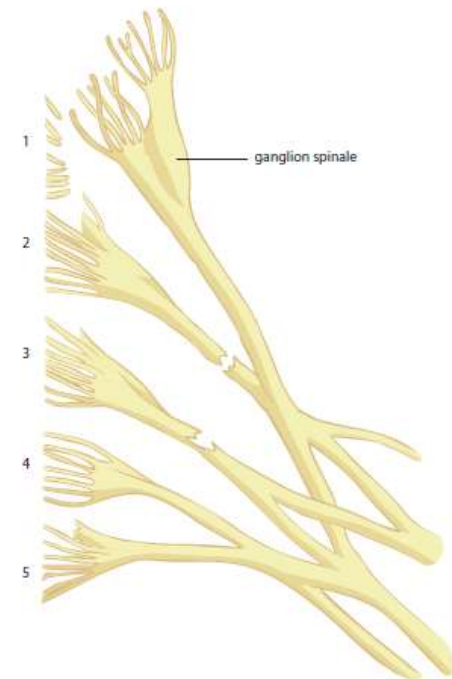
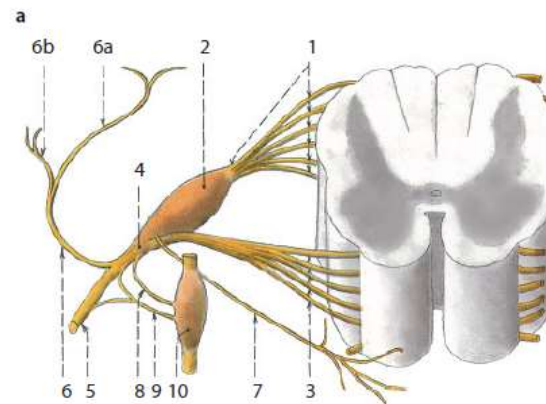
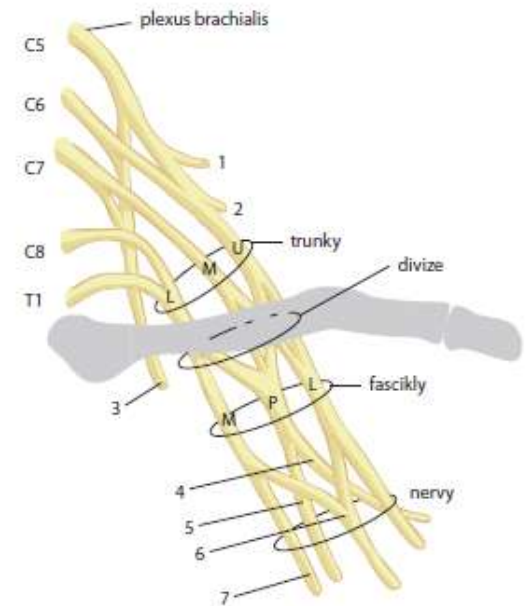
# Types of lesions

## ■ Supraclavicular

- Root avulsion - *supraganglionar*
- Root rupture (typically C5-6) - *infraganglionar*
- Combination

## ■ Infraclavicular – direct injury to the lower part of the BP

## ■ Combined

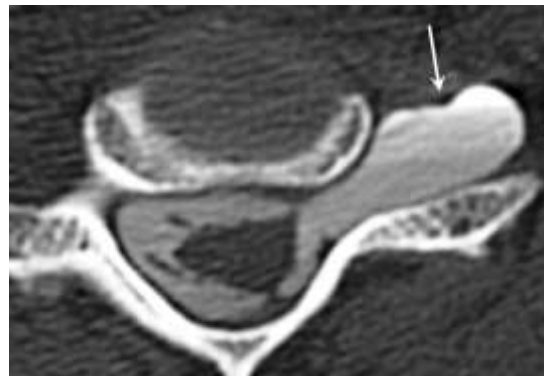
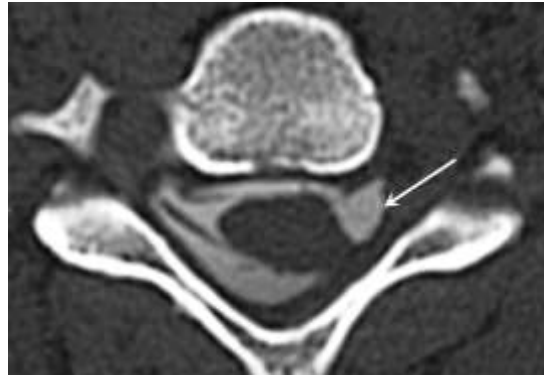


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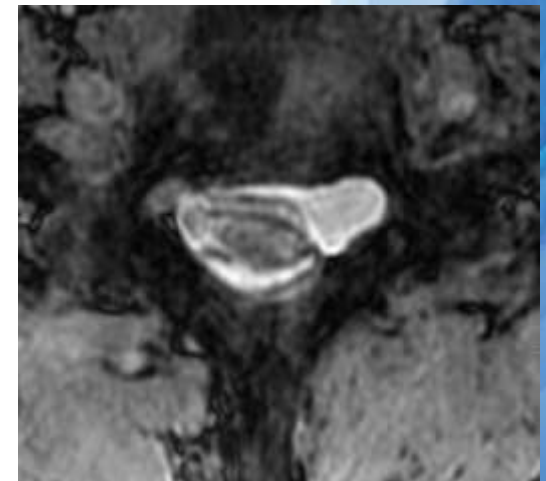
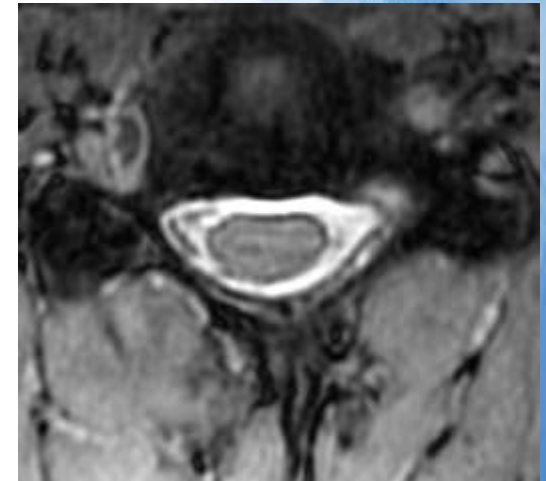
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# Proof of cervical root avulsion

- CT-myelography



- MRI – 3D-COSMIC



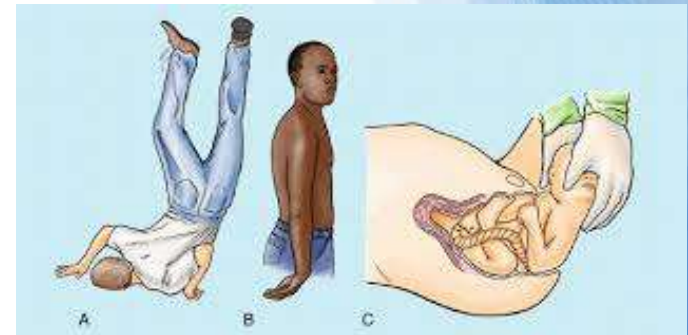
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# Clinical picture

- Upper plexus sy (*Erb's palsy*)
  - C5-6±7 (*shoulder abduction, forearm flexion, supination*)
  - ~ **3/4 cases**
- Complete palsy (flail arm) ~ **1/4 cases**
- Lower plexus sy (*Klumpke's palsy*)
  - C8-T1±C7 (*hand palsy*)
  - **3 % (very rare)**

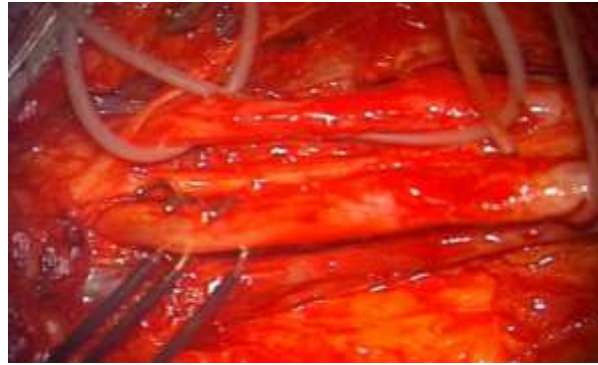


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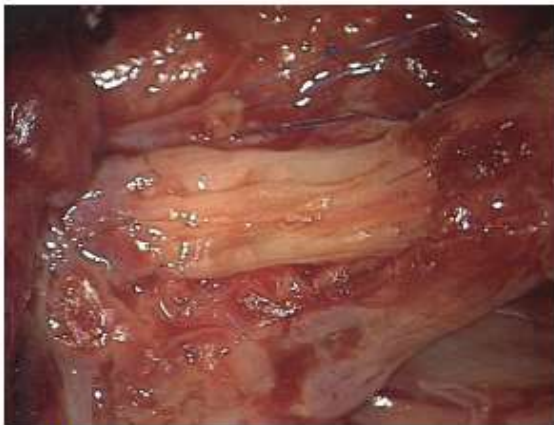
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# Open injuries

- Rare
- Typically infraclavicular
- Supraclavicular extremely rare (motor blades, chainsaw)



Man attacked by his wife  
Stab injury by knife  
Partial injury of MN - grafting  
Non-functional neuroma of UN

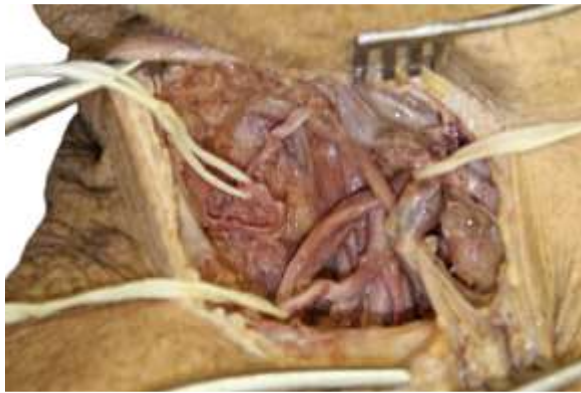
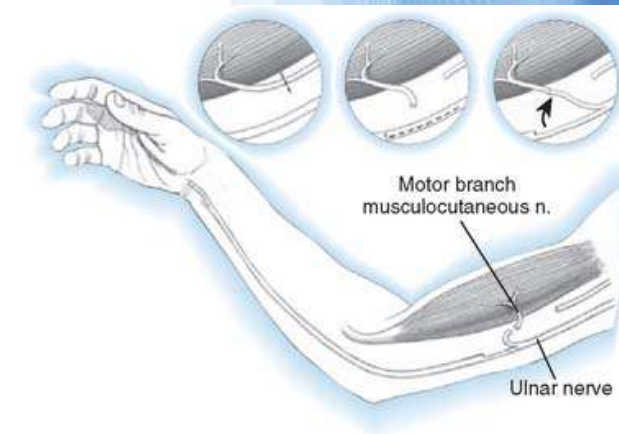


# Neurotization – nerve transfer

- Reconstruction of the distal stump of the injured n. (recipient) by proximal stump of the donor
- Recipient must be functionally more important than a donor
- Very important role of rehabilitation and neuroplasticity

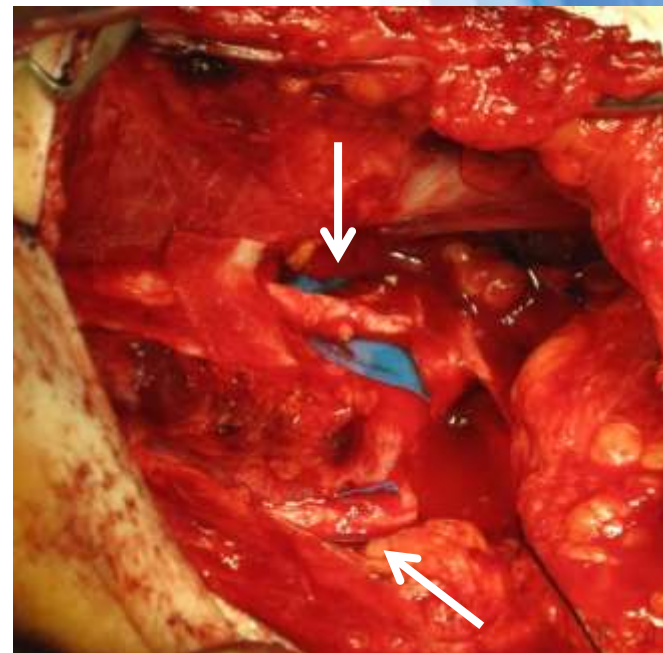
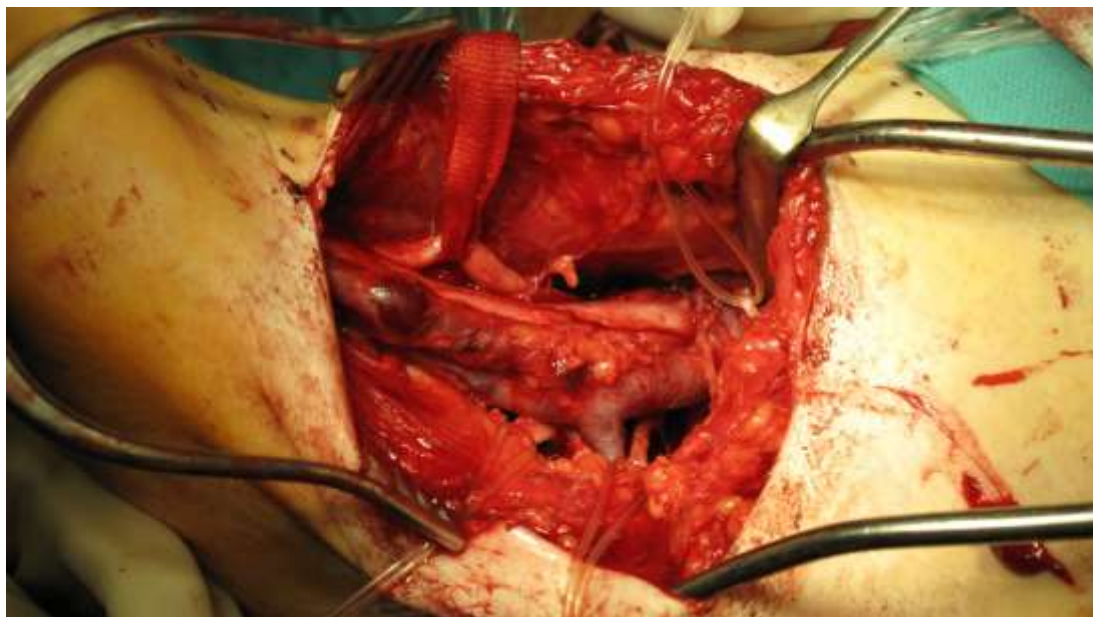
## Extraplexal donors      Intraplexal donors

- XI n
  - C4 root
  - Phrenic n.
  - Intercostal n.
- Pectoral n
  - UN or MN – FT, ETS
  - Radial n. branch for triceps





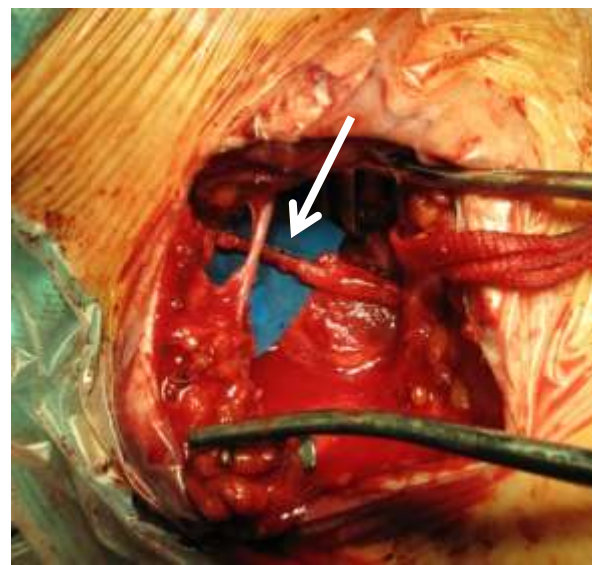
# Restoration of abduction and flexion



Pectoral n. → Musculocutaneous n.

Thoracodorsal n. → Axillary n.

XI n → Suprascapular n.



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# Distal transfers

Sassu et al, 2015

- In proximal lesions without adequate reinnervation or in late revisions
- Most commonly deep branch of UN from anterior interosseous n.

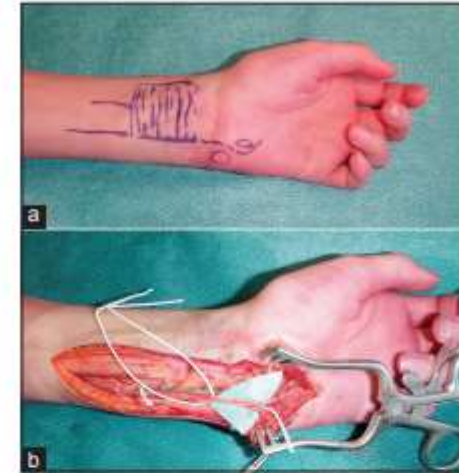
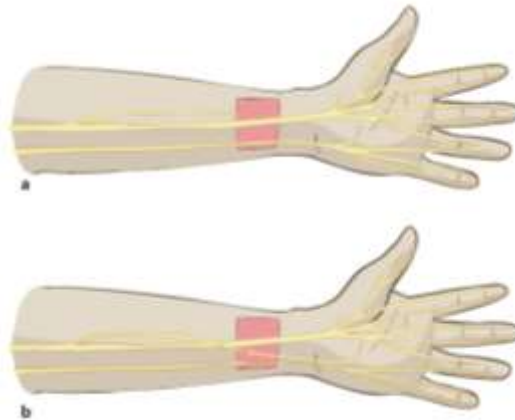


Figure 6: Ulnar nerve deficit. (a) Preoperative drawing showing the course of the motor branch of the ulnar nerve, and the terminal branch of the anterior interosseous nerve into the pronator quadrates; (b) the ulnar nerve and its motor branch after extensive neurolysis

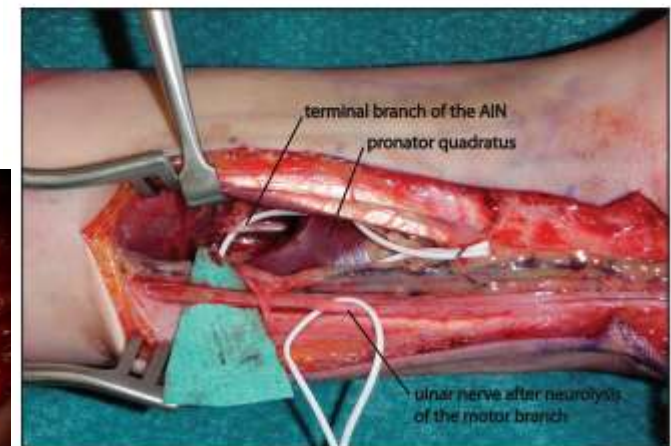
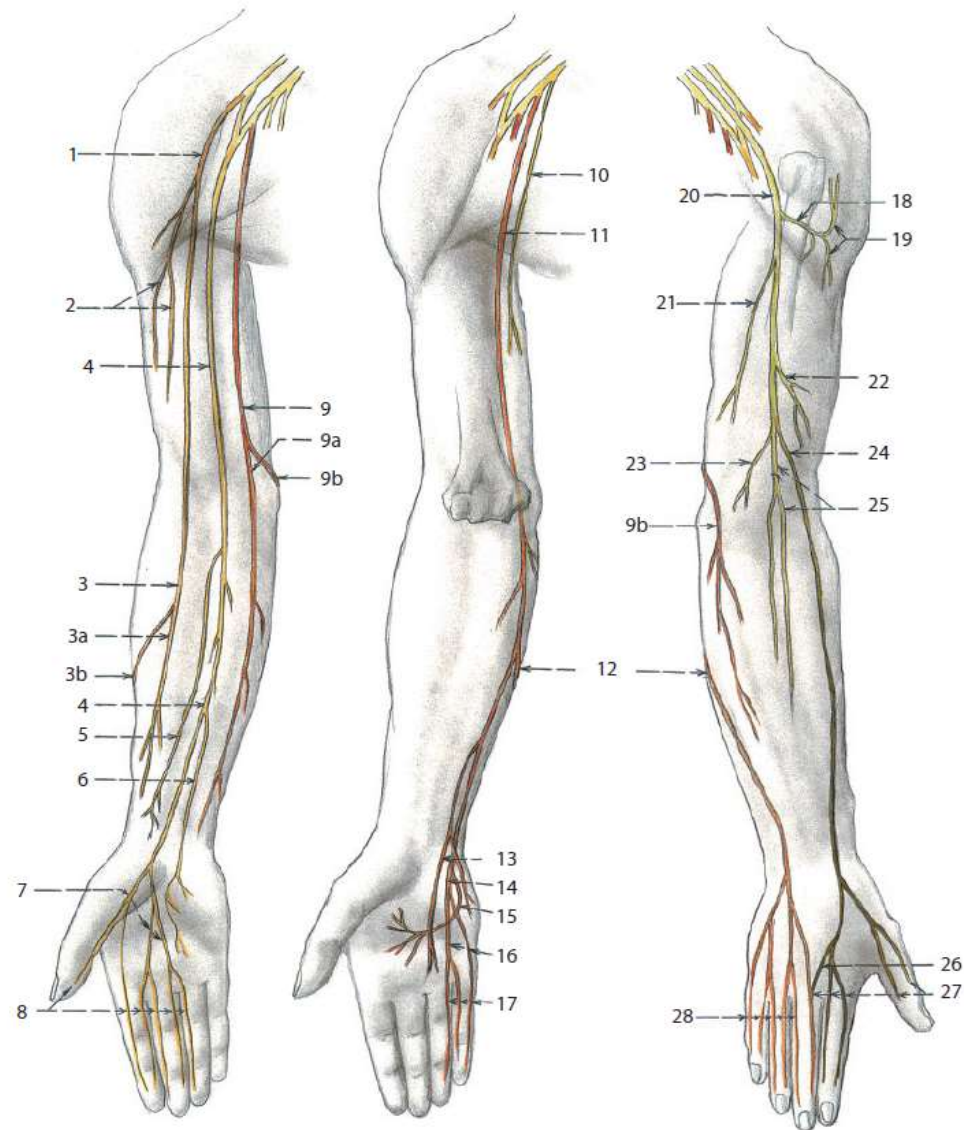


Figure 7: Terminal branch of the anterior interosseous nerve in the pronator quadratus muscle



# Nerves of the upper extremities



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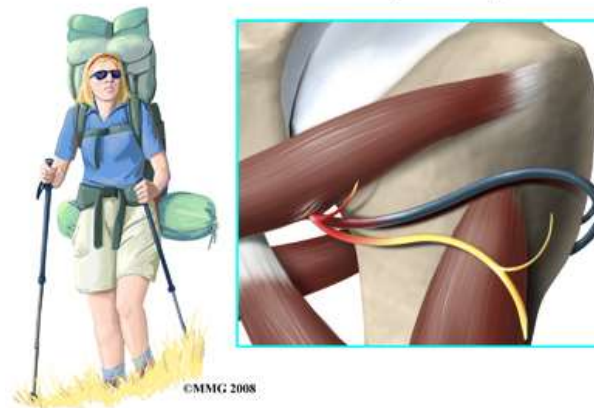


# Axillary nerve

- Abduction , external rotation
- Isolated injury rare, always traction – shoulder dislocation (sports injuries)
- 60% of cases can compensate to full abduction by hypertrophy of supraspinatus muscle
- Compressive neuropathy – quadrilateral space sy – carrying heavy backpack, chronic hyperabduction (volleyball)



Shoulder Quadrilateral Space Syndrome

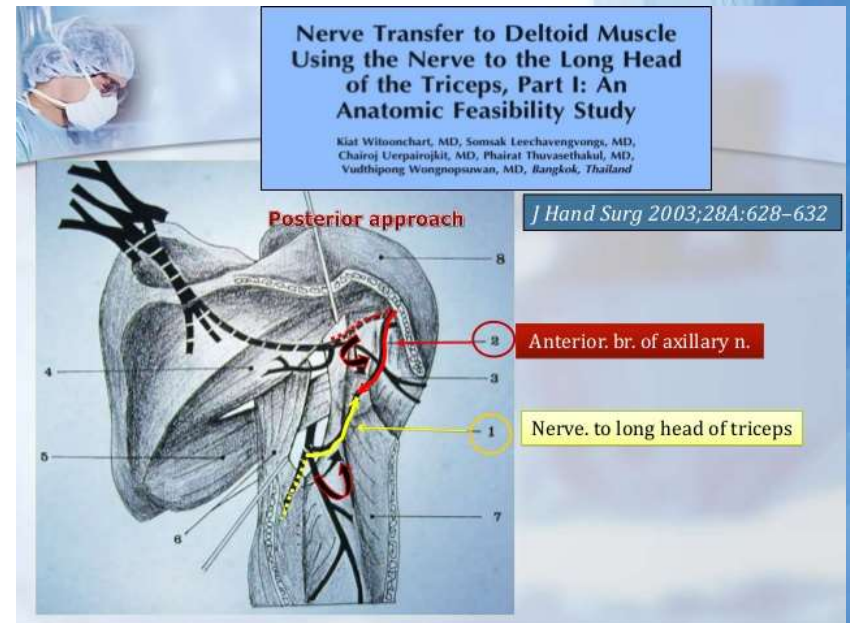
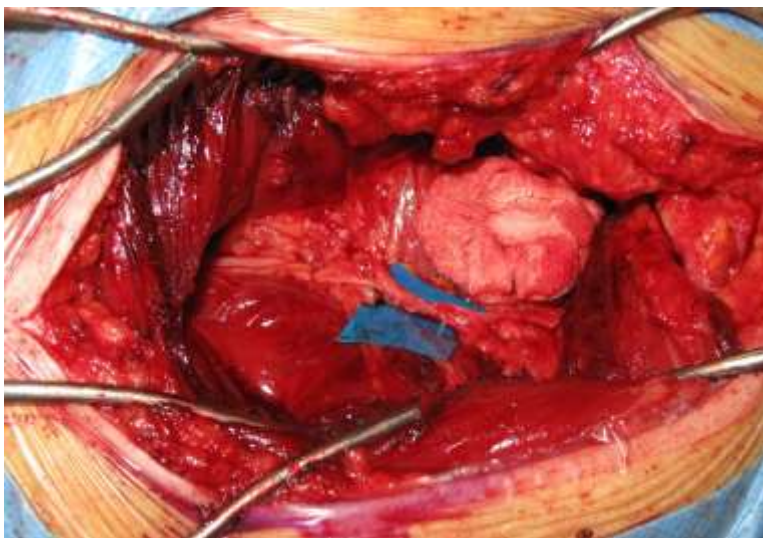
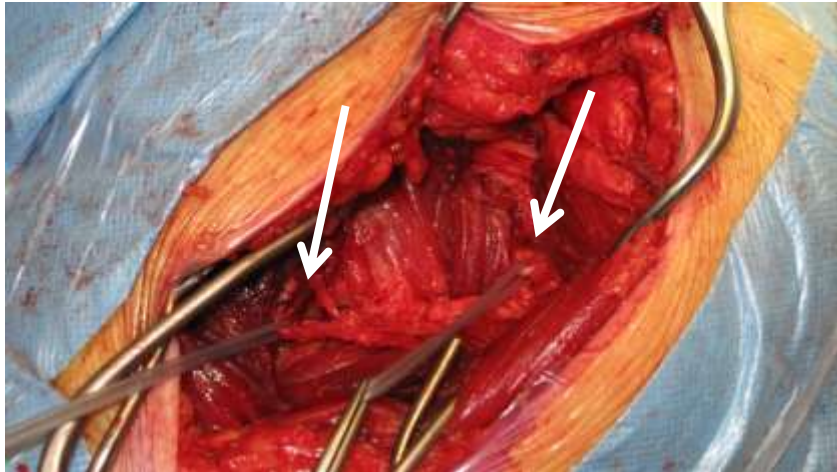


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# Radial branch for triceps to axillary n. transfer

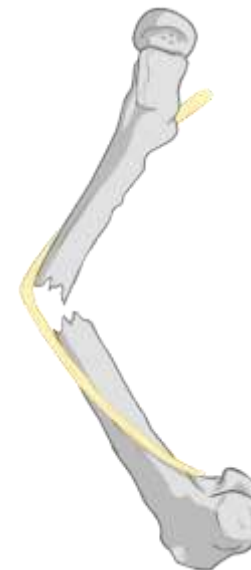
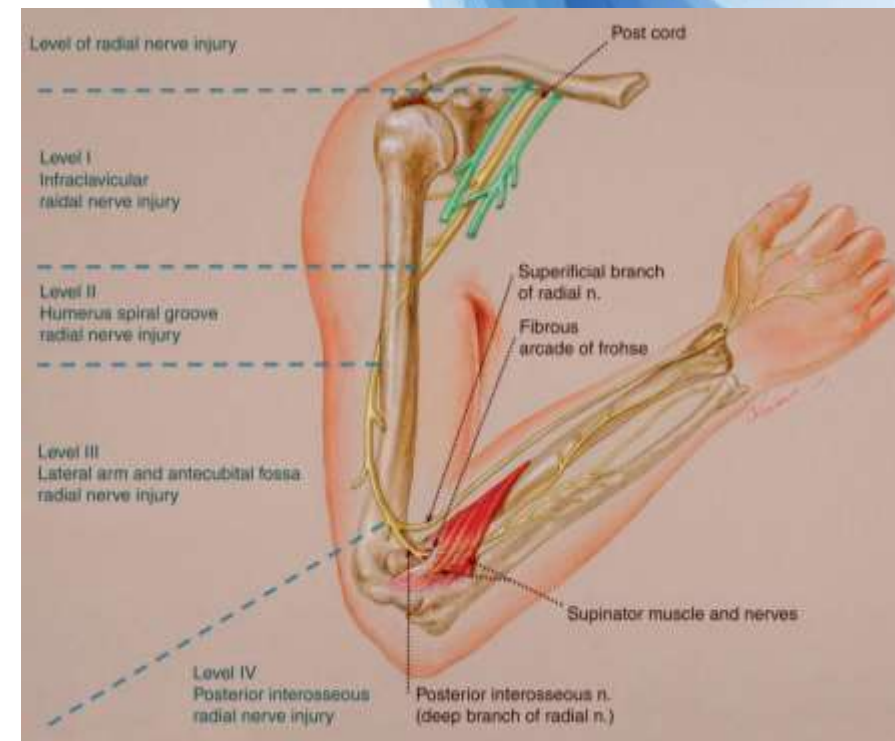
- 60yr, male
- Shoulder dislocation 6mo ago, deltoid palsy





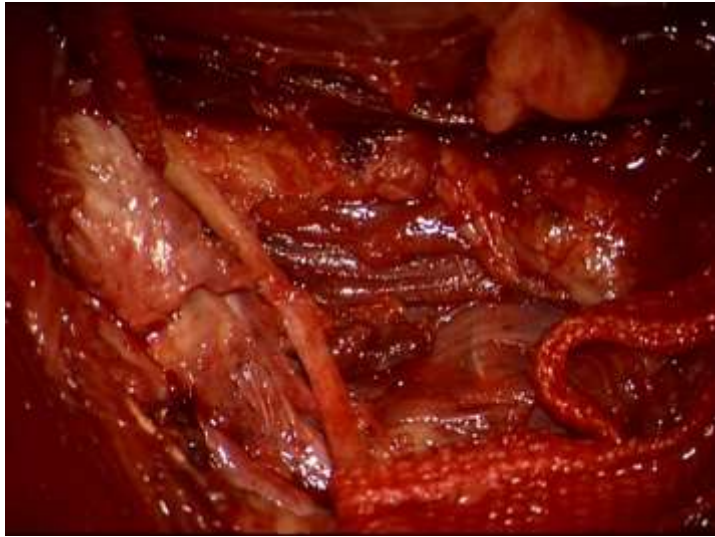
# Radial nerve

- Humeral shaft fracture
- Very good prognosis
- Spont reinnervation in 70%
- Success in 88%
- Revision in 2-3 mo in low-energy trauma
- Earlier in high-energy trauma or open fractures





# Radial nerve



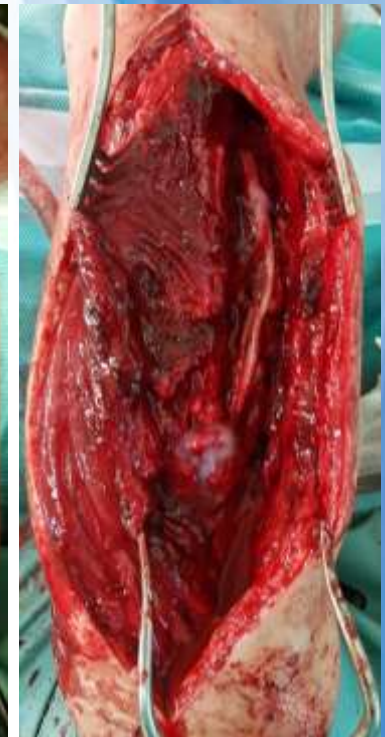
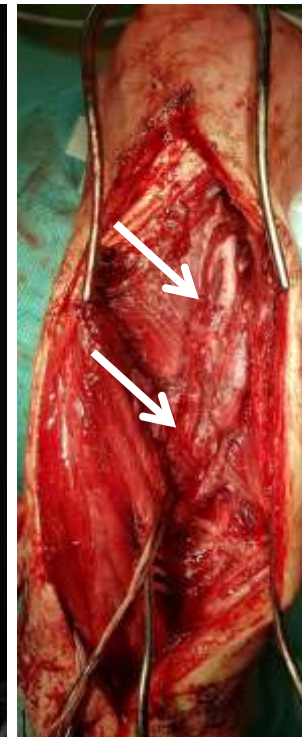
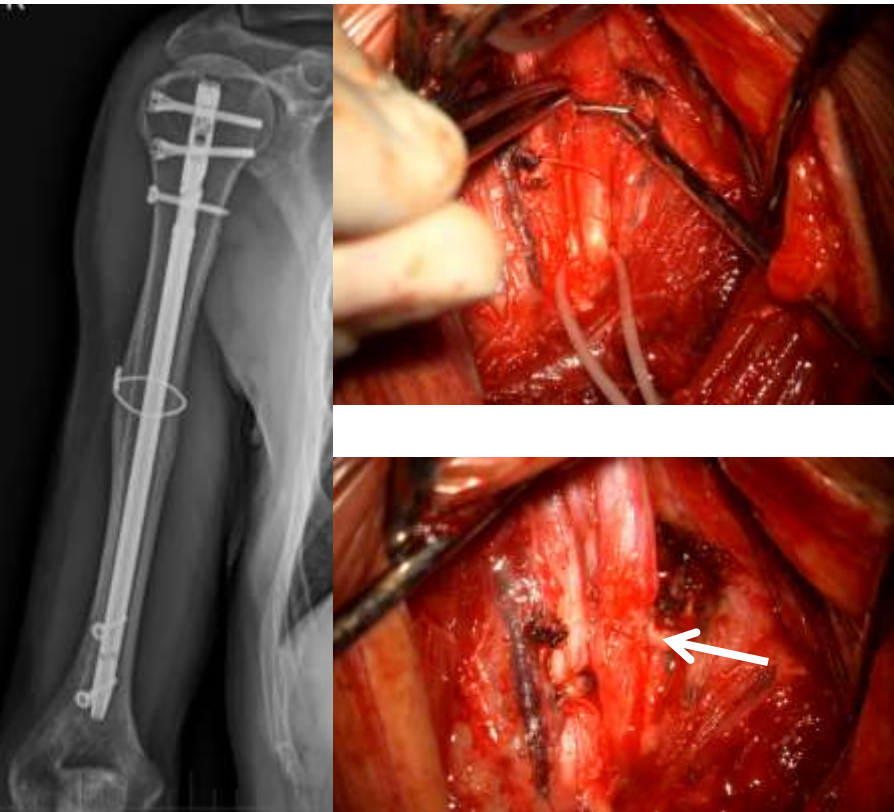
- Female, 60 yrs
- Repeated surgeries for humeral pseudoarthrosis
- Radial nerve laceration during last surgery
- Revision and grafting after 3 weeks
- Reinnervation after 9 months



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# Radial nerve



- Male, 46 yrs
- Spiral fracture of the humerus - arm wrestling
- Intramedullary nail, RN injury by wireloop
- End-to-end suture

- RN laceration in serious humeral fracture
- Reconstruction by 7cm long grafts



# Median and ulnar nerve

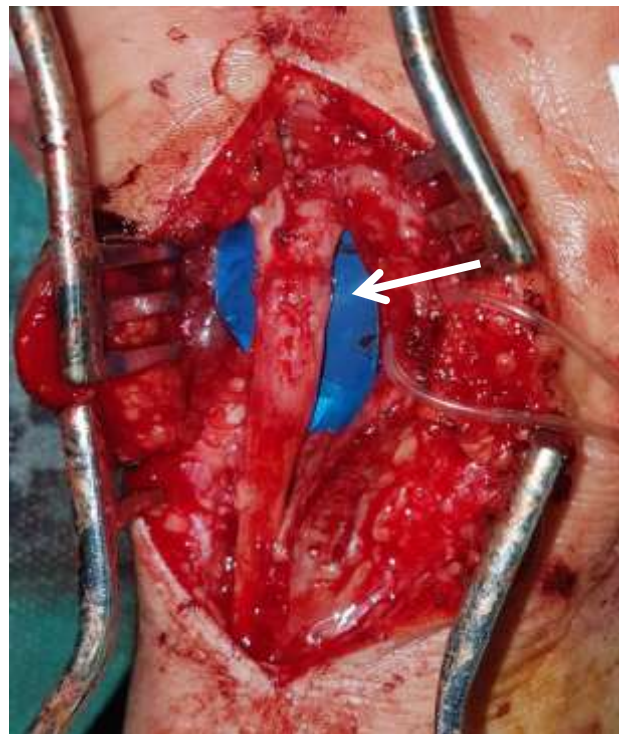
- Most commonly suicidal attempts
- MN better prognosis than UN (sensitivity X intrinsic muscles)
- 20yr old women, cut injury of MN, UN and forearm flexors
- Primary treatment in the trauma dept
- EMG 6 m – total denervation of both nerves
- Revision, grafting





# Ulnar nerve - ETE

- 28yr old male, stab wound in hypothenar
- Neuroma resection, UN transposition in the elbow to shorten the gap, ETE

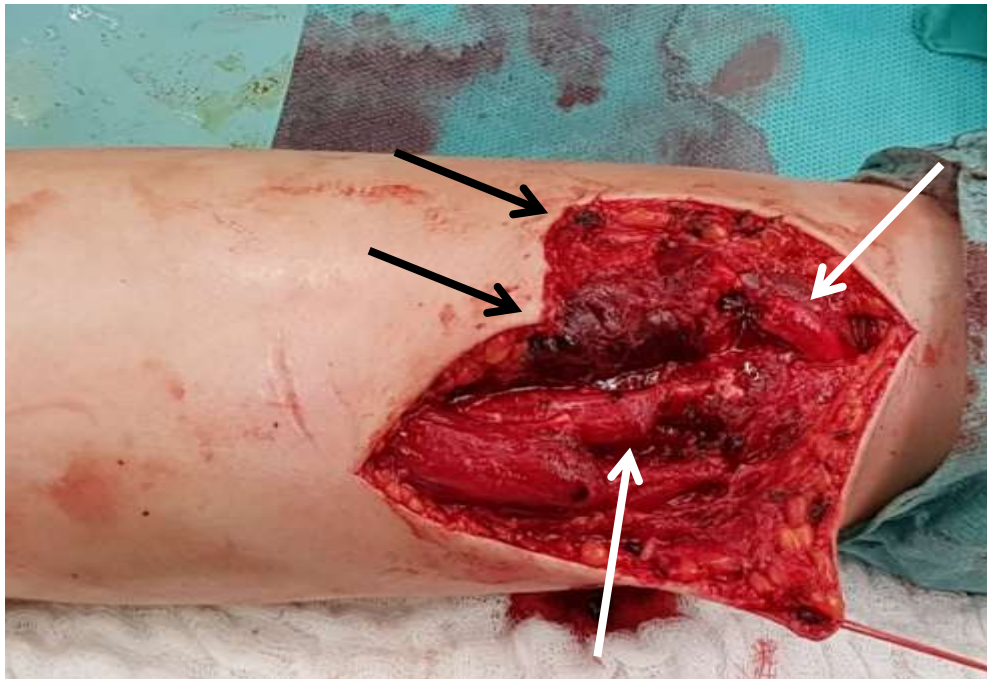


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# Ulnar nerve - grafting

- 25yr old woman, stab wound in the forearm
- Severe pain of the whole upper limb
- Severe swelling during surgery – compartment sy, provisional closure
- Reconstruction after 3 days – 3 sural n. grafts



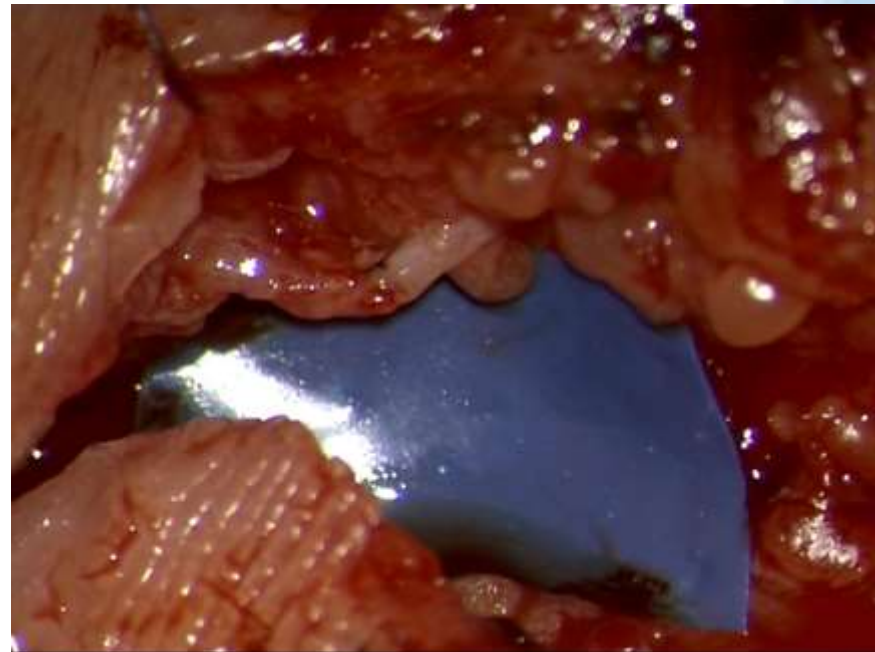
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# Digital nerves

- 35yr old man, sharp injury in the MP area of the II digit caused by a screwdriver
- Anesthesia of the medial half of II digit
- ETE suture

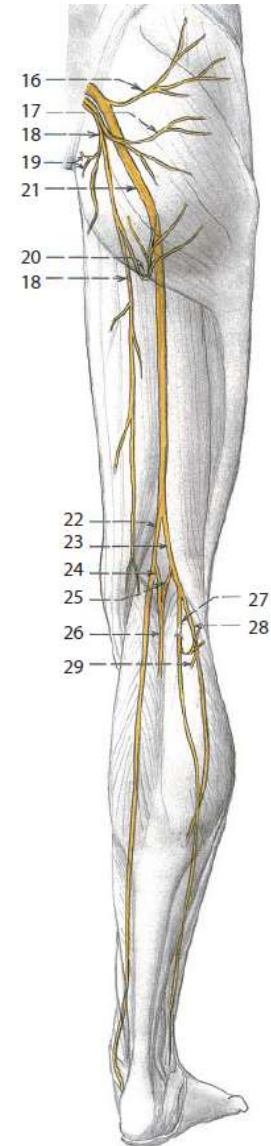
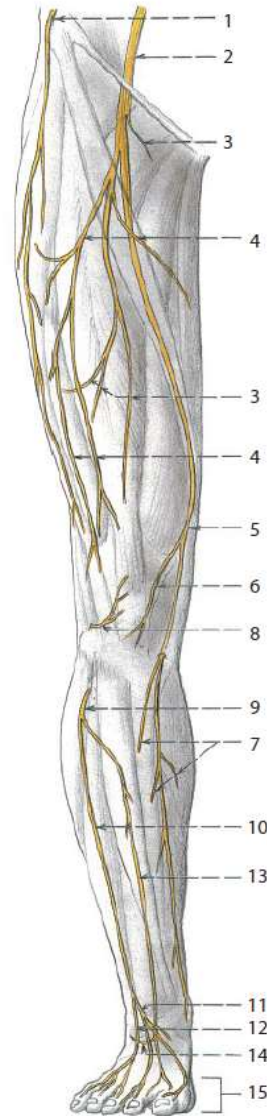
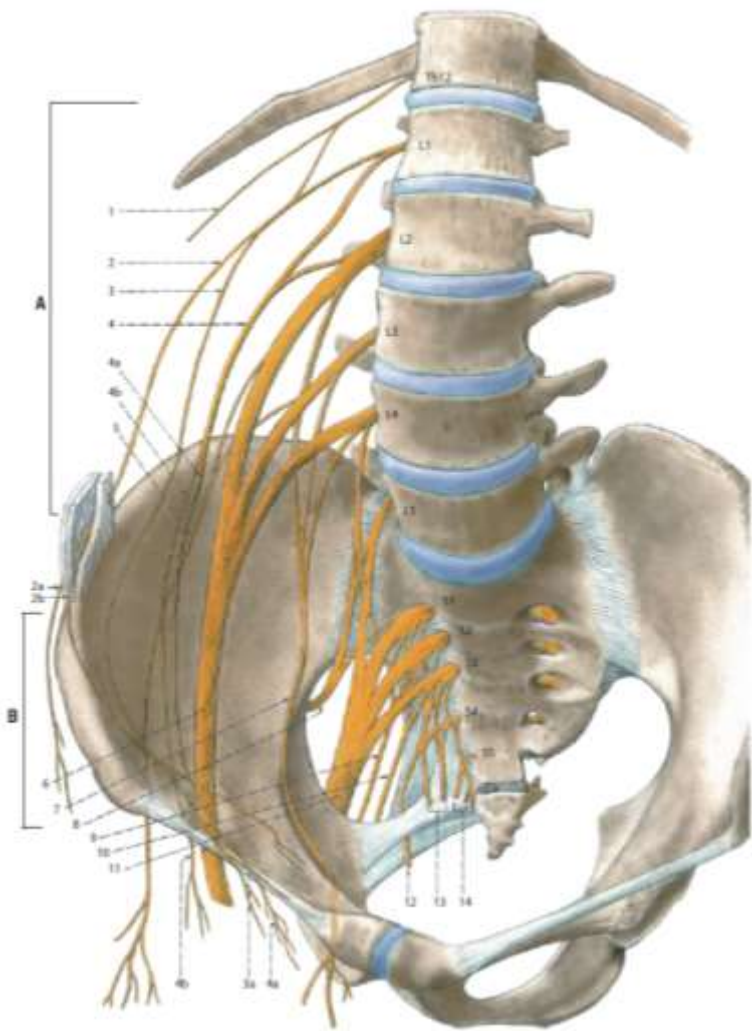


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# Nerves of the lower extremities



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# Sciatic nerve

- Typical war injuries (lying soldier – grenade shrapnel)
- Most commonly iatrogenic injury (hip prosthesis, needle injury)
- Traumatic – acetabular fracture with dorsal dislocation of the hip
- Tibial portion better prognosis and is functionally more important (plantar sensitivity)



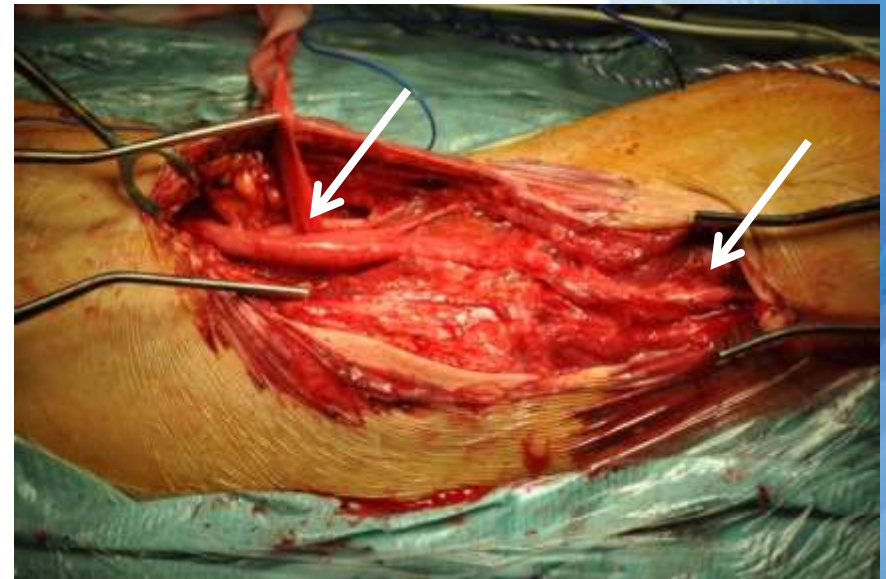
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# Peroneal nerve

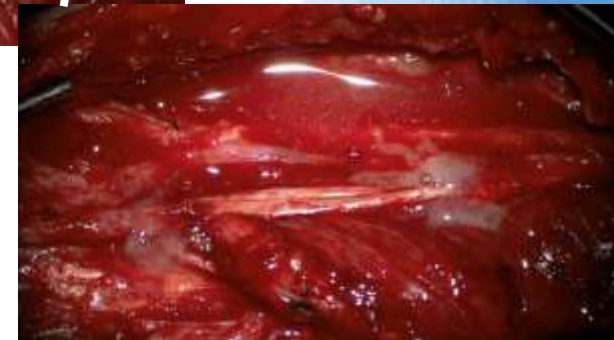
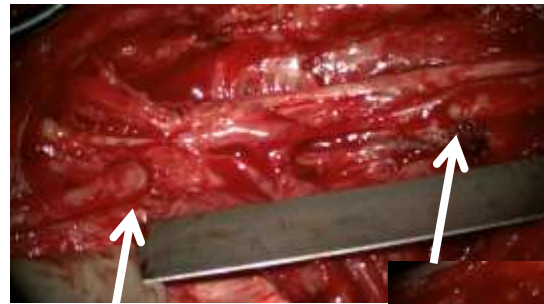
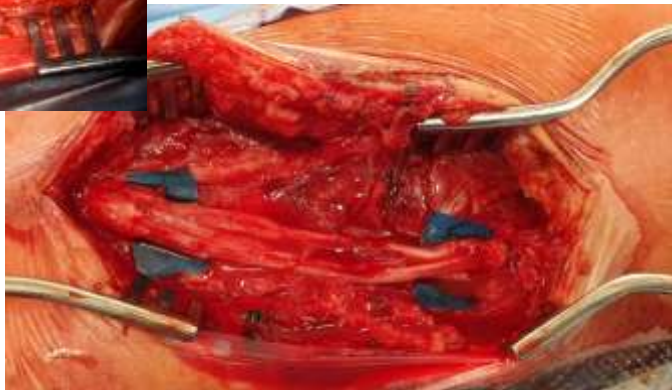
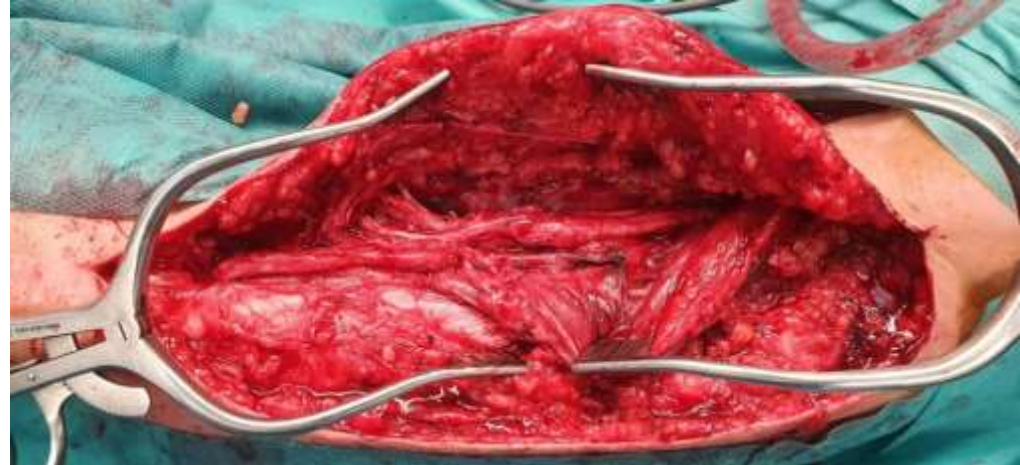
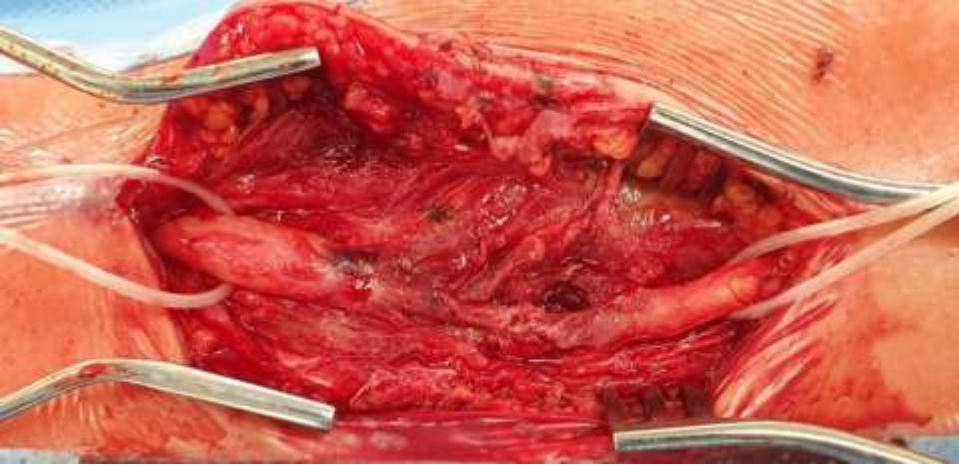
- The most commonly injured nerve of LE
- Traction injuries after knee distorsion (ski, falls...)
- Commonly long lesions in continuity – non-reconstructable
- Good prognosis neuromas < 6cm



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- 1st league football player, 20yrs
- latrog peroneal nerve injury during ganglion resection
- Grafting

- Tibial fracture
- Neuroma in continuity
- Grafting



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GRADA

CHIRURGIE  
HLAVOVÝCH A PERIFERNÍCH  
NERVŮ  
S ATLASEM PŘÍSTUPŮ

Radek Kaiser  
a kolektiv

**Thank you for  
your attention!**



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