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Museo dell'Automobile

Anatomy of the motor branches of upper limb muscles and guidelines for hyperselective neurectomy

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Reduction of spasticity

- Pharmaceutical agents
- Nerve blocks
- Botulinum toxin (Botox)
- Neurotomy
- « Hyponeurotisation »

  Stoffel 1913, Brunelli 1983

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Upper limb spasticity pattern

- Shoulder abduction and internal rotation
- Elbow flexion
- Forearm pronation
- Wris ion

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Selective neurectomy

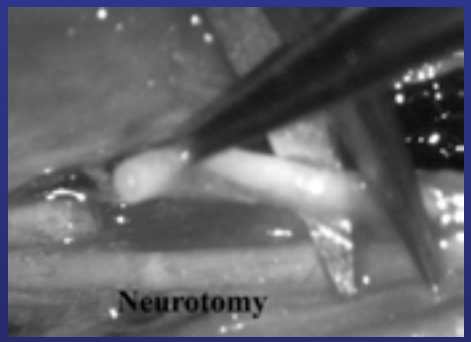
- Partial denervation at the muscle level
- Reduce hypertonia at long term (Maarawi 2006)
- Improve muscle balance

- 2 techniques
  - Nerve trunk approach and electrostimulation

    (Stoffel I 1913, Porohit 1998, Shin 2010, Puligopu 2011)

  - Motor branches dissection and resection of 5 mm of 2/3 branches

    (Stoffel II 1913, Brunelli 1980, Buffenoir 2005, Maarawi 2006)



Maarawi 2005

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Objective of the study

- Description of the distal branching pattern of the
  - Musculocutaneous nerve → elbow flexors
  - Median nerve → pronator teres, wrist, fingers and thumb flexors
  - Ulnar nerve → wrist and fingers flexors
  - Radial nerve → brachioradialis
  - Ulnar nerve → Thumb adductor + IOD1
- Develop guidelines for hyperselective neurectomy

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Objective of the study

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Stoffel A. 1913

Brunelli G. 1983

"Hyponeurotisation"

NOT VERY GOOD AND PROLONGED OUTCOMES

The treatment of spastic contractures. Adolf Stoffel *Am J Orthop Surg*, 1913 May; 210 (4): 611 -644

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Anatomical study

97 anatomical dissections
Laboratoire du Fer à Moulin, Parigi

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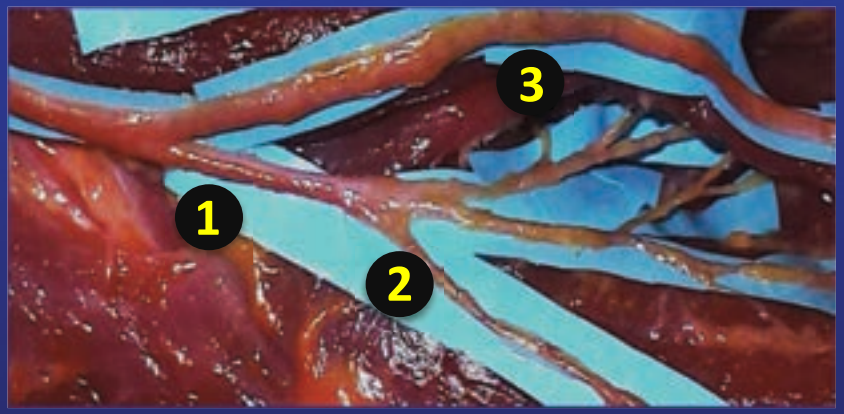
- Upper limbs from different fresh cadavers
- One limb per cadaver
- One nerve per limb
- For each muscle : number of trunks 1, primary branches 2, and terminal branches 3



- Musculocutaneous and radial nerves : % of arm length
- Median and ulnar nerves : % of forearm length

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Musculocutaneous nerve n = 16

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Trunks for biceps

Number of trunks :

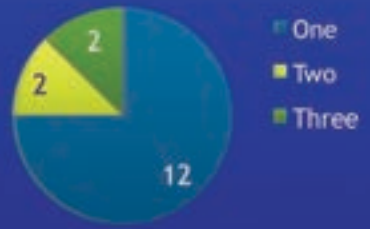
First trunk :
37% of the arm length (18-45%)

Last terminal branch : 56% (29-64%)

Terminal branches : 8 (2-13)

Trunks for brachialis

Number of trunks :



First trunk :
52% of the arm length (35-63%)

Last terminal branch : 69% (60-75%)

Terminal branches : 7 (3-13)

! last trunk more distal than the brachialis trunks in 4 cases

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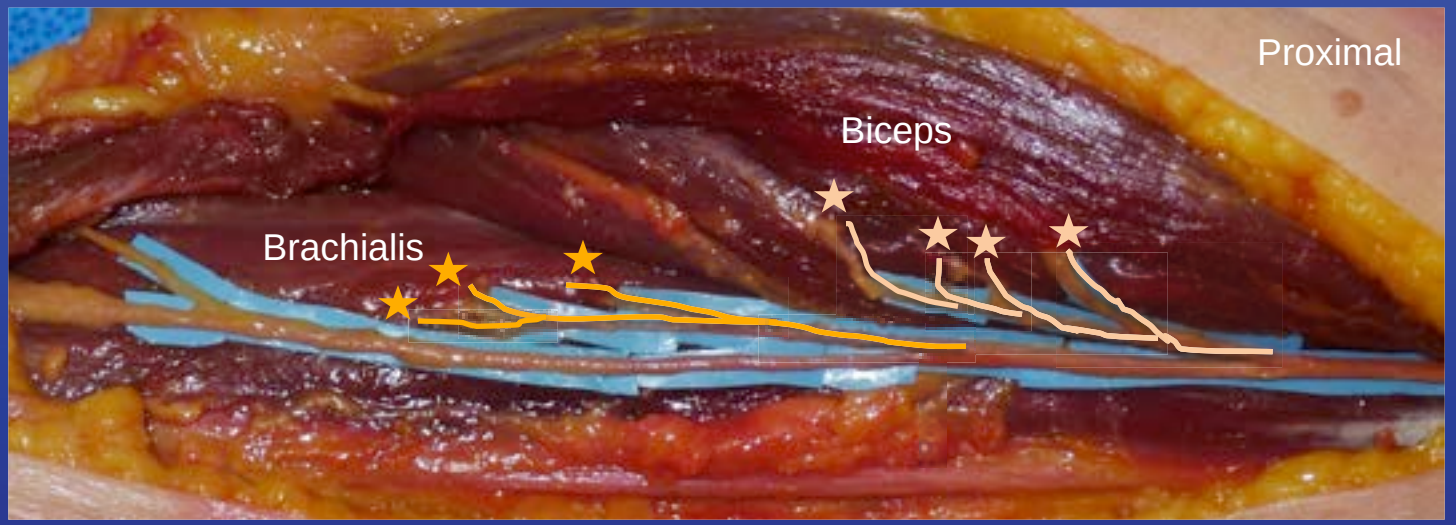
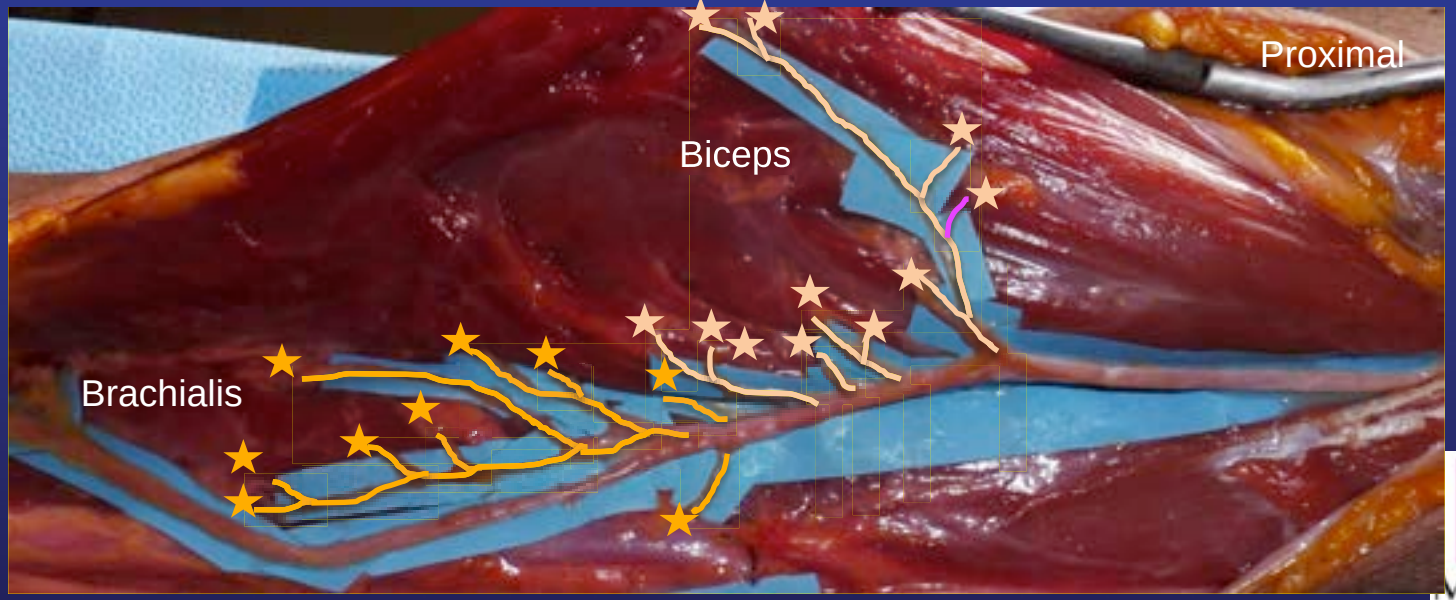
Musculocutaneous nerve

Case 4



Case 10



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Musculocutaneous nerve n = 16

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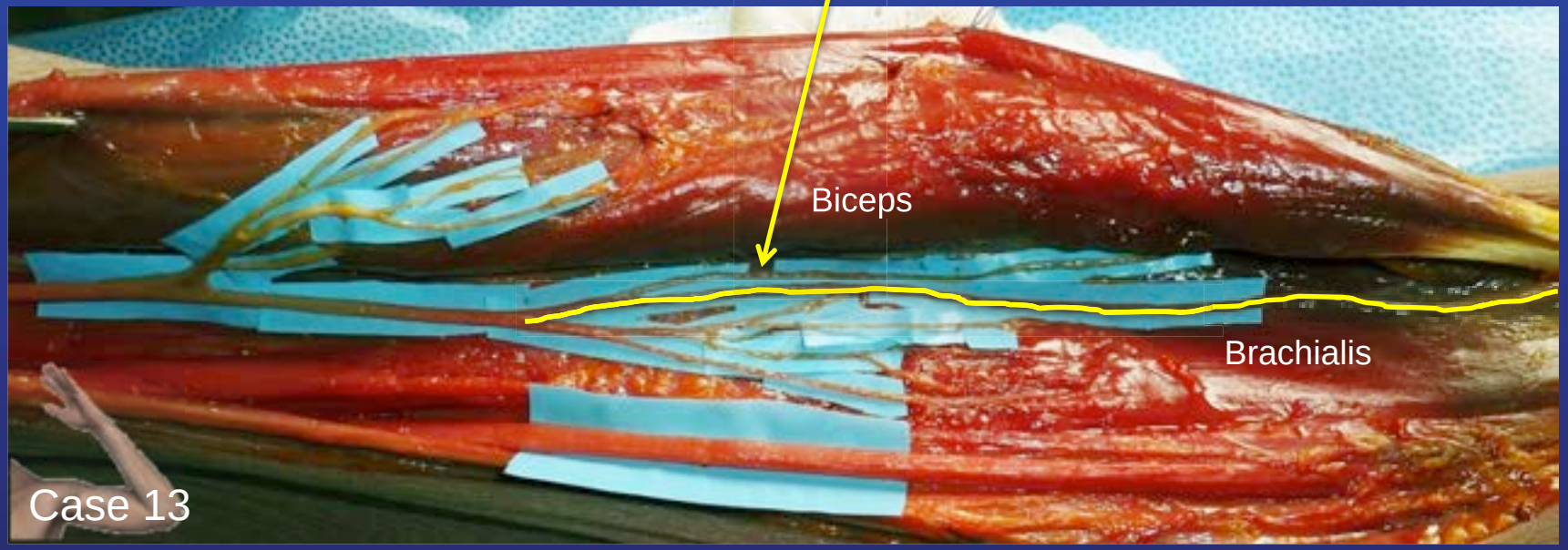
- The lateral cutaneous branch of the forearm Distance from the coracoid: 56 % of the arm length
- Accessory sensory branch for the lateral aspect of elbow (12/16 cases): 76 % of the arm length



Dissection from 18 to 75% of the arm length allows identification of all motor branches of the musculocutaneous nerve.

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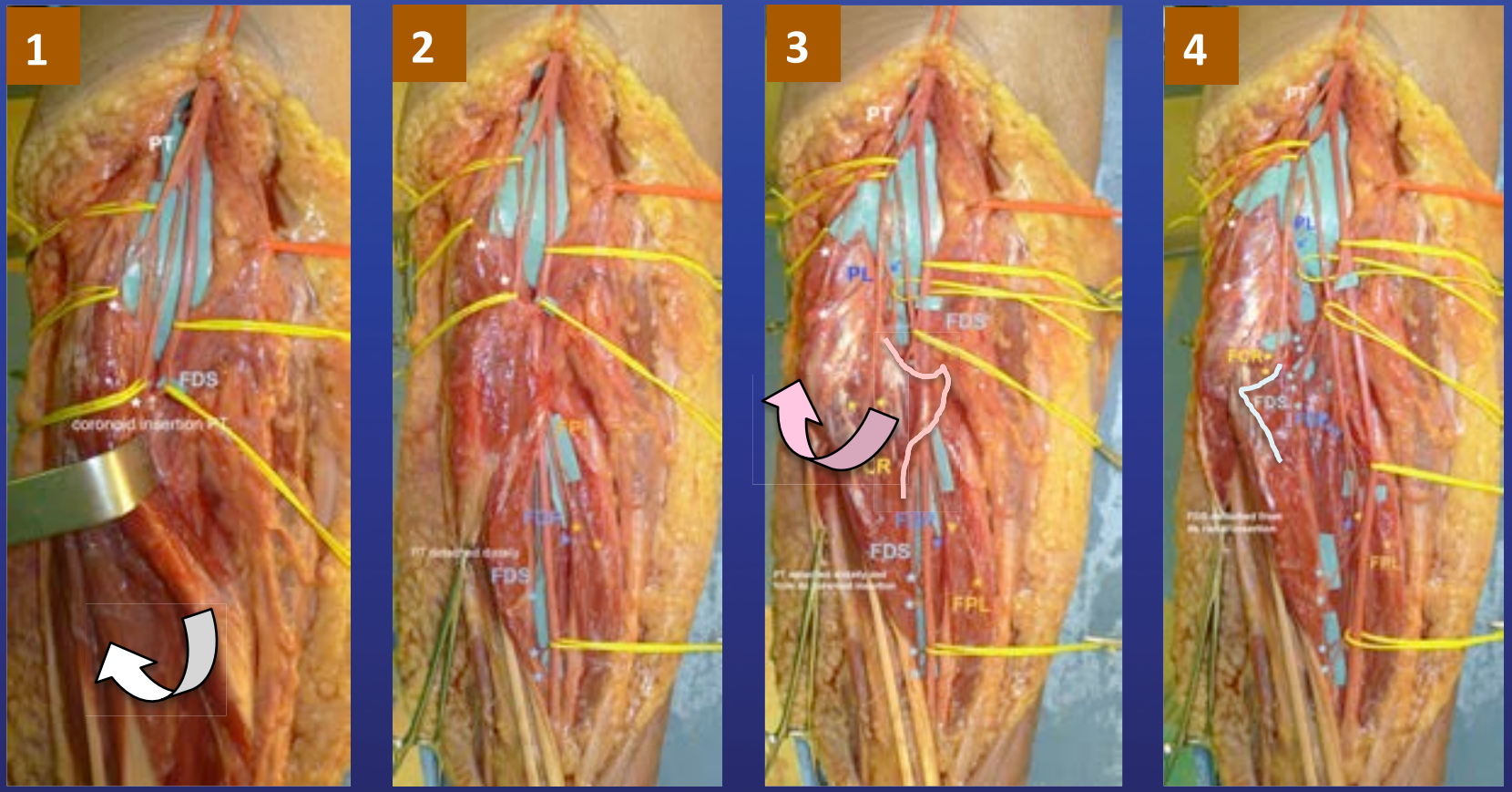
Median nerve n = 20

Exposition



Pronator teres detached distally and from its coronoid insertion proximally

Flexor digitorum superficialis detached from its proximal radial insertion

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Median nerve: Pronator Teres

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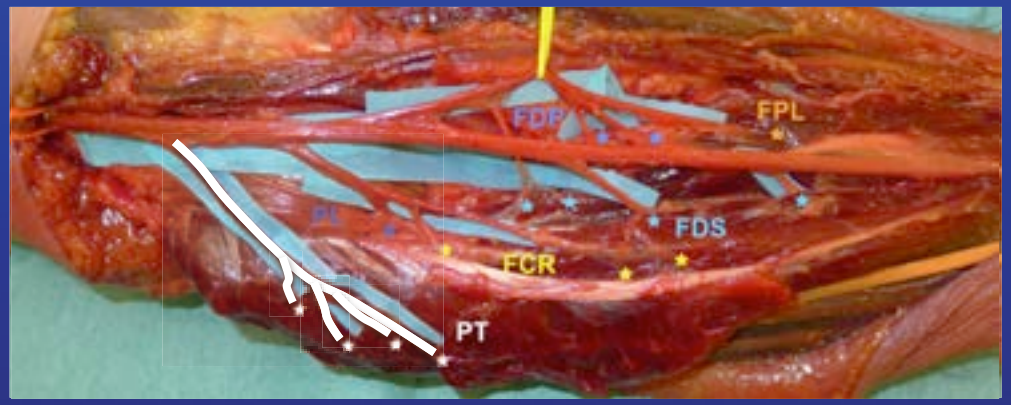
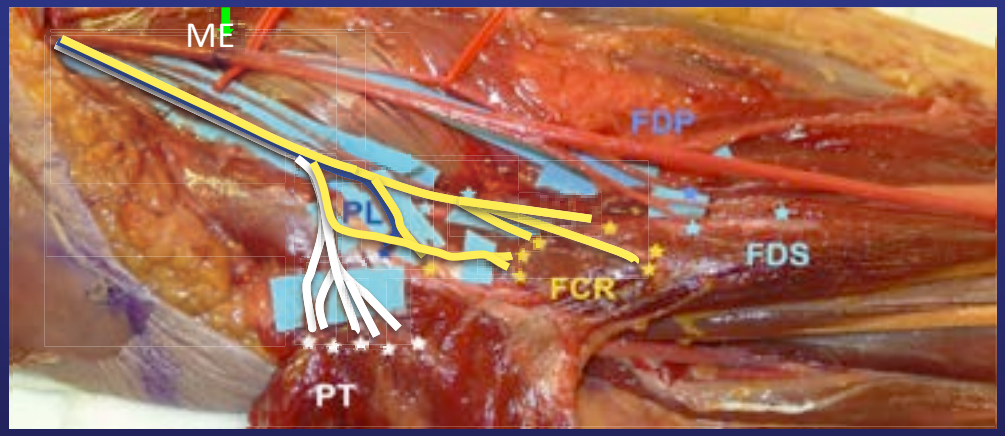
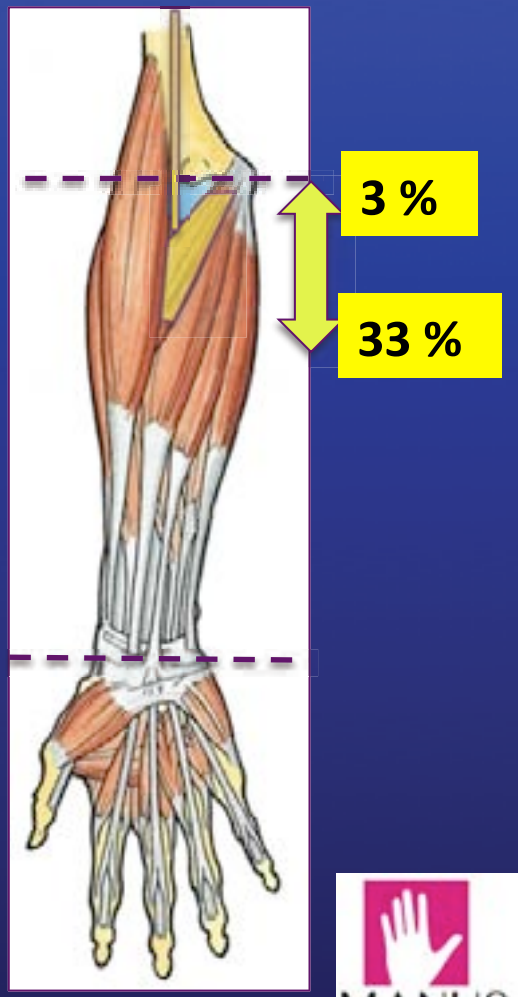
- Number of trunks: 1 (16/20), 2 (4/20)
- Trunks n°1 exiting the nerve
- Arose in a common trunk with other motor branches







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Median nerve: Flexor Carpi Radialis

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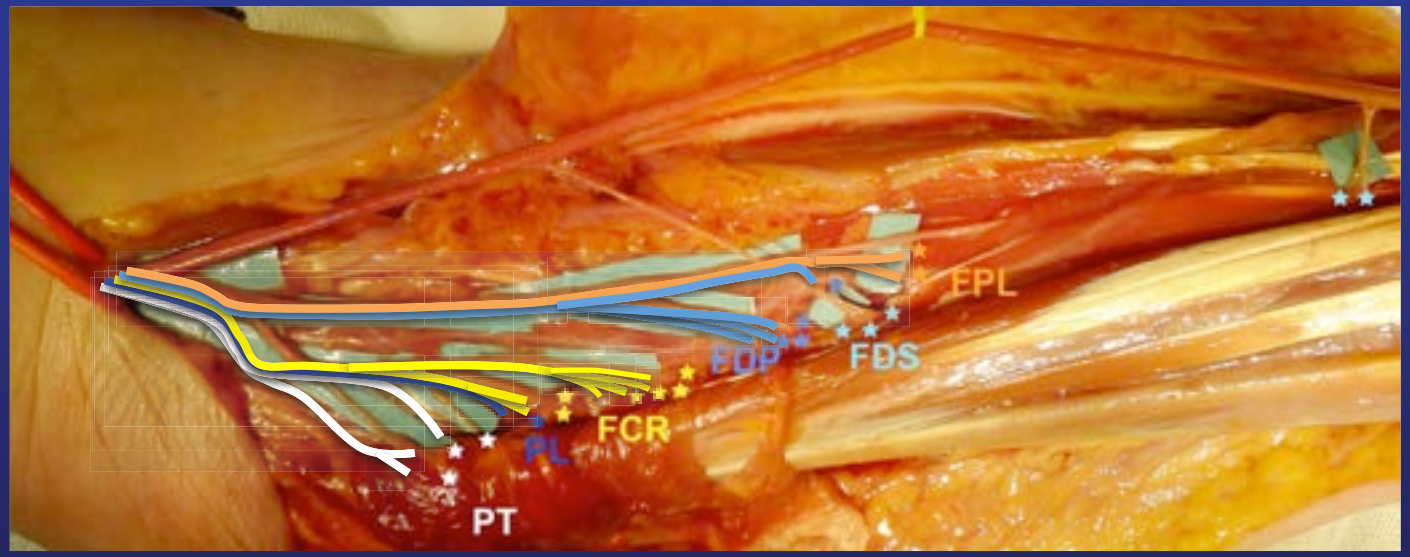
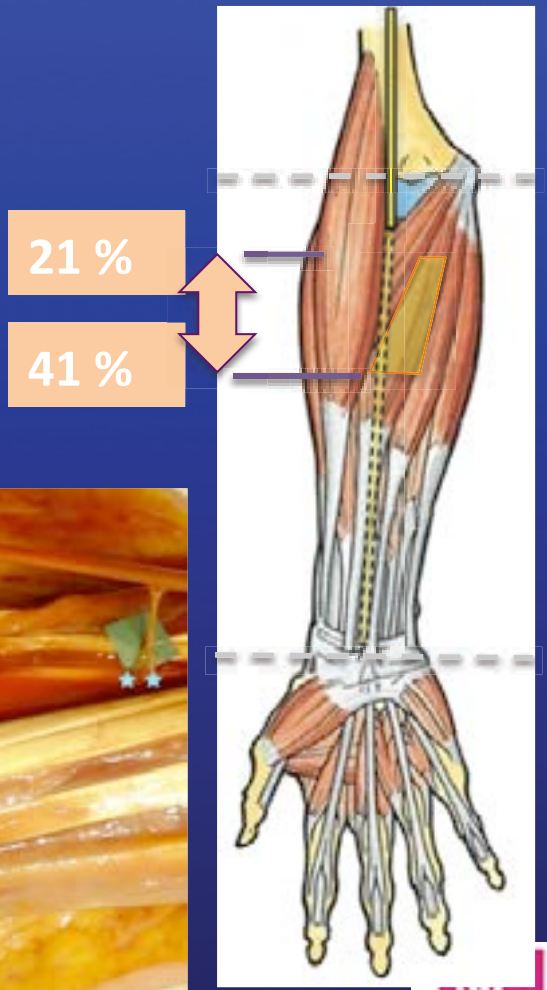
- Number of trunks: 1 (20/20)
- Arose in a common trunk with other motor branches (19/20)





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Median nerve: Flexor Digitorum Superficialis

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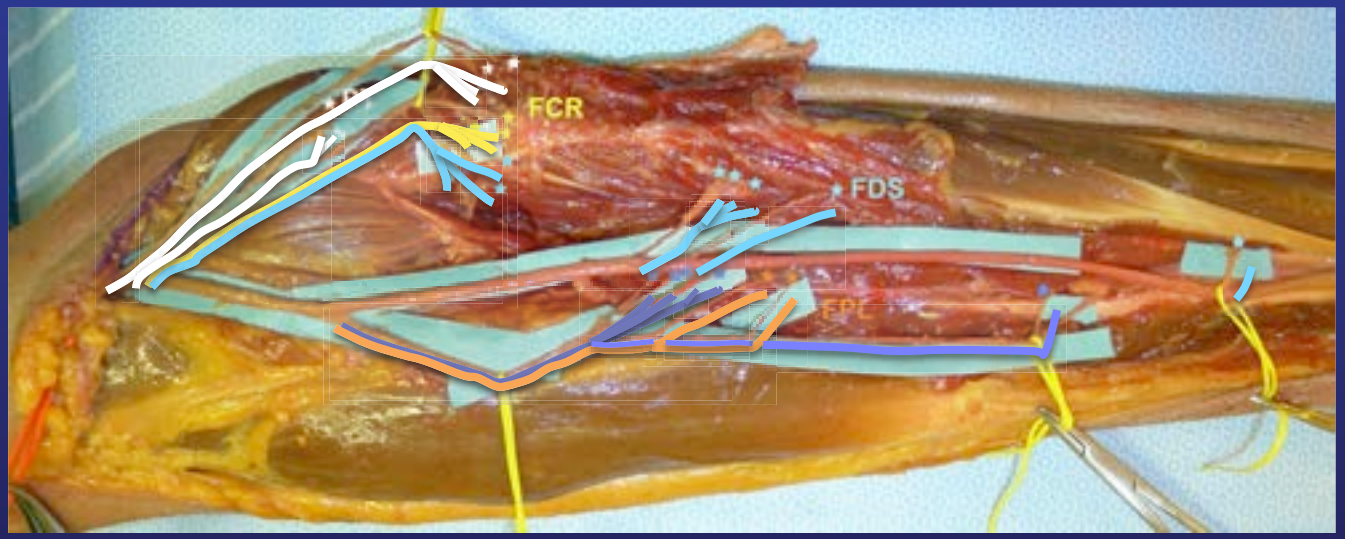
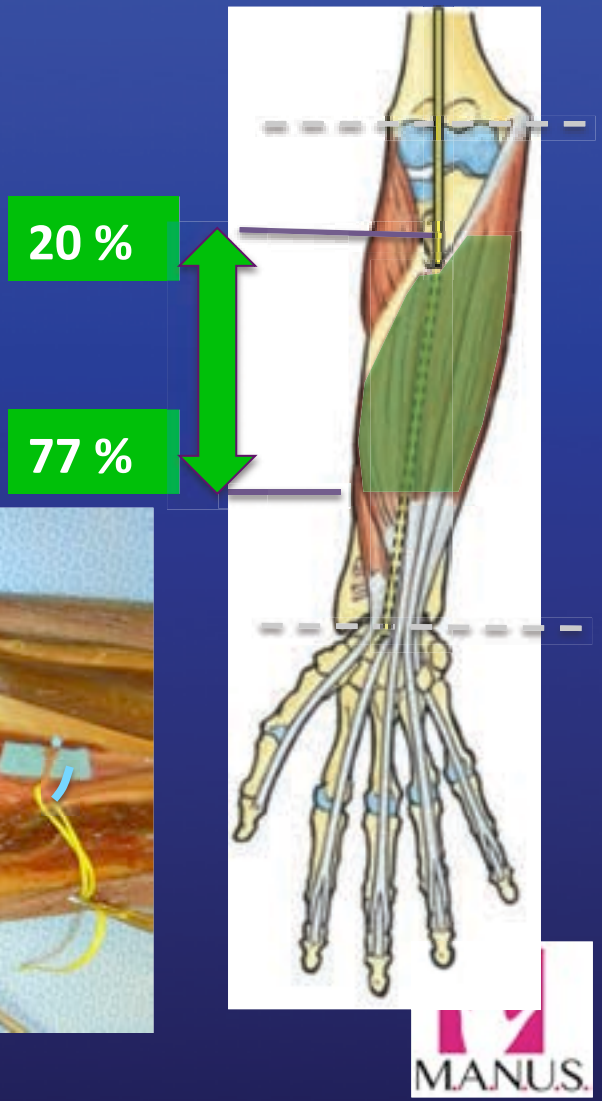
- Number of trunks: 2 (3/20), 3 (13/20), 4 (4/20)
- The 1rst trunk arose in a common trunk with other motor branches (15/20)
- The other trunks arose alone





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Median nerve: AIN

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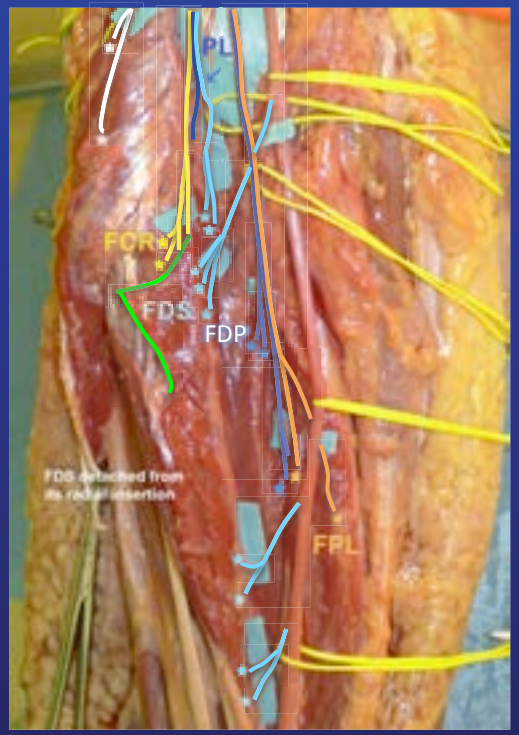
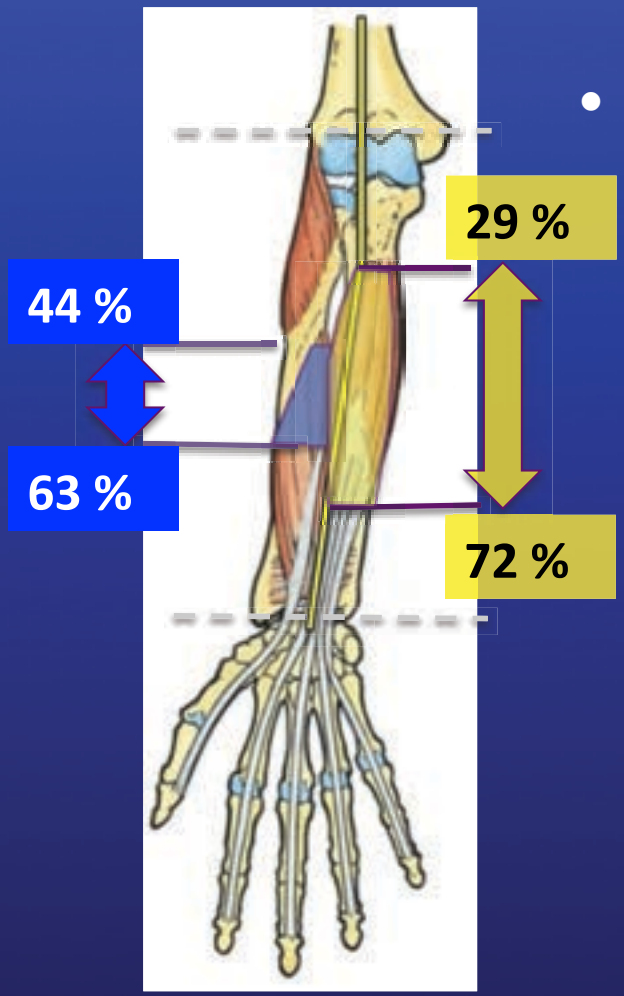
Flexor Pollicis Longus

- **1 trunk (18/20)**

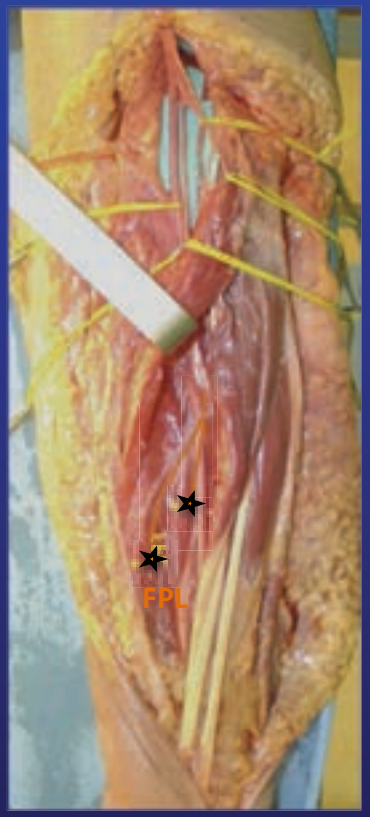




Flexor Digitorum Profundus

- **Number of trunks:**

  1 (8/20), 2 (7/20), 3 or more (5/20)



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Median nerve approach

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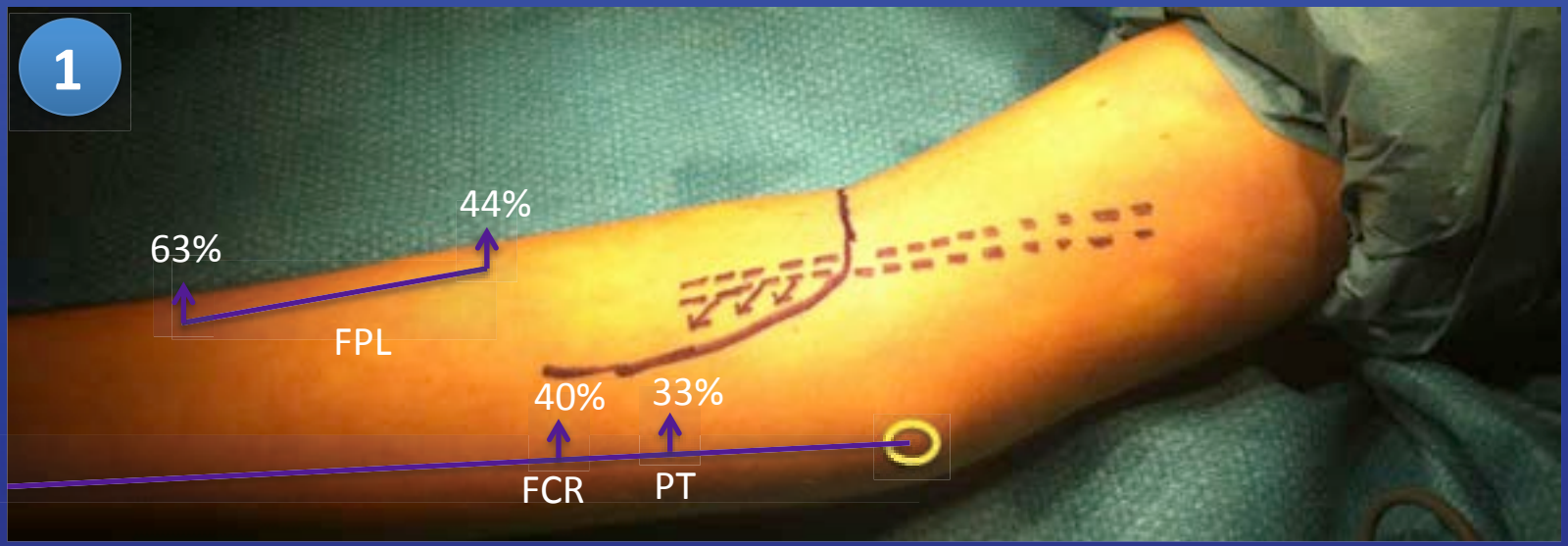

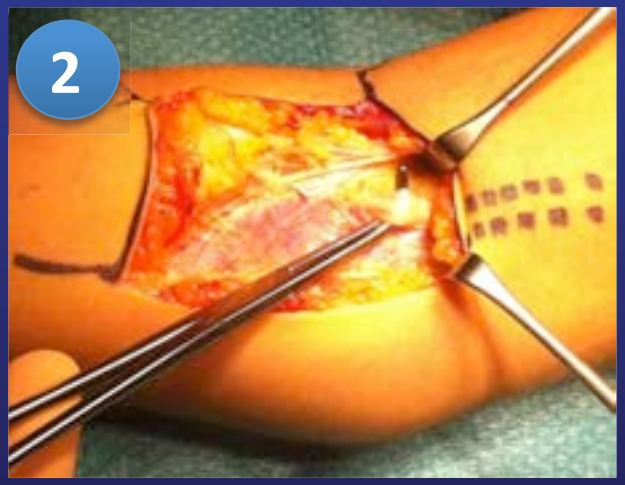

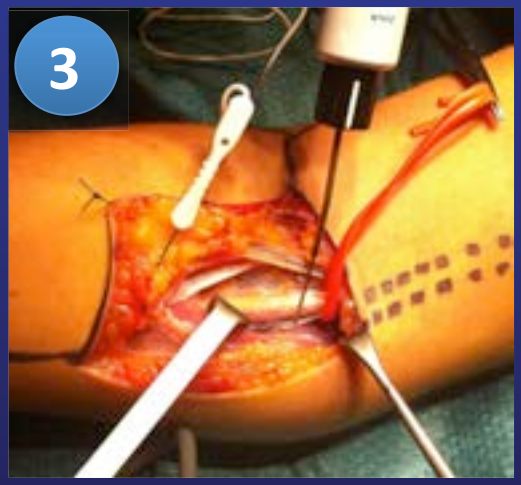

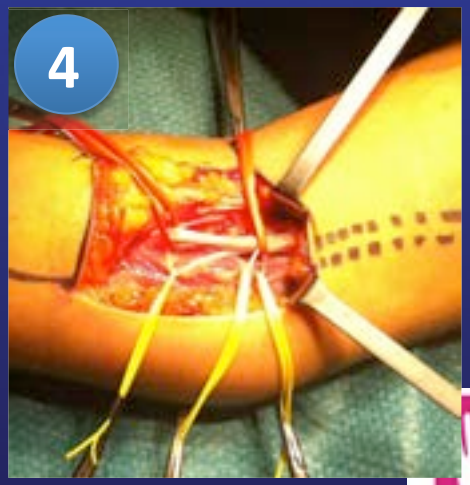

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Median nerve

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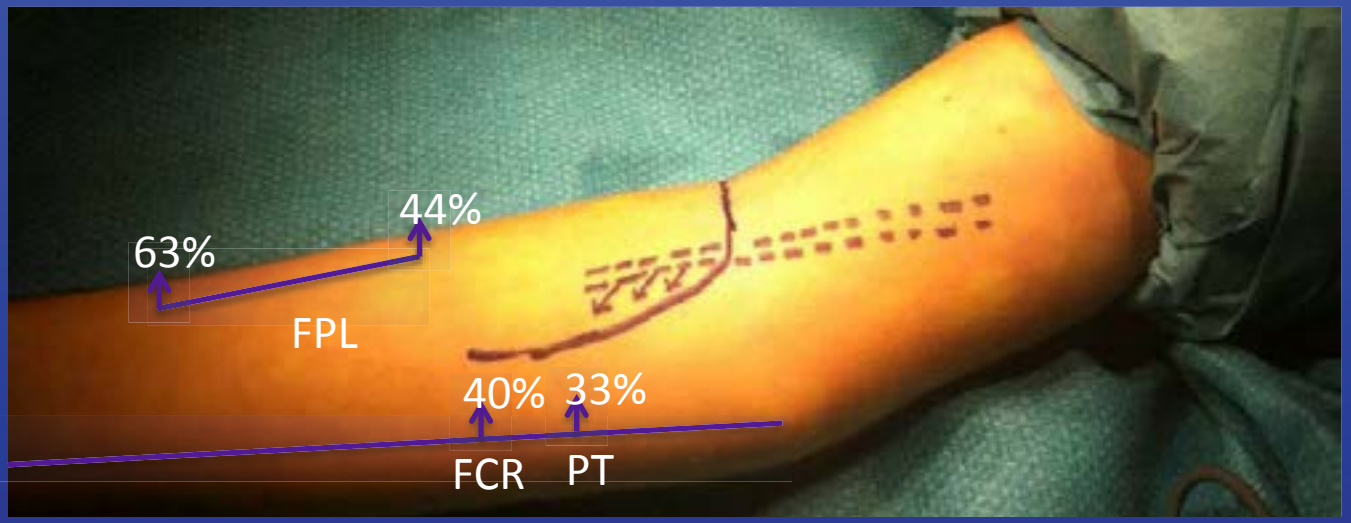

- **FDS: Great distance between 1st and last branch**
- **Impossible to reach all branches without detaching the muscle →→ Selective neurotomy is not suited for FDS**
- **Nerve stimulation is REQUIRED**

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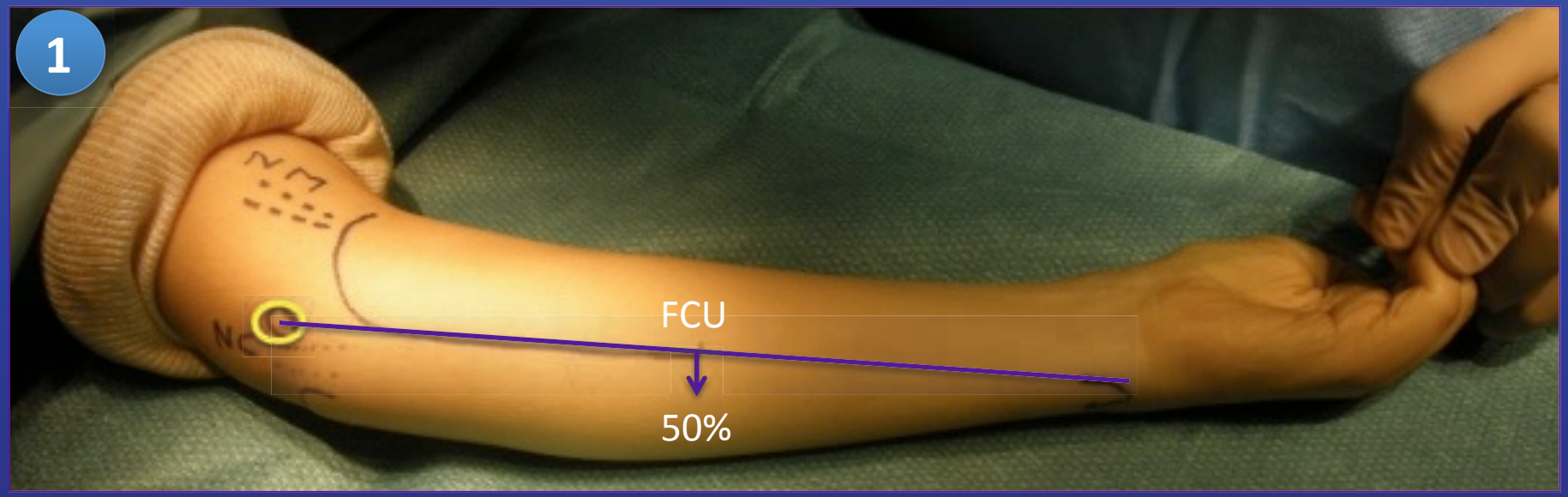
Ulnar and median nerve approach



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Radial nerve n = 20

Brachioradialis

- Trunks: 1 (13/20),2 (5/20), 3 (2/20)
- Penetration point: 66 % of the arm length (proximal to the lateral epicondyle) to 10% of the forearm length (distal to the lateral epicondyle)
- 3,3 terminal branches (1-7)

Dissection from 60% of the arm length to 15% of the forearm length allows identification of all motor branches of the radial nerve for BR.

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Ulnar nerve at forearm n = 20

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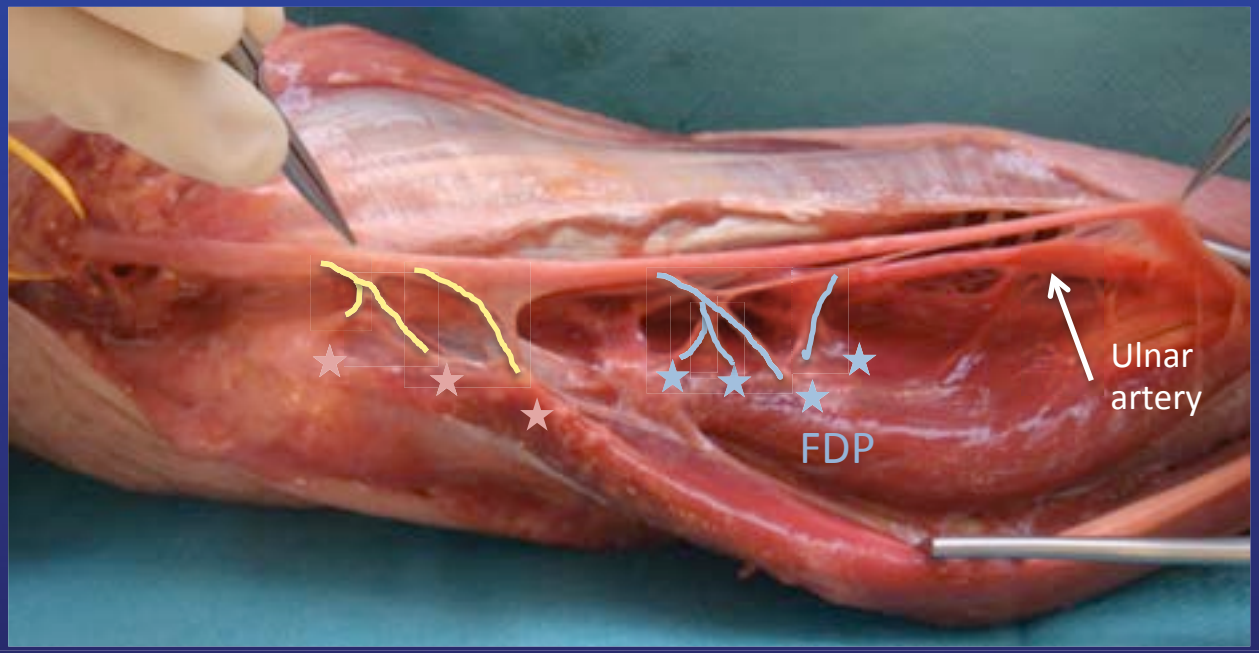
- Flexor carpi ulnaris : 1 to 4 trunks, 14 mm below the medial epicondyle
- Flexor digitorum profundis : 1 trunk (18/20), 50 mm below the medial epicondyle
- No motor branches after the ulnar artery joins the nerve (≅ 50%)



Dissection from 4 cm above the medial epicondyle to 50% of the forearm length allows identification of all motor branches of the ulnar nerve.

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Ulnar nerve at palm n = 21

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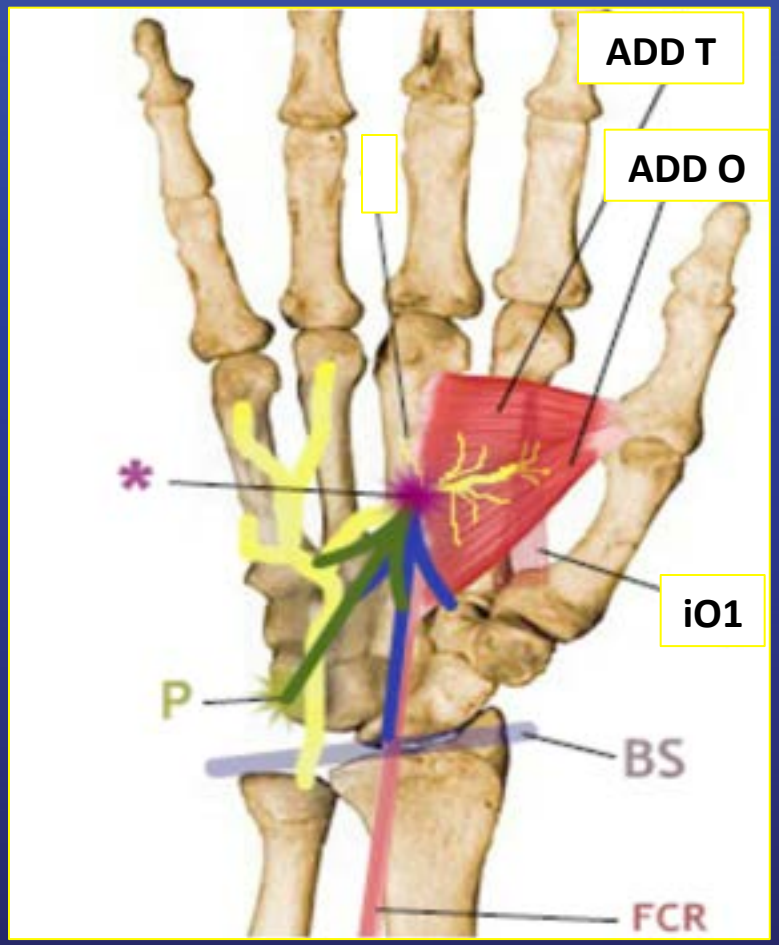

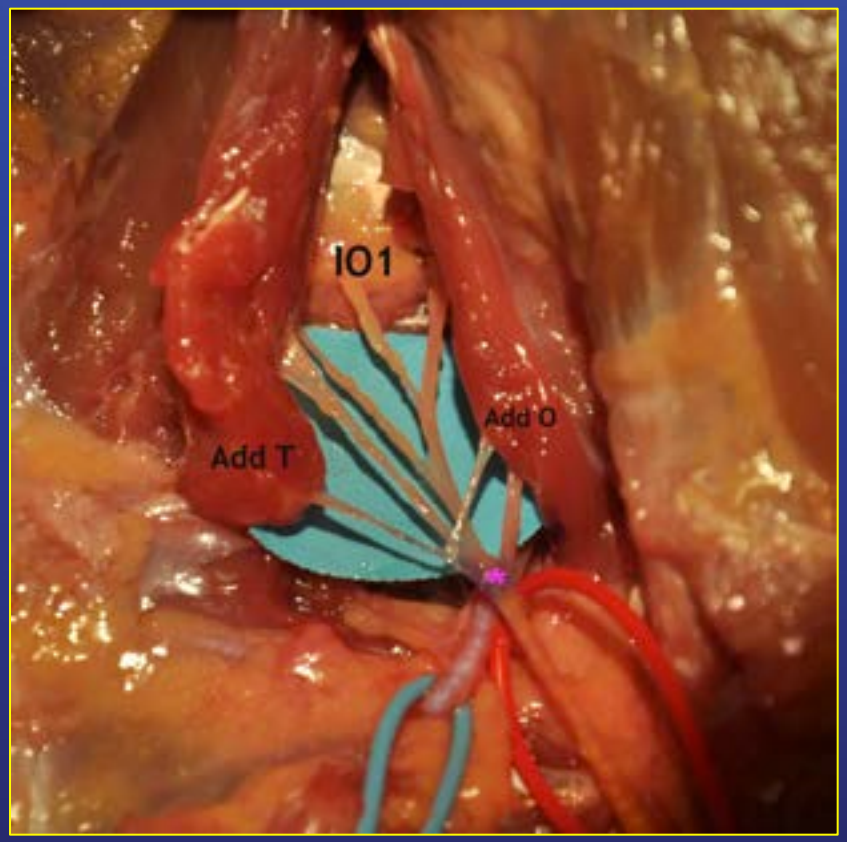

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Ulnar nerve at palm n = 21

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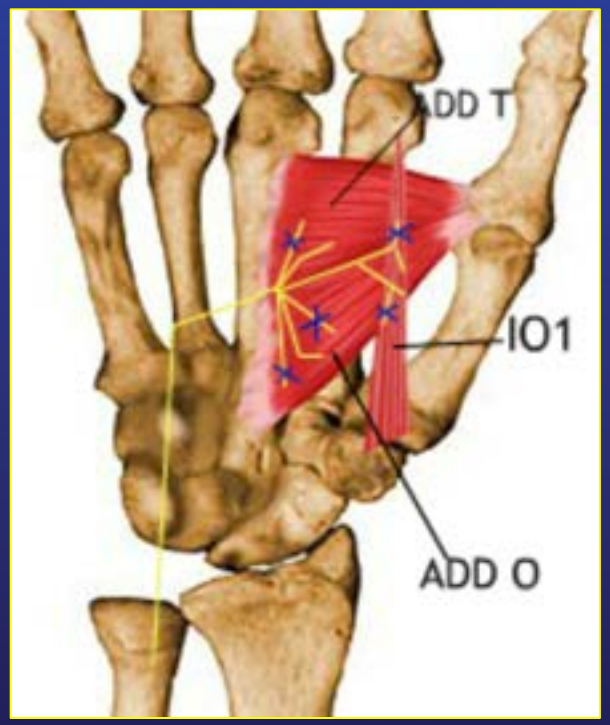
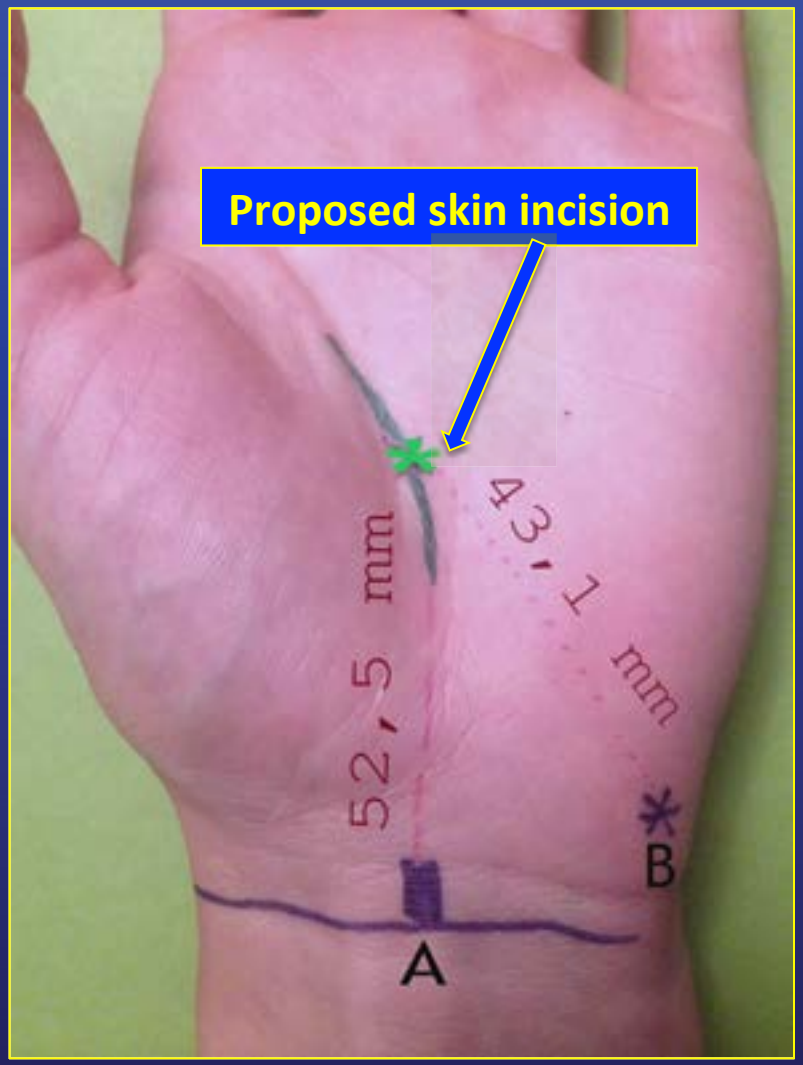
ADD. Transverse head: 1,7 branches (1-3)
>1 in 62%
ADD. Oblique head: 1,3 branches (1-3)
>1 in 95%
IO1: 1,8 branches (1-3). If 1 → 2 or 3 terminal branches





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