



ВВЕДЕНИЕ В НЕЙРОХИРУРГИЮ

**Нейрохирургия — раздел хирургии,
занимающийся вопросами оперативного
лечения заболеваний нервной
системы включая
ГОЛОВНОЙ МОЗГ, СПИННОЙ МОЗГ
и периферическую нервную
систему**

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05/25/2020 18

2)



До операции

2D 3 - 1 - 6, Series#8

2D T2 SAG

5.6 (L)

**Спинальная
нейрохирургия**



**Спинальная
нейрохирургия**



Extradural tumors



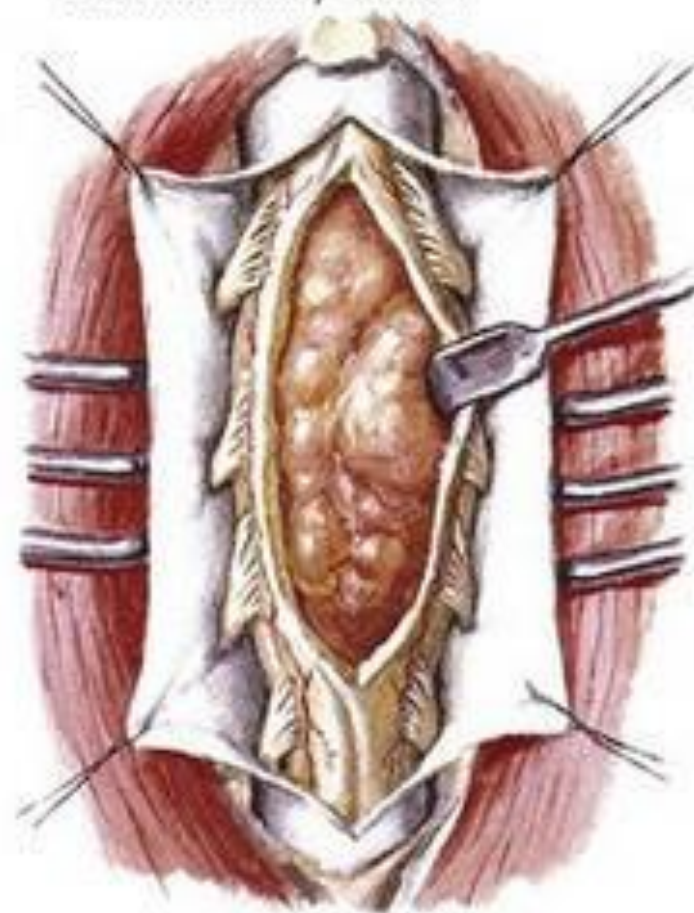
Lymphoma invading spinal canal via intervertebral foramen, compressing dura mater and spinal cord

Intradural extramedullary tumors

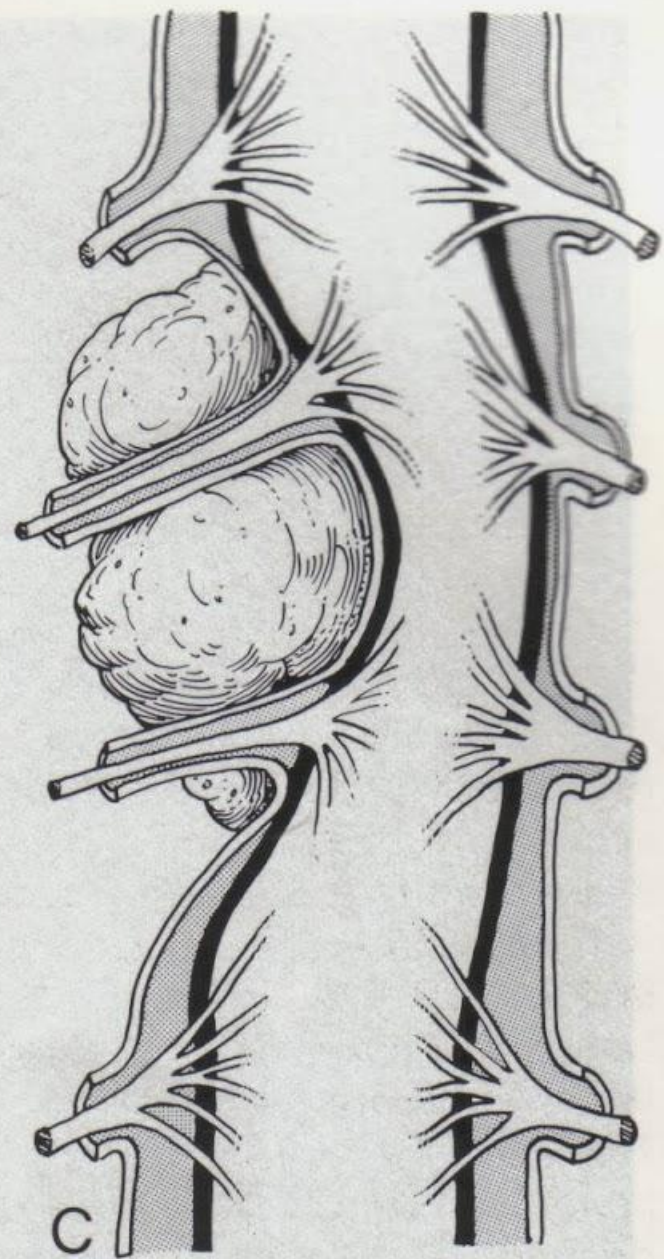
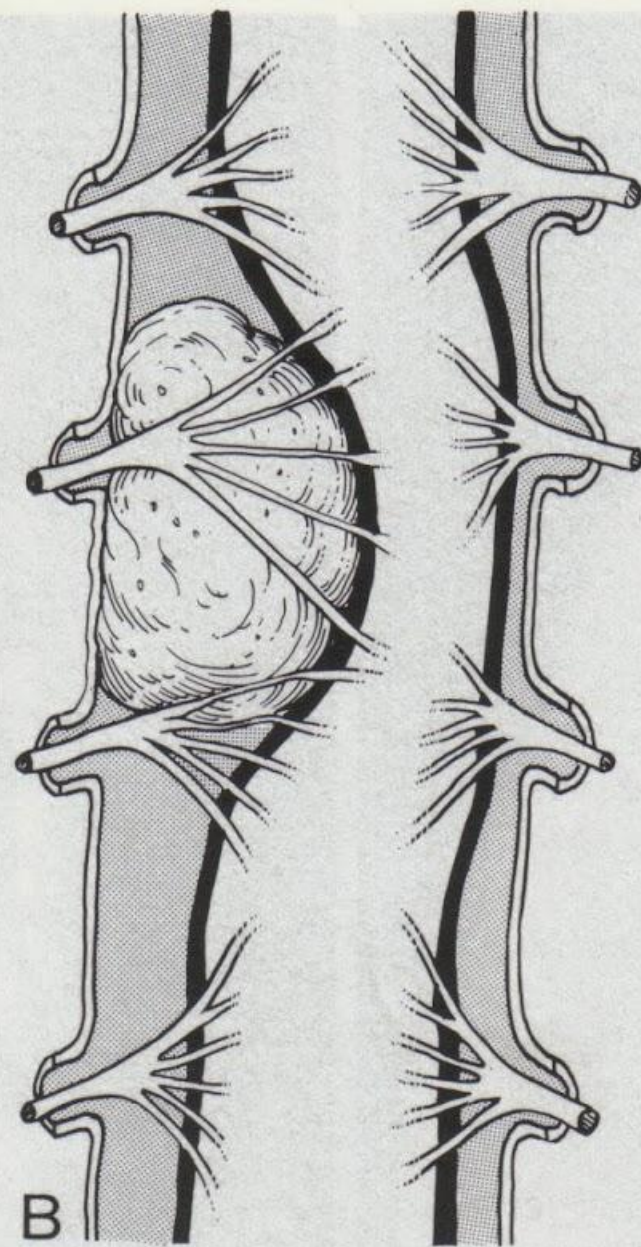
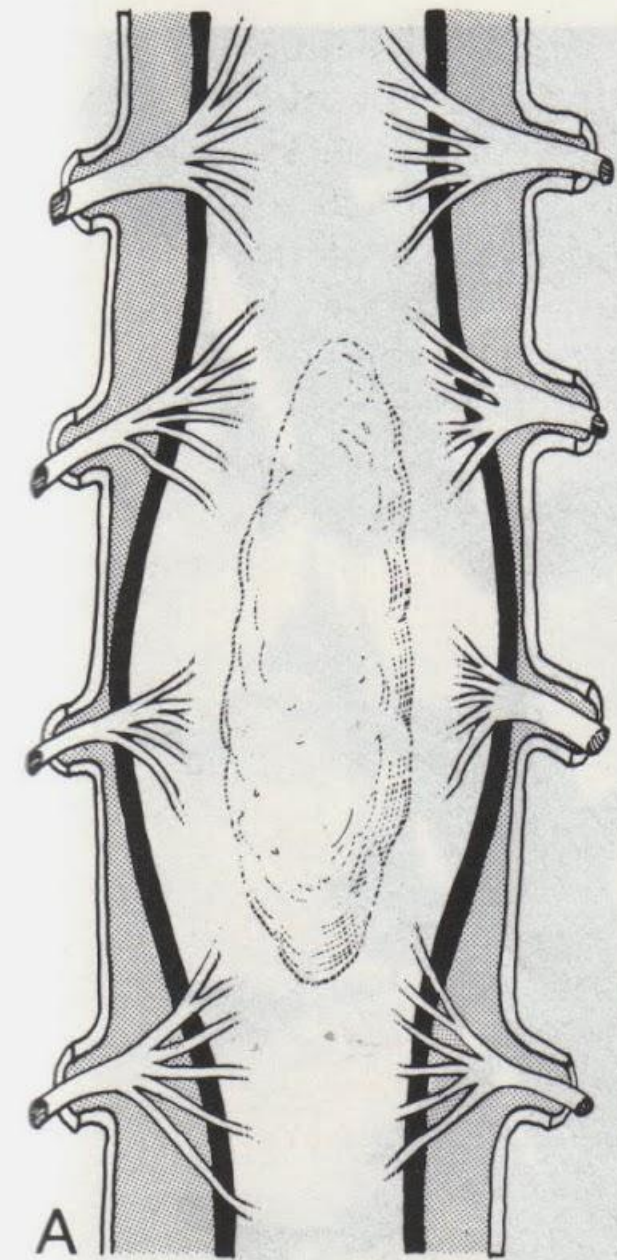


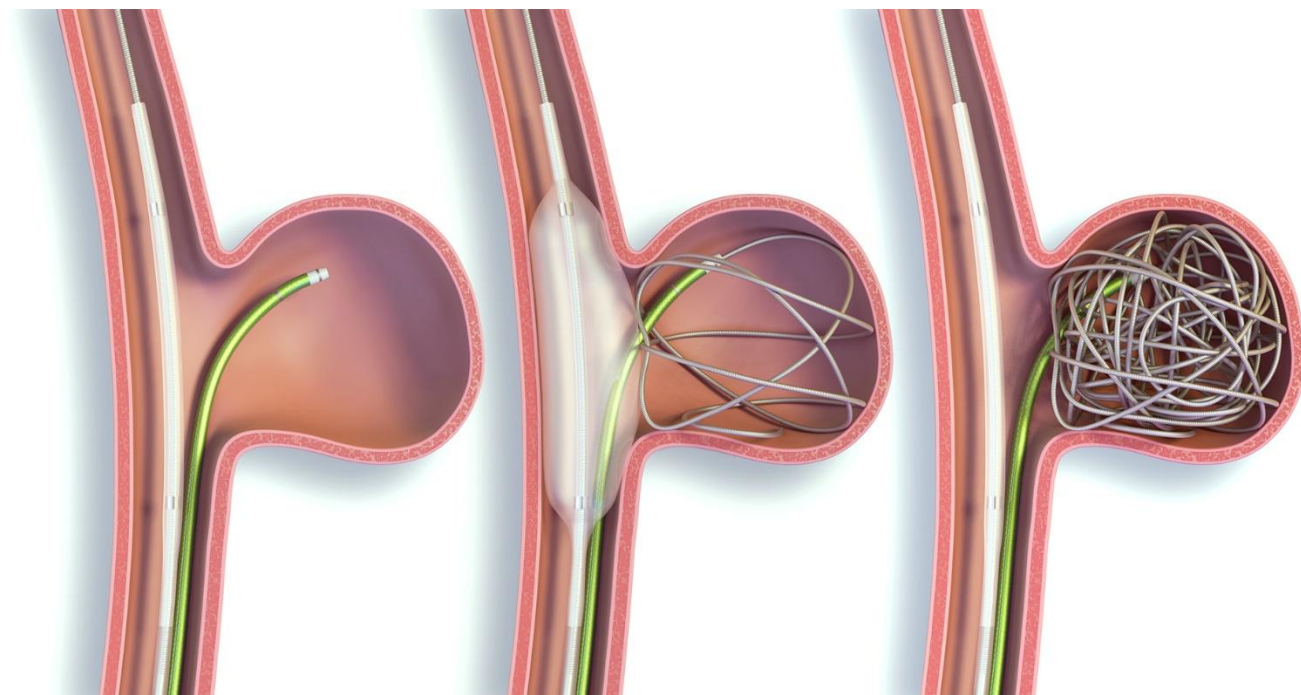
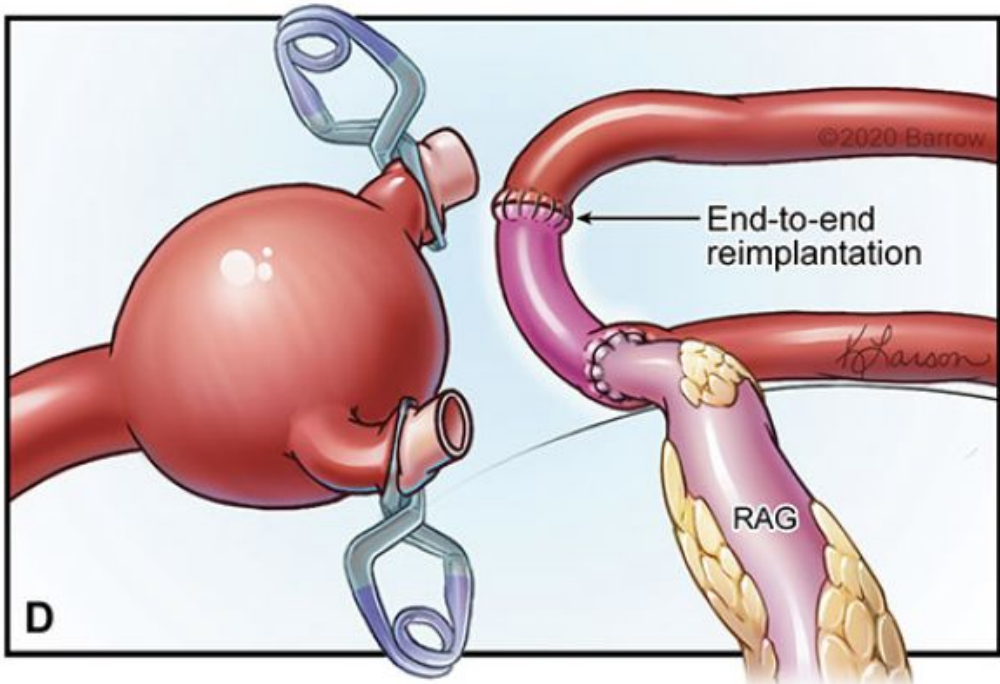
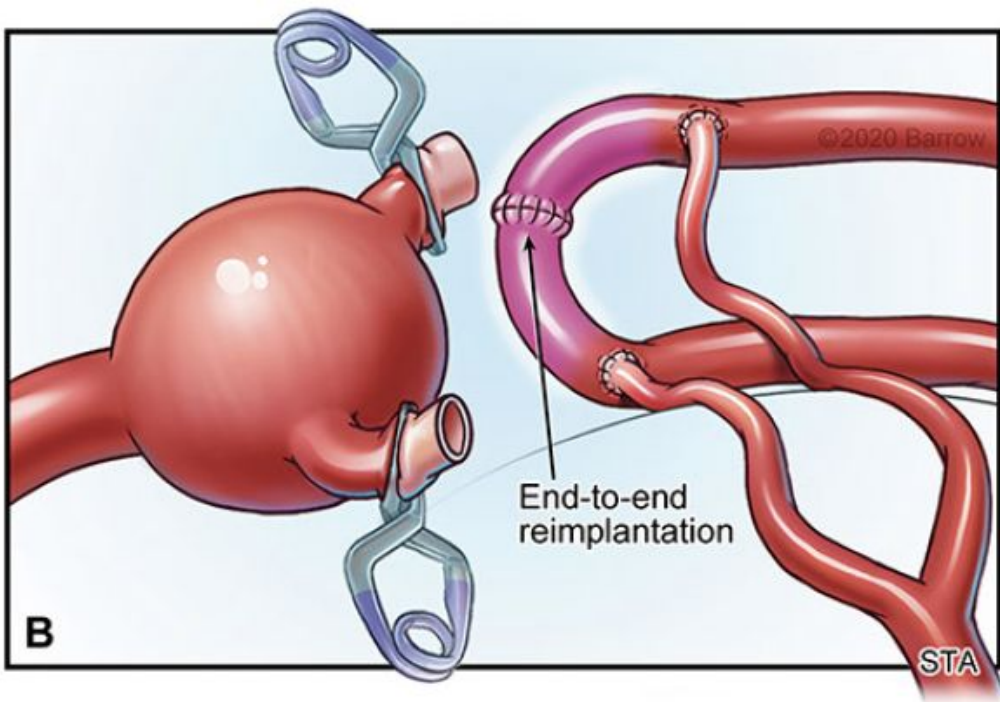
Meningioma compressing spinal cord and distorting nerve roots

Intramedullary tumors

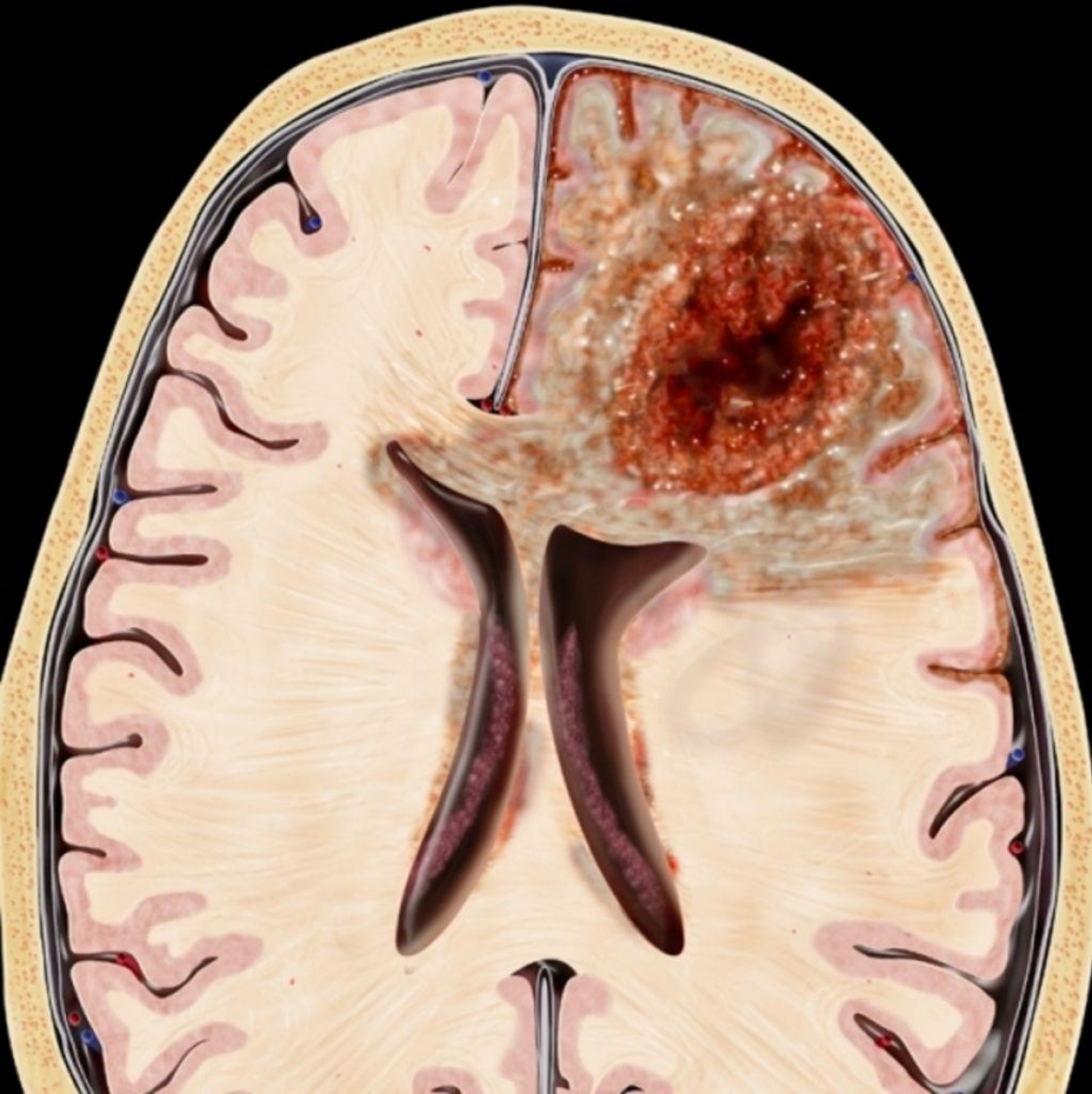


Astrocytoma exposed by longitudinal incision in bulging spinal cord



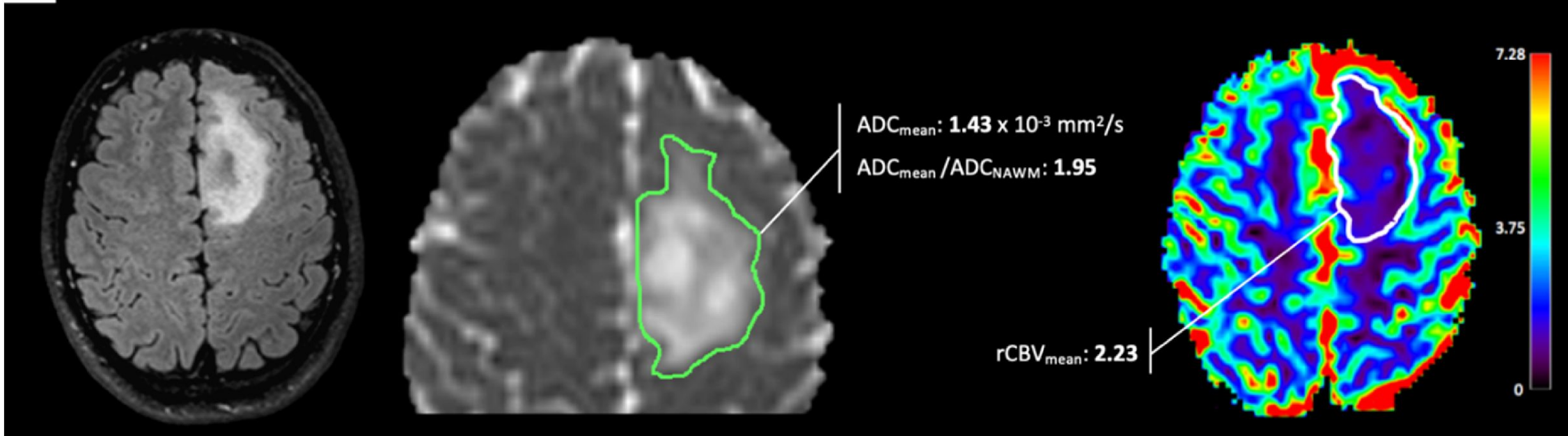


Сосудистая нейрохирургия

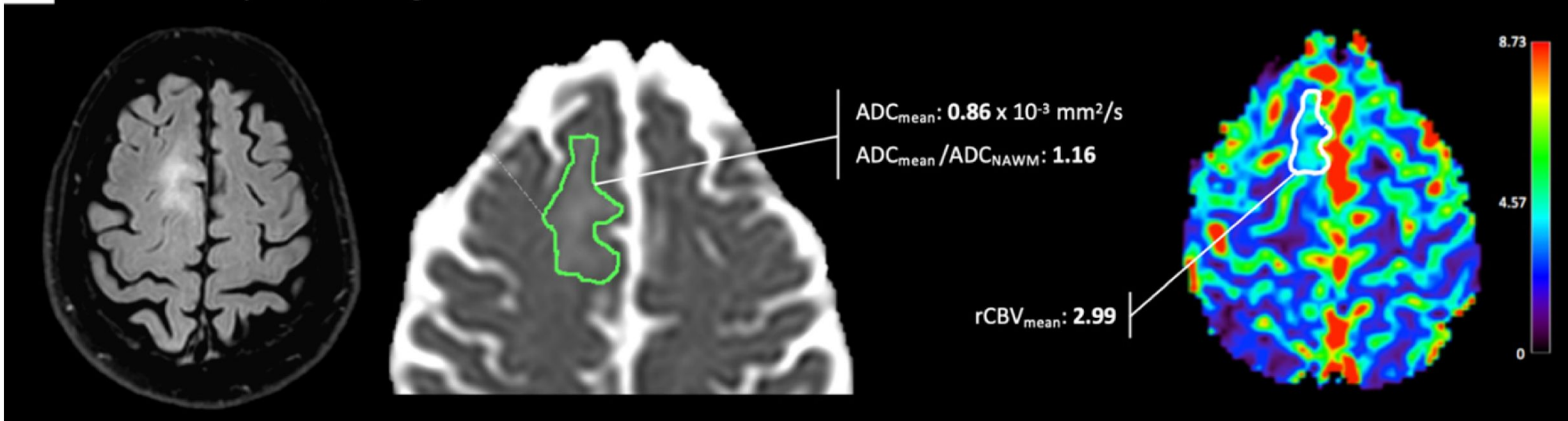


Нейроонкология

A *IDH^{mut}* astrocytoma, WHO grade 3



B *IDH^{wt}* astrocytoma, WHO grade 3



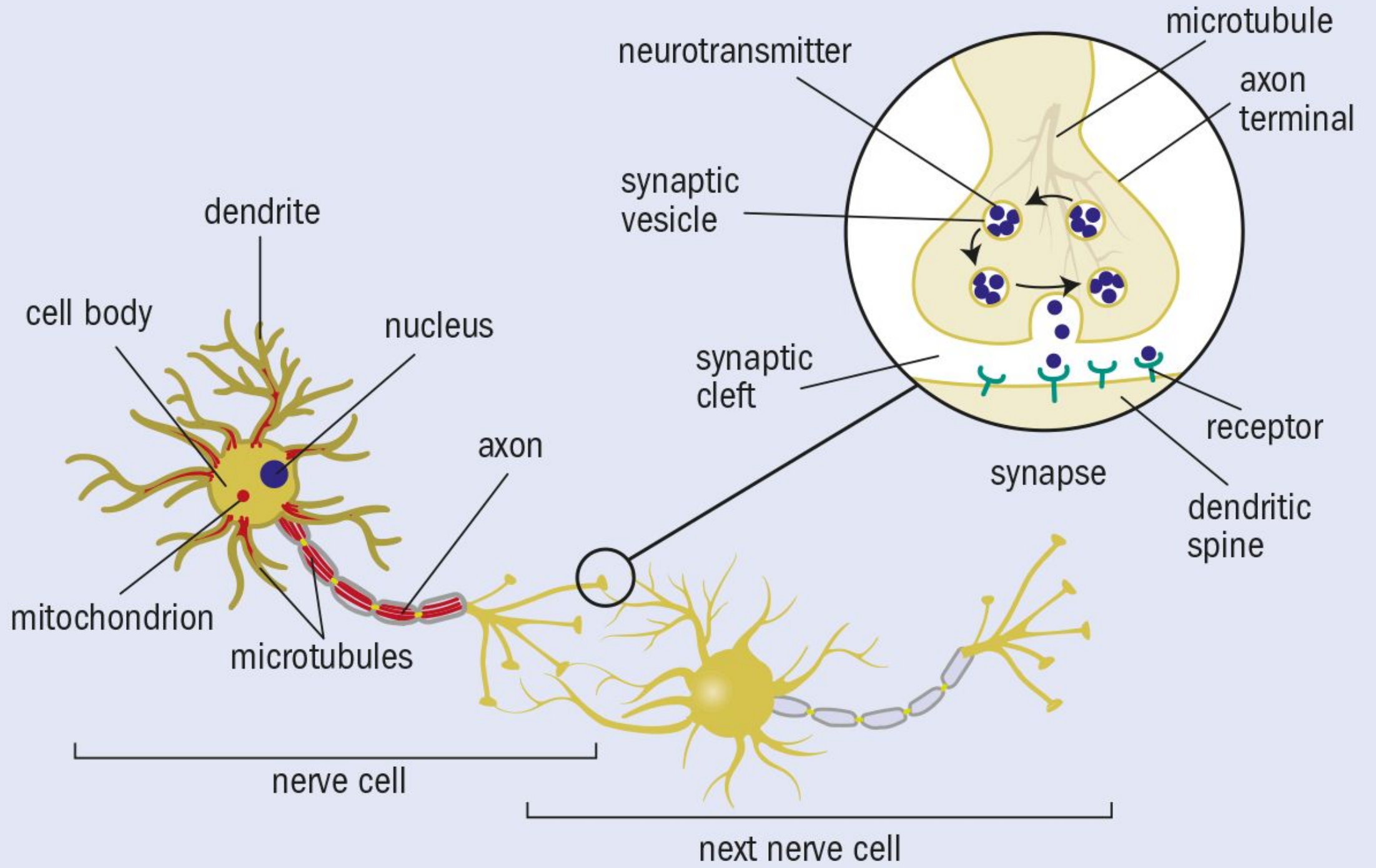
Нейроэндокринология

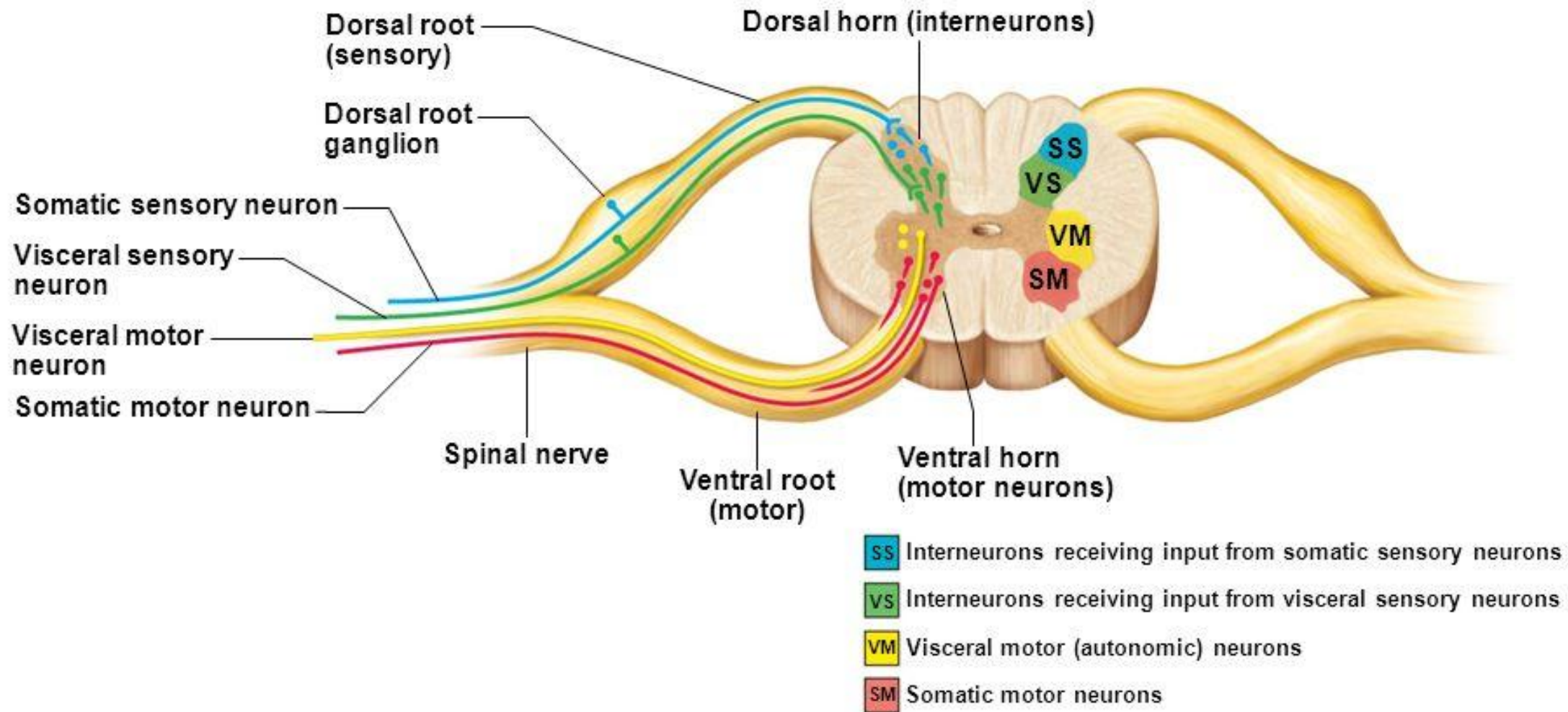
Функциональная нейрохирургия

Детская нейрохирургия

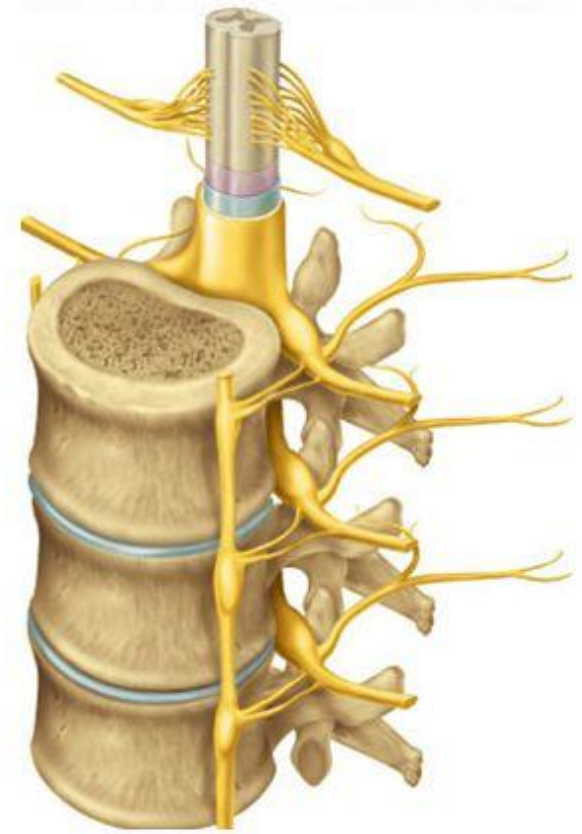
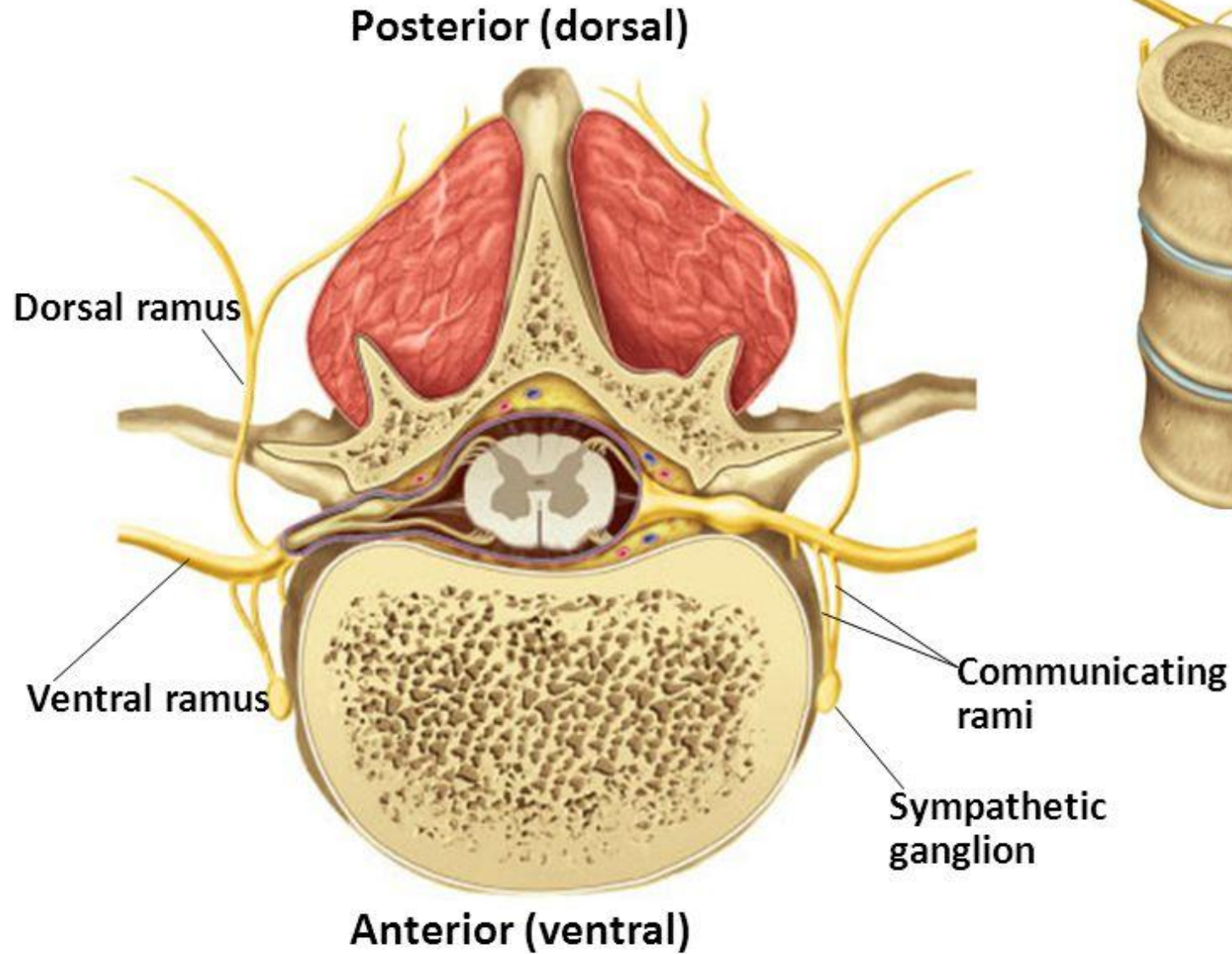
Хирургия периферических нервов

**немного о
хирургии
периферических
нервов**

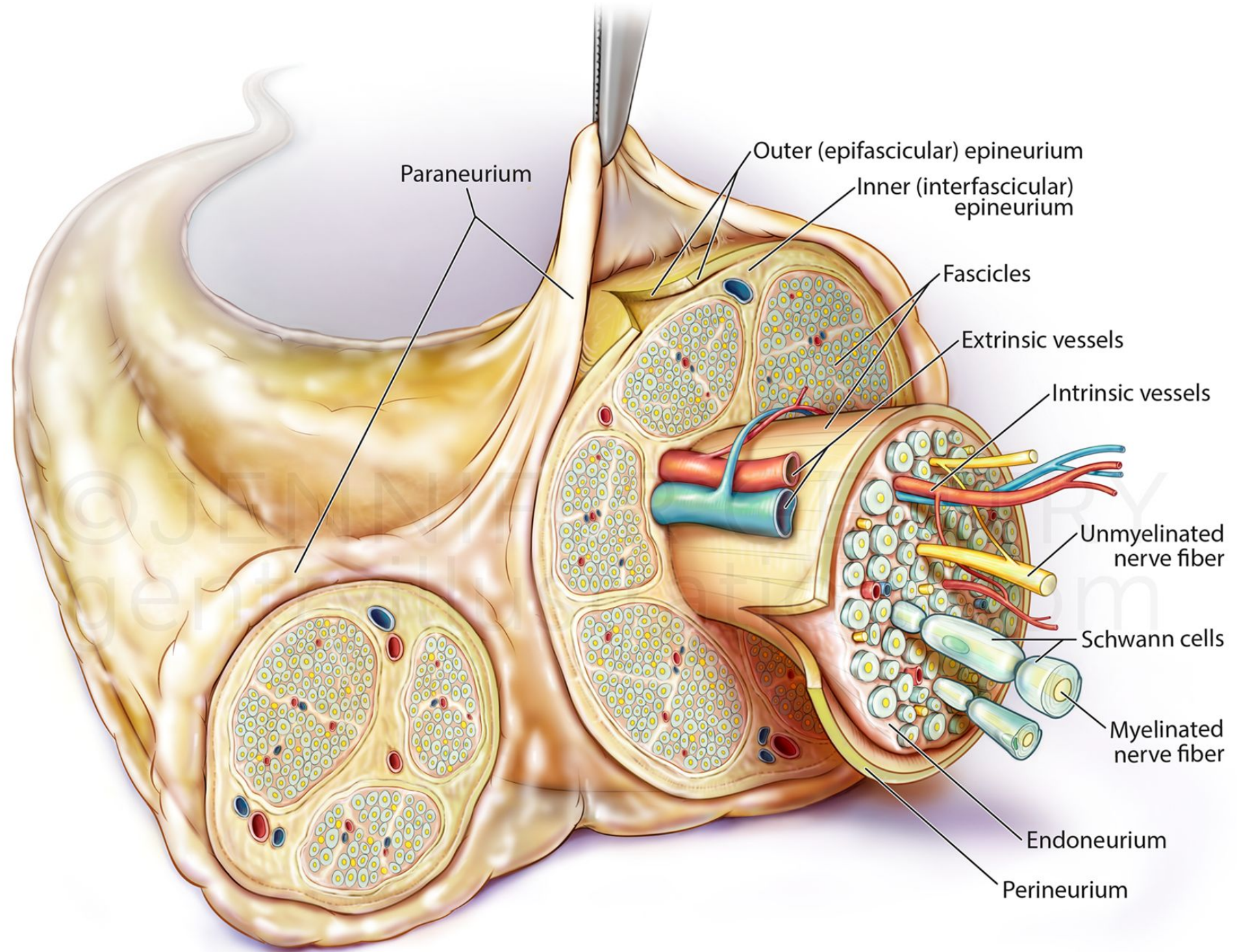




Anatomy of sympathetic chain







Paraneurium

Outer (epifascicular) epineurium

Inner (interfascicular) epineurium

Fascicles

Extrinsic vessels

Intrinsic vessels

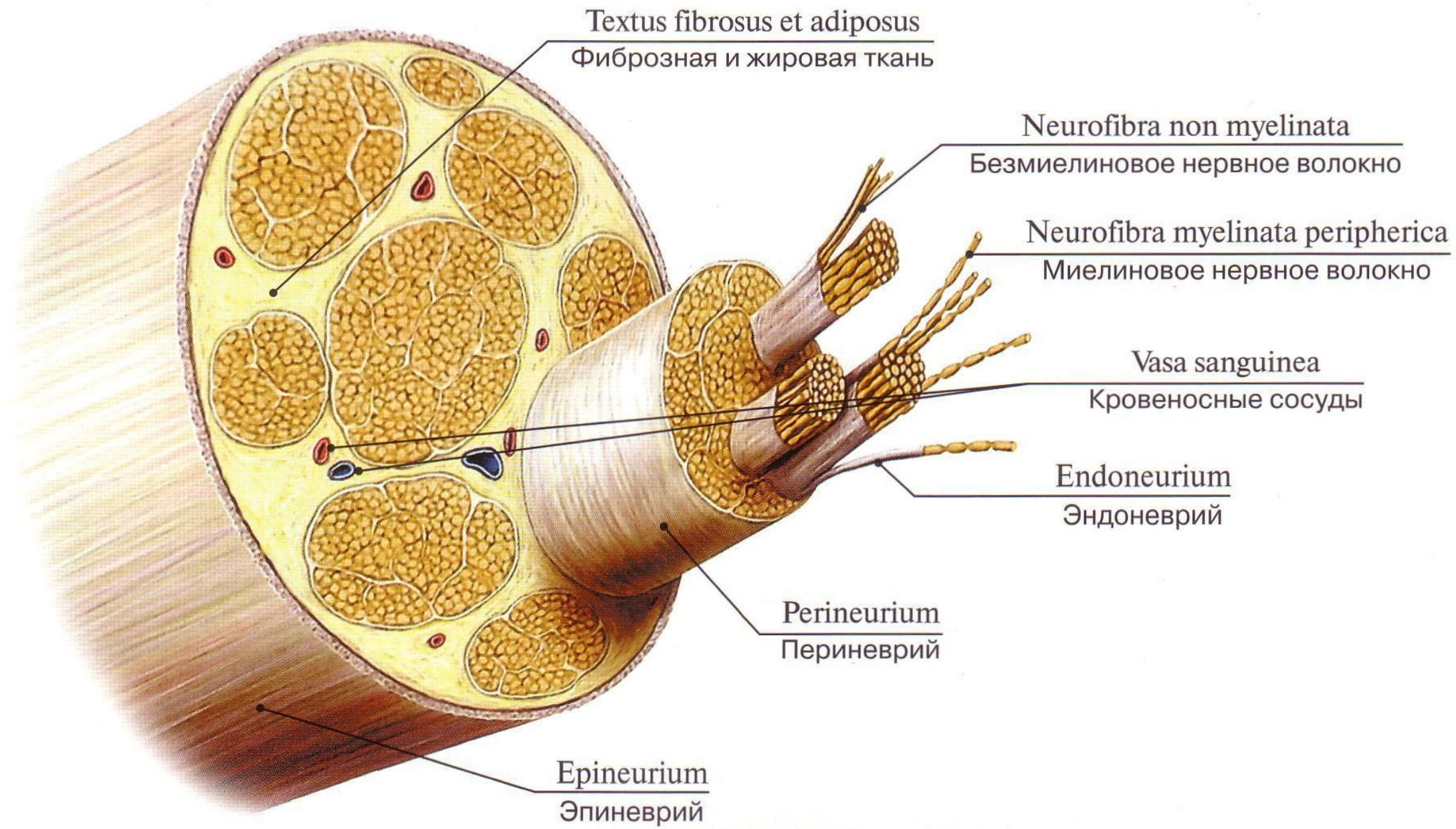
Unmyelinated nerve fiber

Schwann cells

Myelinated nerve fiber

Endoneurium

Perineurium



Textus fibrosus et adiposus
Фиброзная и жировая ткань

Neurofibra non myelinata
Безмиелиновое нервное волокно

Neurofibra myelinata peripherica
Миелиновое нервное волокно

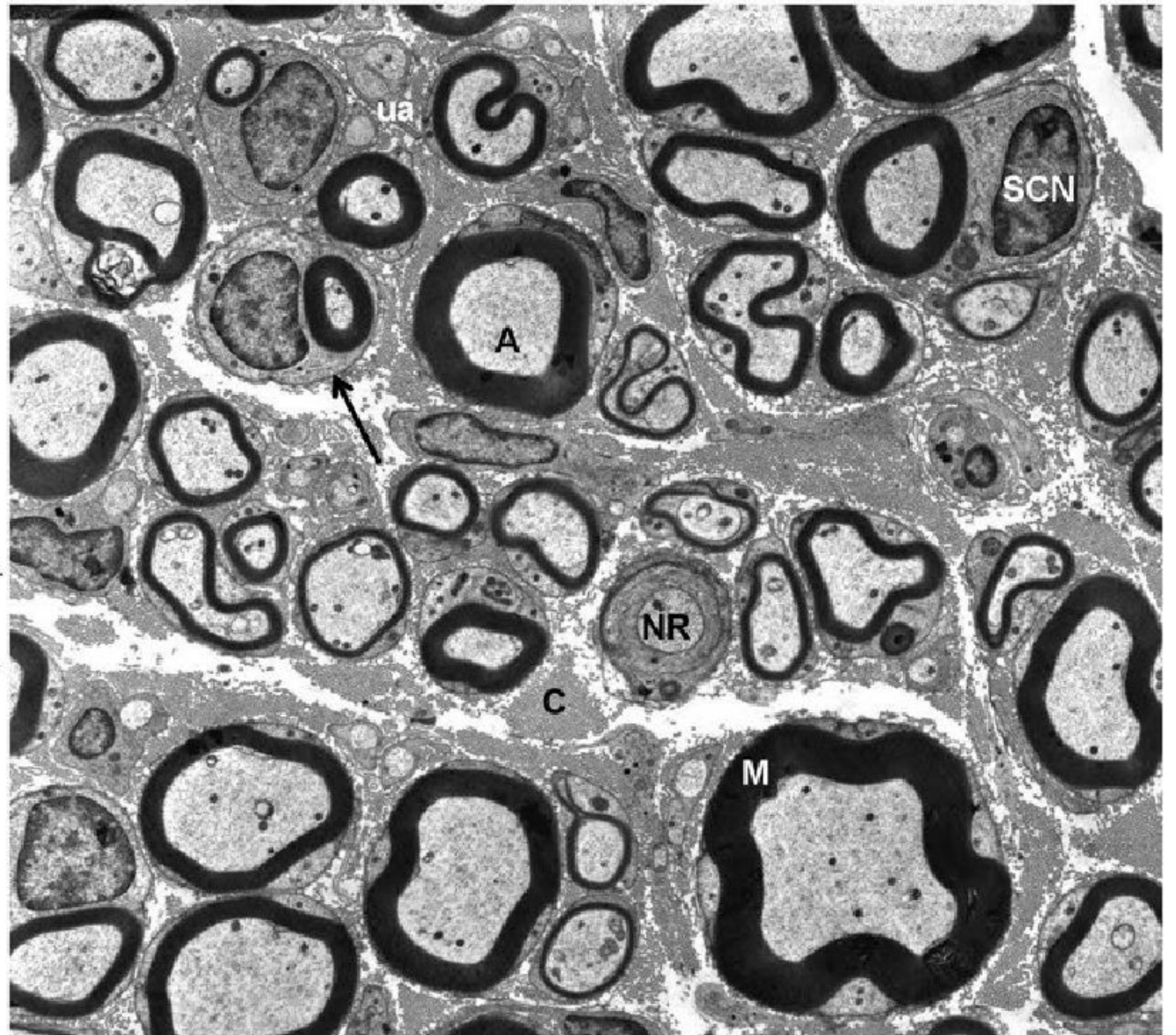
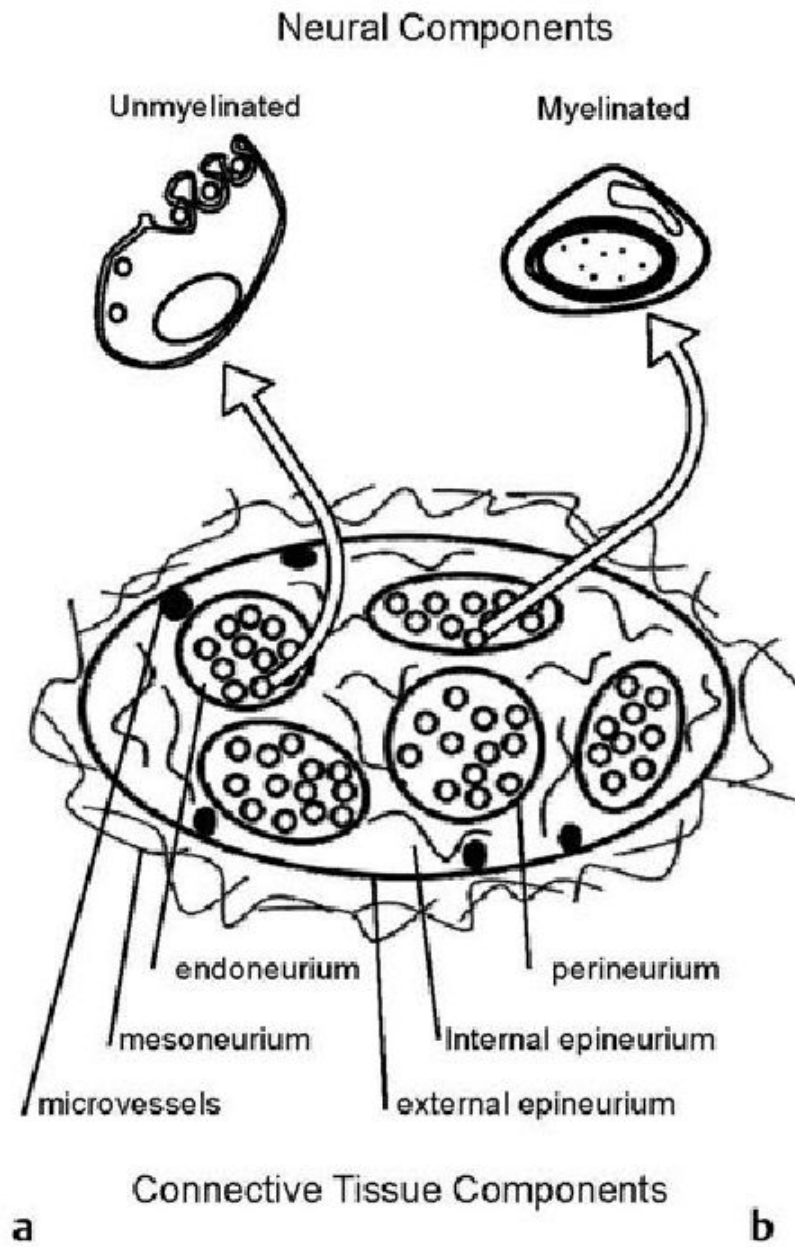
Vasa sanguinea
Кровеносные сосуды

Endoneurium
Эндоневрий

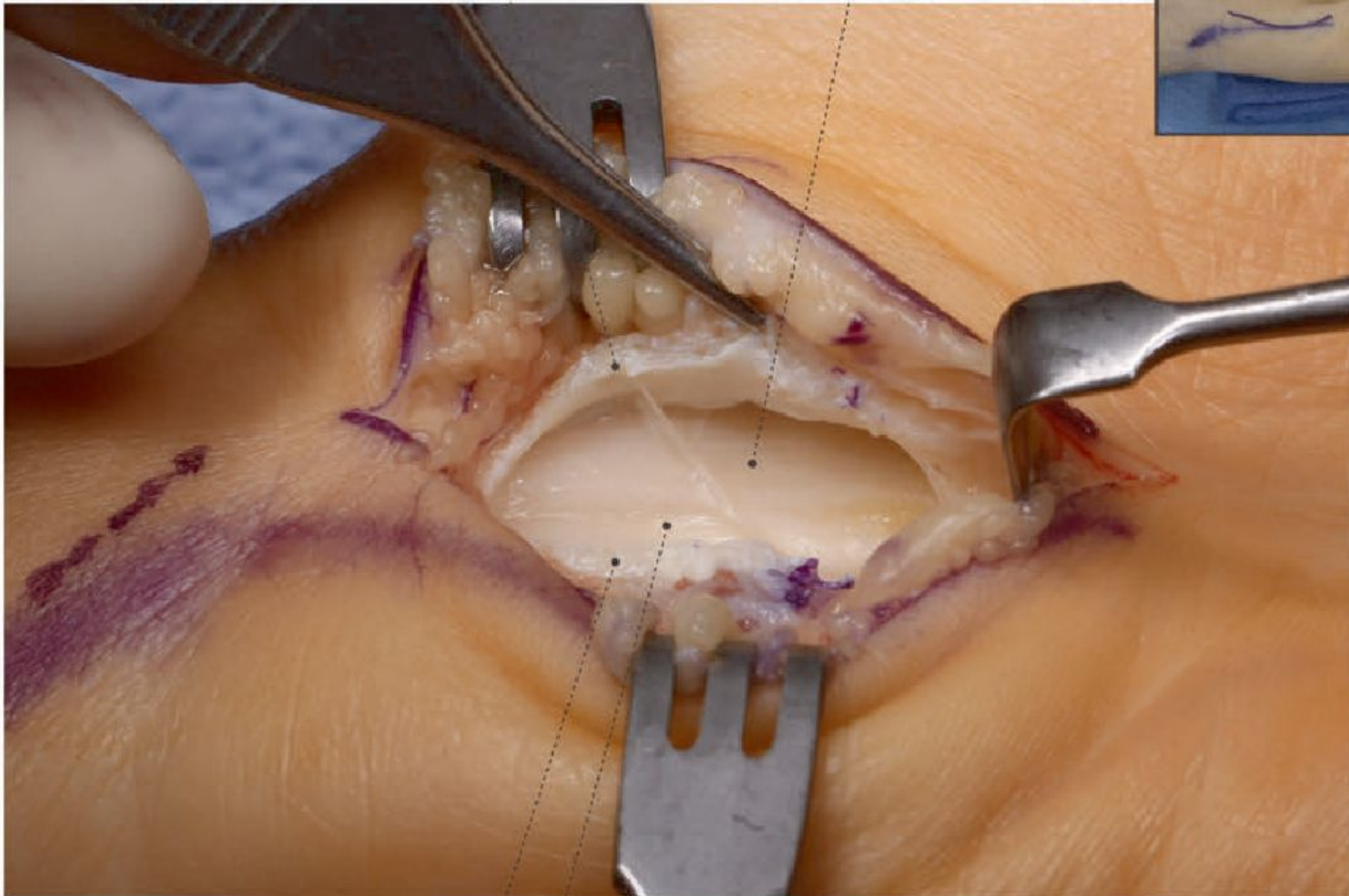
Perineurium
Периневрий

Epineurium
Эпиневрй

Normal Nerve



transverse carpal ligament (transected)



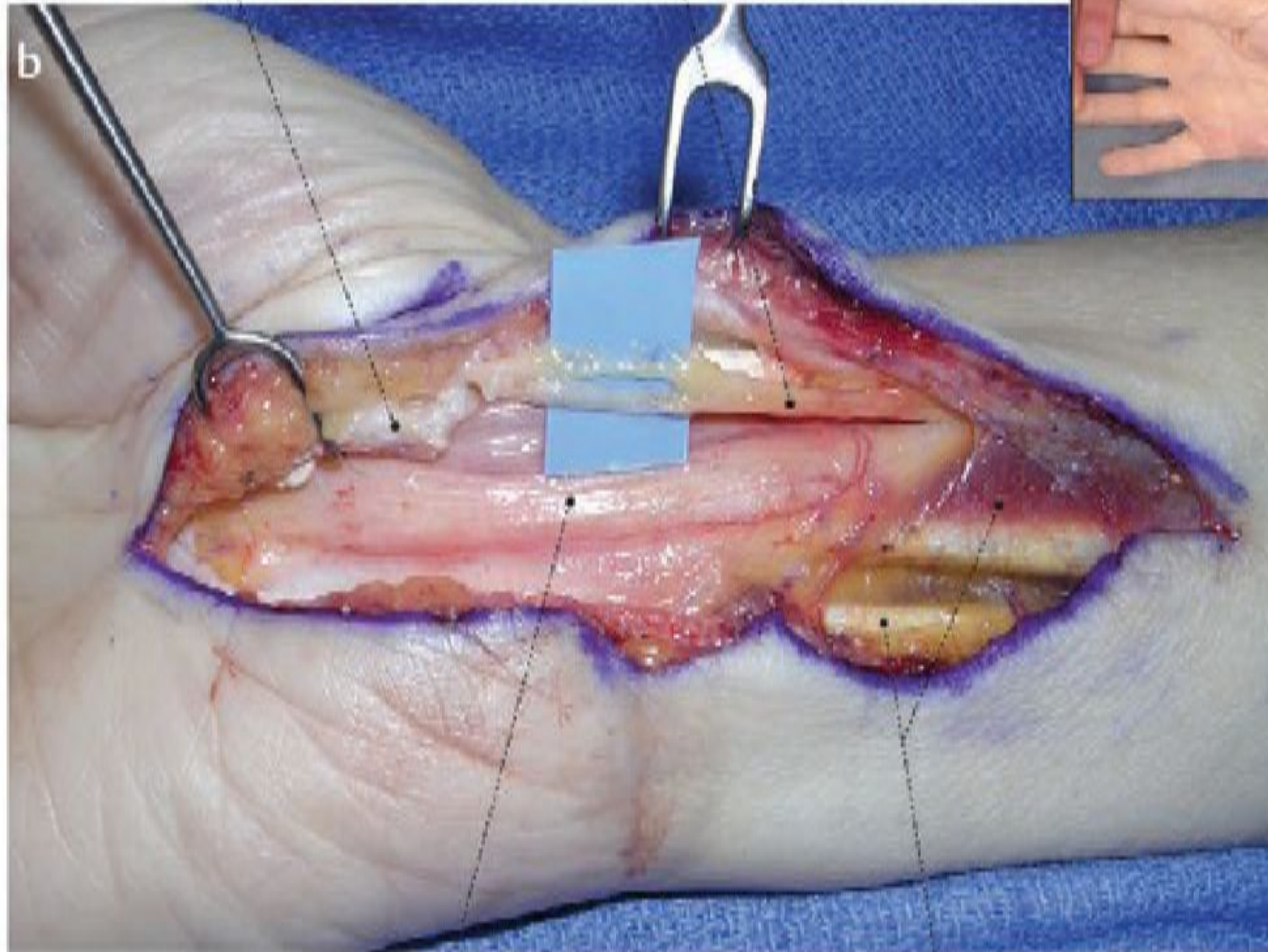
transverse carpal ligament (transected)

(M) tendons of flexor digitorum superficialis

transverse carpal ligament (transected)

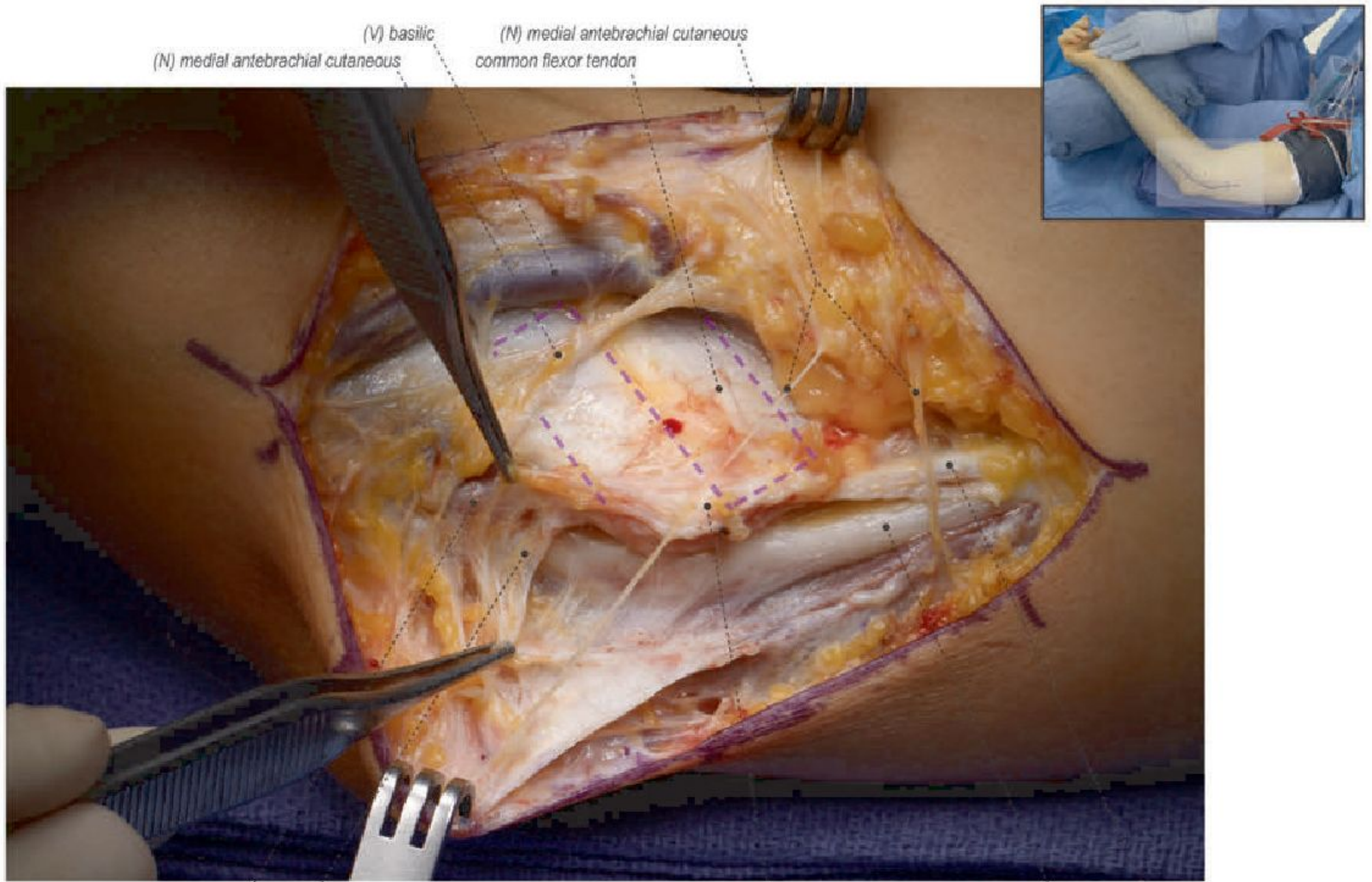
(N) palmar cutaneous branch of median

b



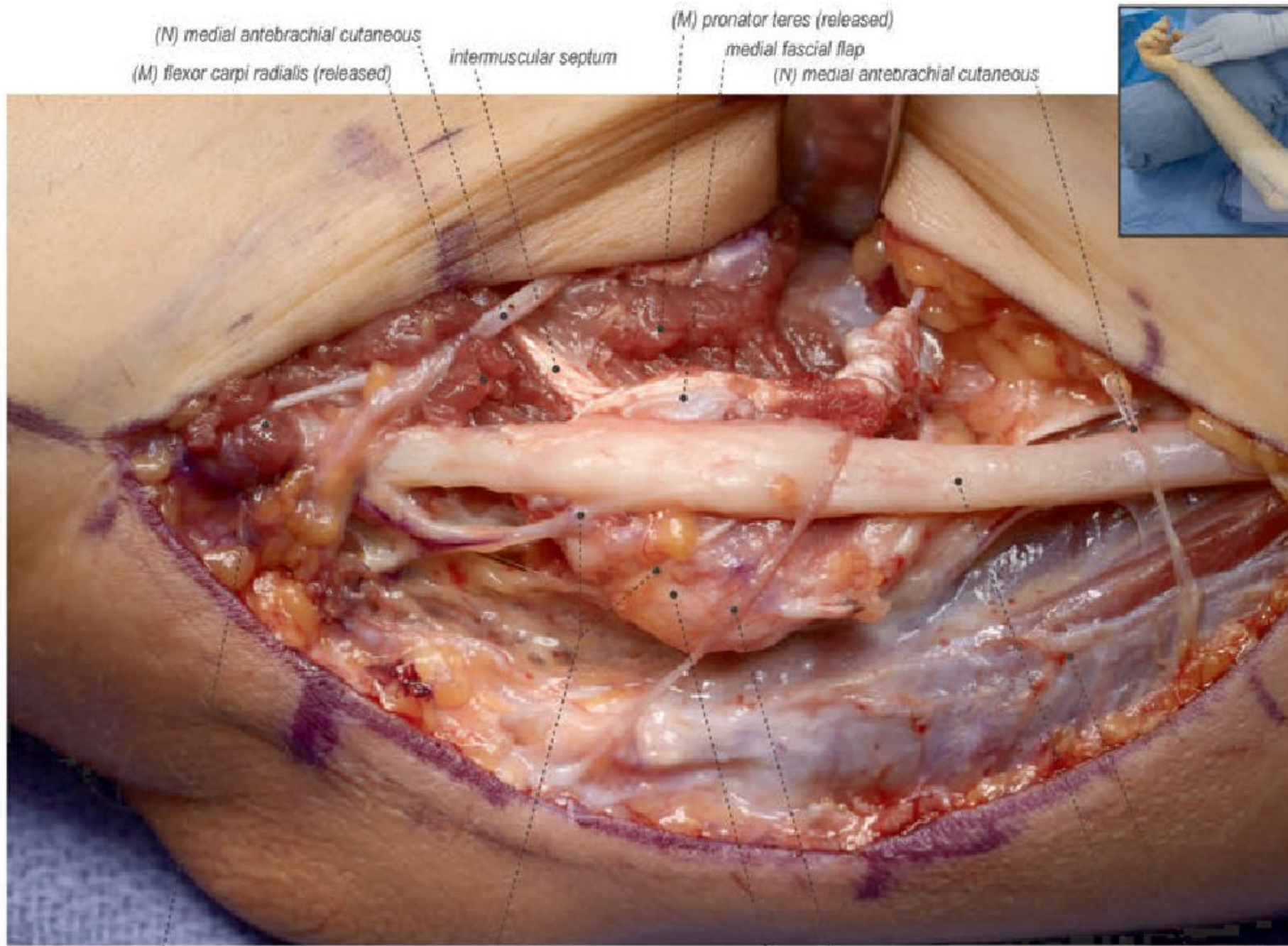
(N) median

(M) flexor digitorum superficialis



(V) basilic
(N) medial antebrachial cutaneous
(N) medial antebrachial cutaneous
(N) medial antebrachial cutaneous
common flexor tendon

(M) flexor carpi ulnaris
Osborne's ligament
(tendinous leading-edge of flexor carpi ulnaris)
(B) medial epicondyle of humerus
medial intermuscular septum



(N) medial antebrachial cutaneous
(M) flexor carpi radialis (released)

intermuscular septum

(M) pronator teres (released)

medial fascial flap

(N) medial antebrachial cutaneous



(M) flexor carpi ulnaris (divided)

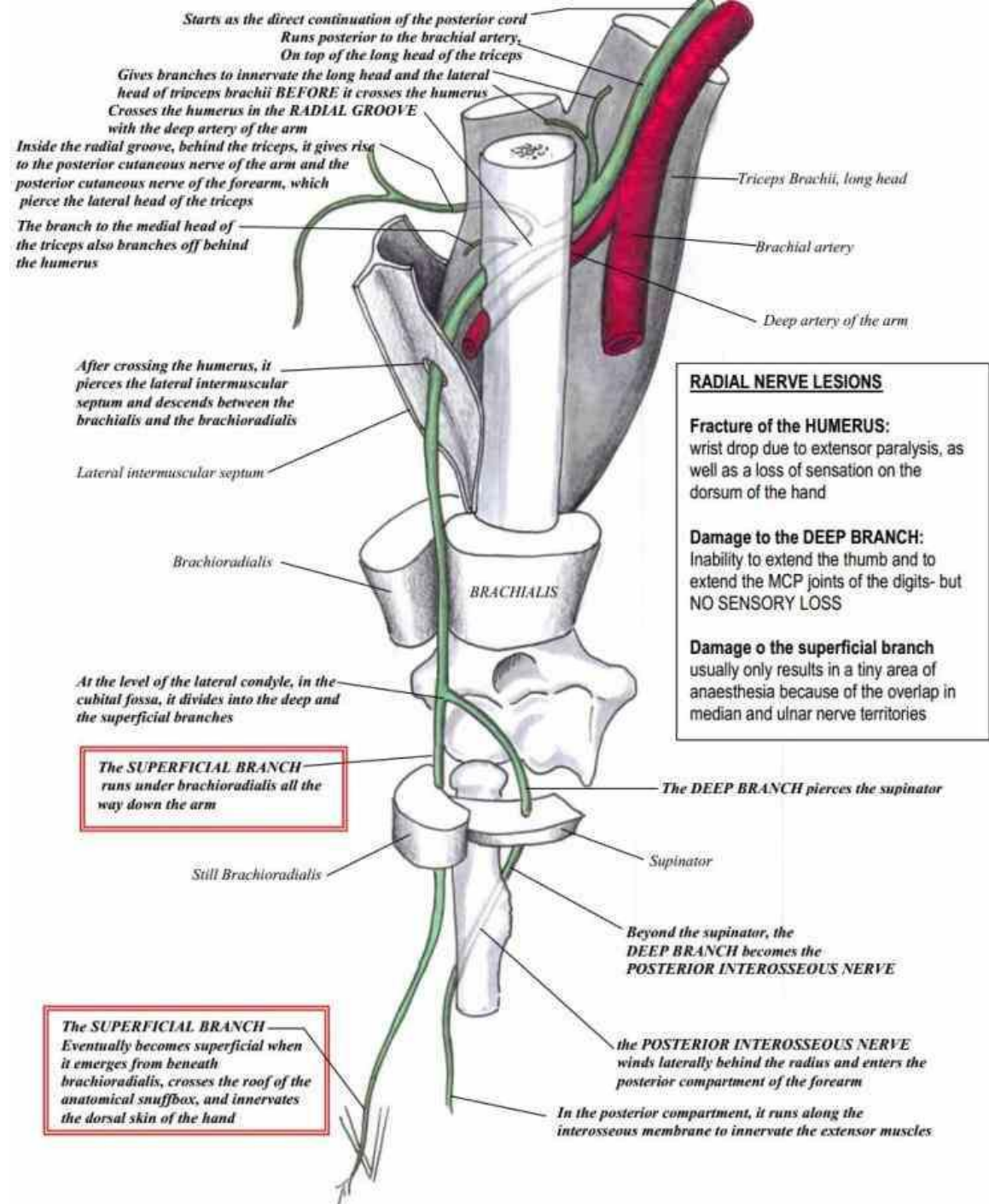
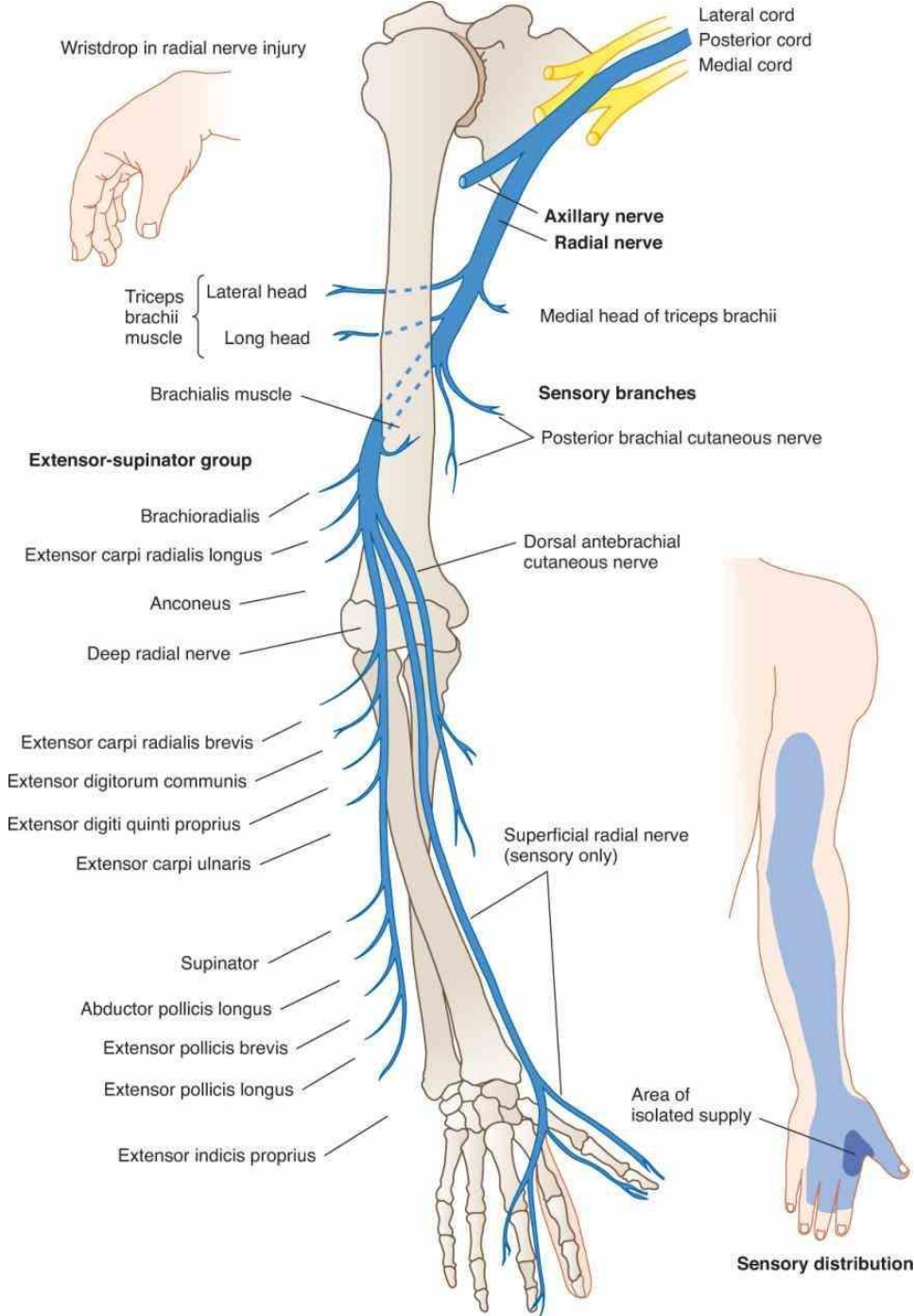
(N) flexor carpi ulnaris

(B) medial epicondyle of humerus

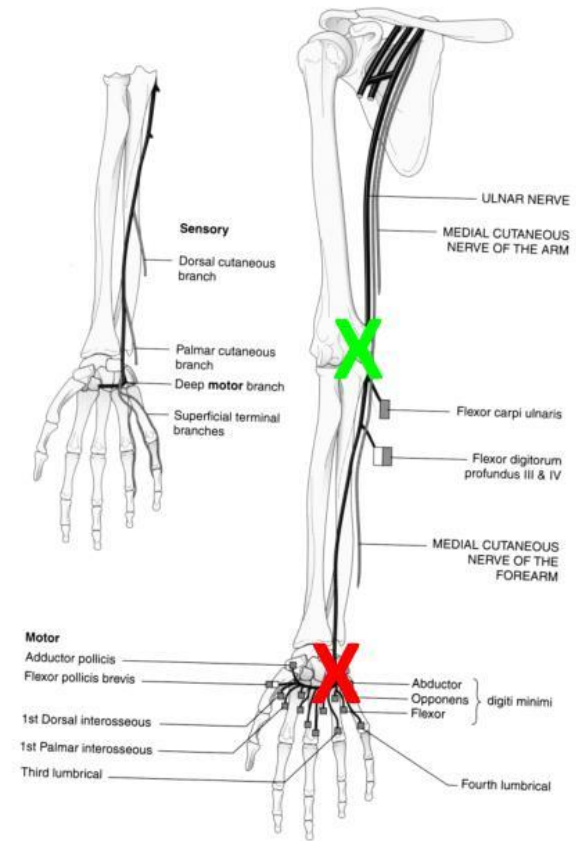
(N) medial antebrachial cutaneous

(M) triceps brachii, medial head
(N) ulnar

Под туннельным синдромом принято обозначать комплекс клинических проявлений (чувствительных, двигательных и трофических) обусловленных сдавлением, ущемлением нерва в узких анатомических пространствах (анатомический туннель). Стенки анатомического туннеля являются естественными анатомическими структурами (кости, сухожилия, мышцы), и в норме через туннель свободно проходят периферические нервы и сосуды. Но при определенных патологических условиях канал сужается, возникает нервно-канальный конфликт.



Ulnar Nerve Injury



Damage at the elbow or proximal

No flexion of distal IP joint of Digits 4 & 5 = Lack of FDP

Wrist abducts on flexion = Lack of FCU

No digit ab- or adduction (except thumb abduction)

Some clawing of digits 4 & 5 at rest = loss of lumbricals & interossei

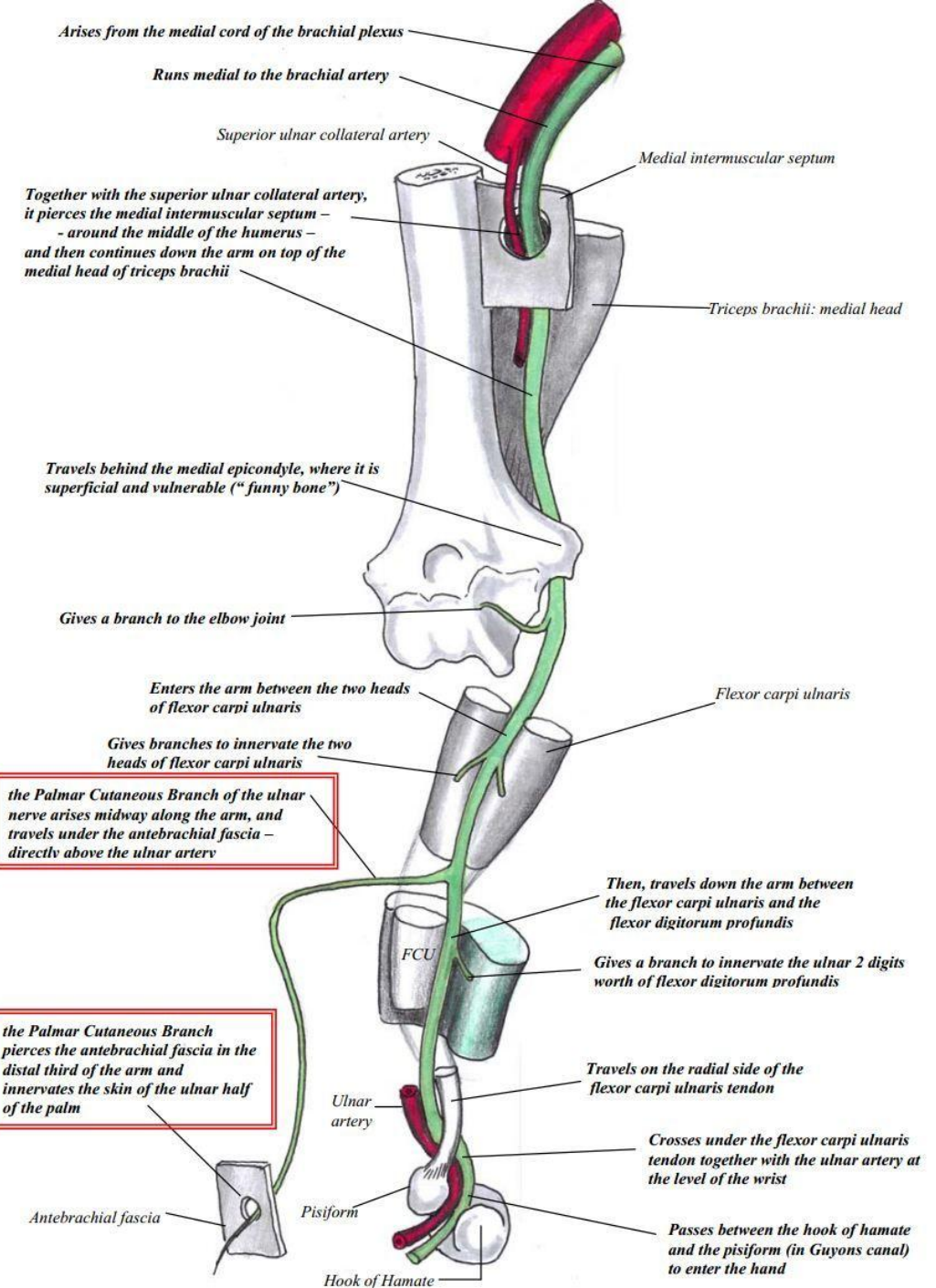
No clawing of digits 2 & 3 as lumbricals 1 & 2 OK

Damage at the wrist

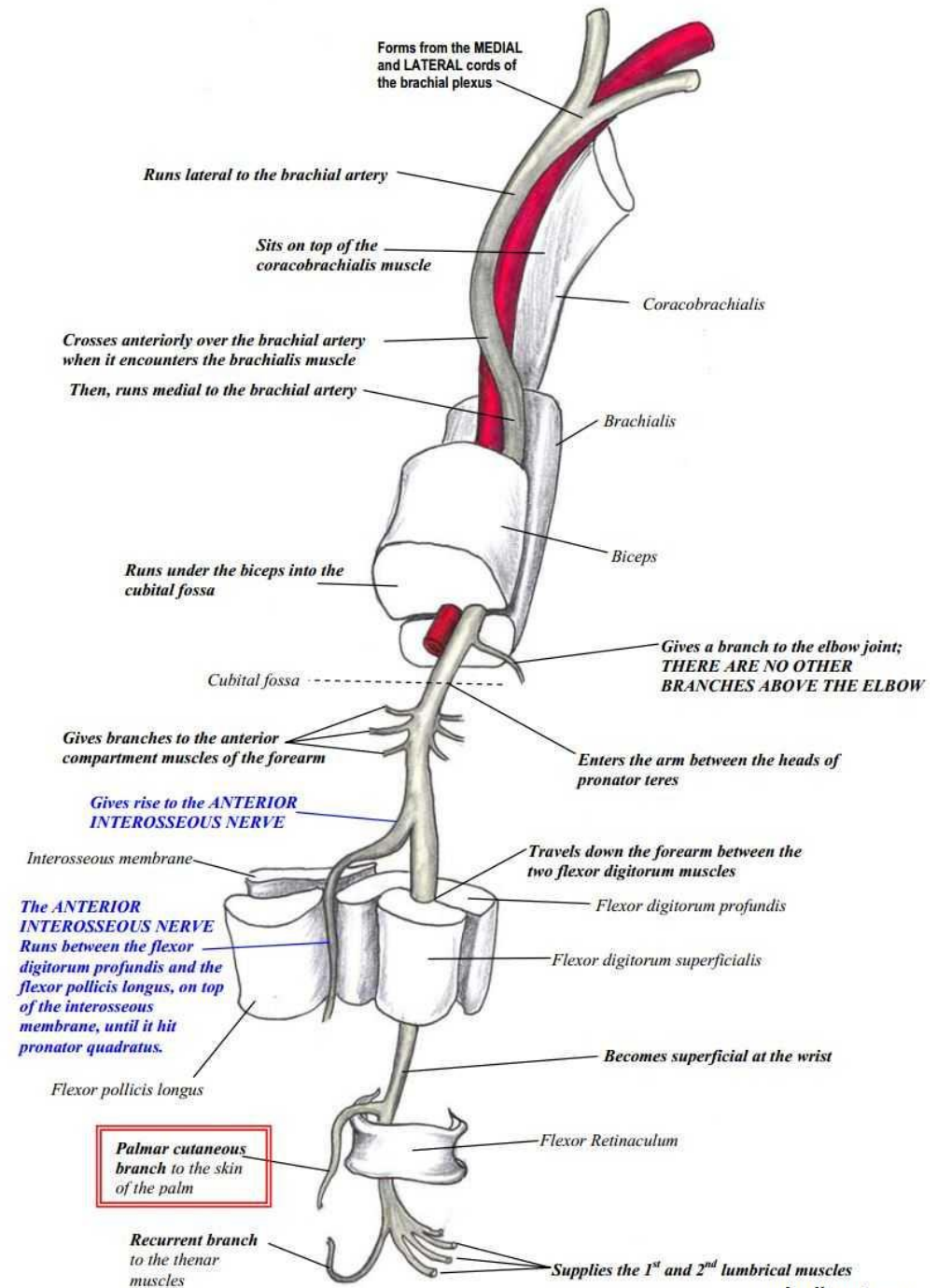
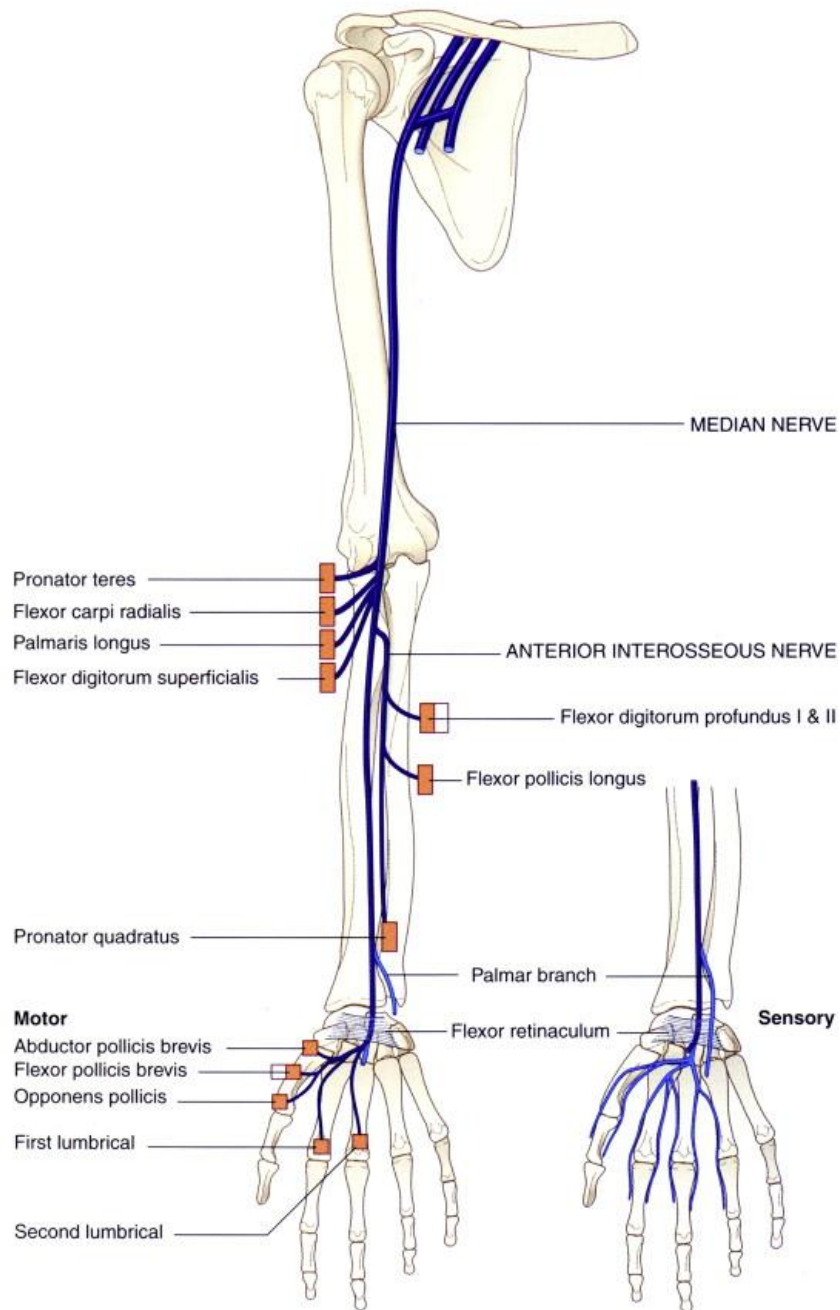
Loss of most intrinsic hand muscles

Hypothenar & interosseous wasting

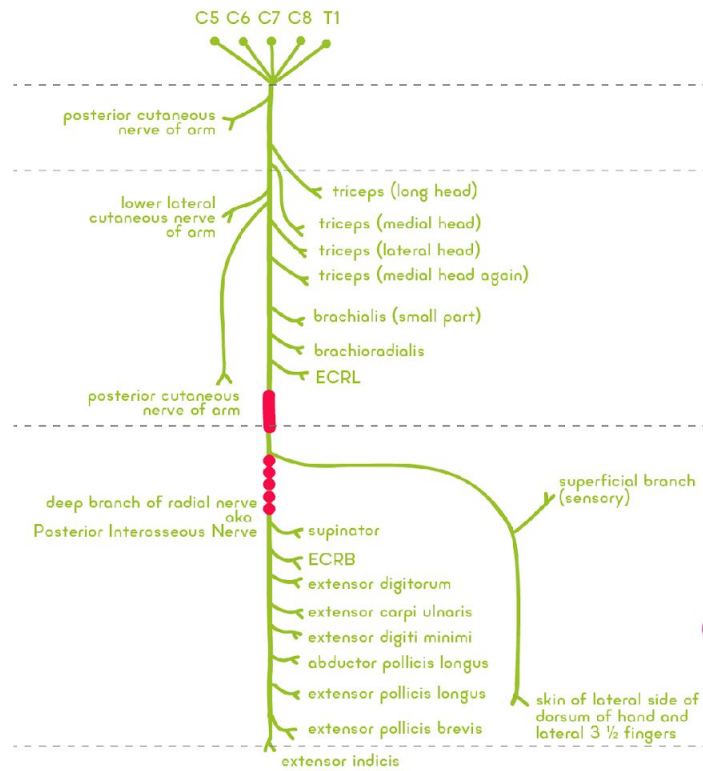
Clawing of digits 4 & 5 worse in low lesion as FDP remains innervated and exacerbates IP joint flexion



MEDIAN NERVE



RADIAL NERVE



Points of Compression (proximal to distal)

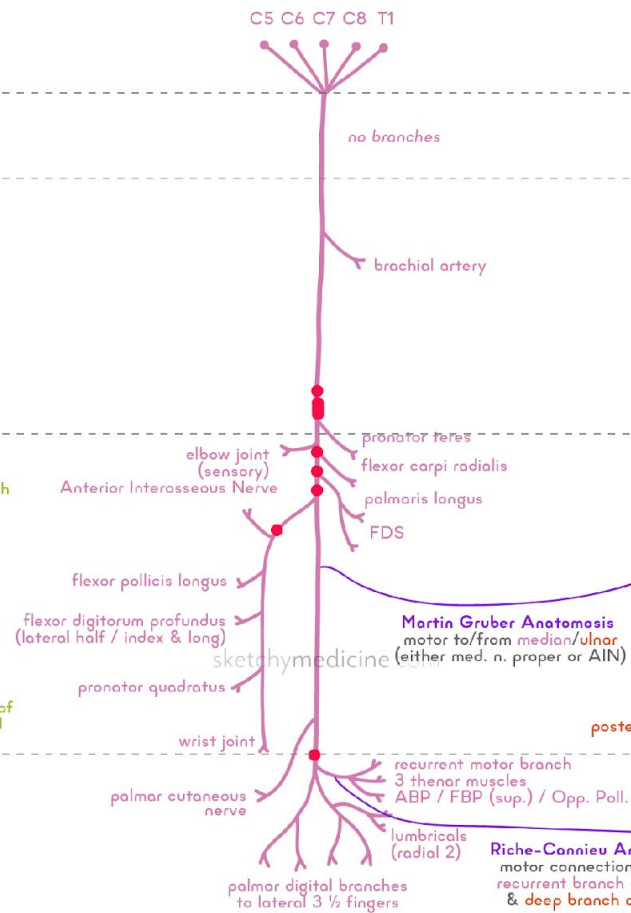
Proximal

1. Spiral groove / fibrous arch from lateral head of triceps

Radial Tunnel Syndrome aka Early PIN Syndrome

2. Fibrous bands of radiocapitellar joint (attached to and superficial to the joint)
3. Leash of Henry (radial recurrent artery and venae comitantes)
4. Tendinous margin of ECRB
5. Arcade of Frohse (most common) aka proximal fibrous edge of supinator muscle
6. Fascial border at distal edge of supinator

MEDIAN NERVE



Points of Compression (proximal to distal)

Pronator Syndrome

1. Supracondylar process of humerus (only present in 1% of population)
2. Ligament of Struthers (supracondylar process to medial epicondyle)
3. Bicipital aponeurosis aka lacertus fibrosis (biceps tendon to the fascia of the flexors)
4. Between ulnar and humeral heads of pronator teres
5. FDS aponeurotic arch (6.5 cm distal to elbow)

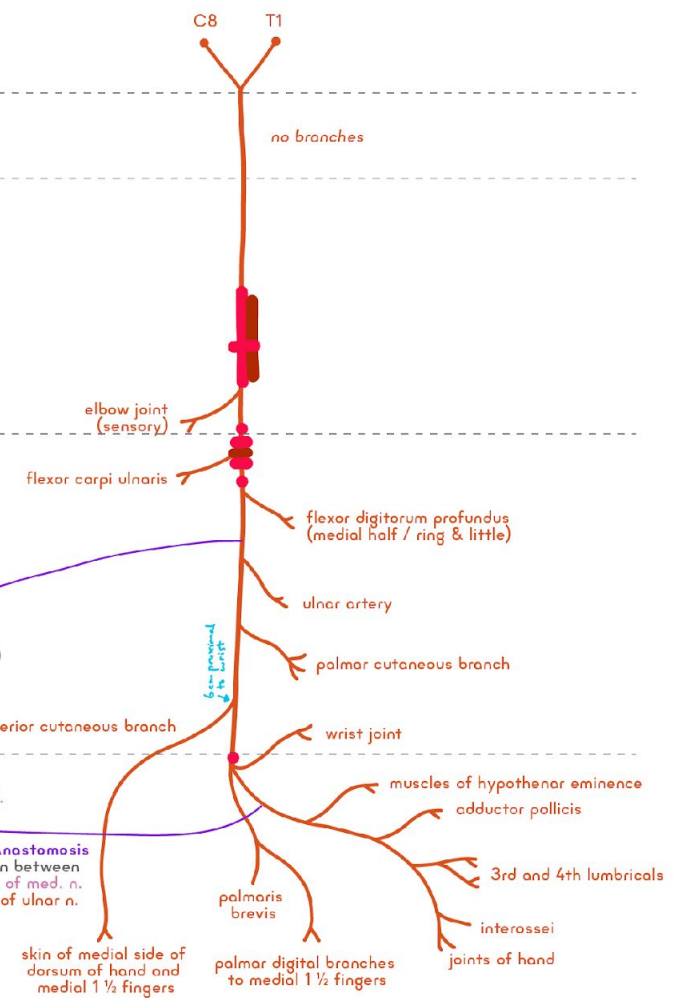
AIN Syndrome - pronator syndrome points plus:

6. Accessory head of FPL aka Gantzer's muscle
- AIN is often affected in Parsonage Turner Syndrome

Carpal Tunnel Syndrome

7. Carpal tunnel +/- local tumors, persistent median artery, low-lying muscle bellies (FDS most common), accessory muscles (manus) or lumbricals, lysosomal storage diseases

ULNAR NERVE



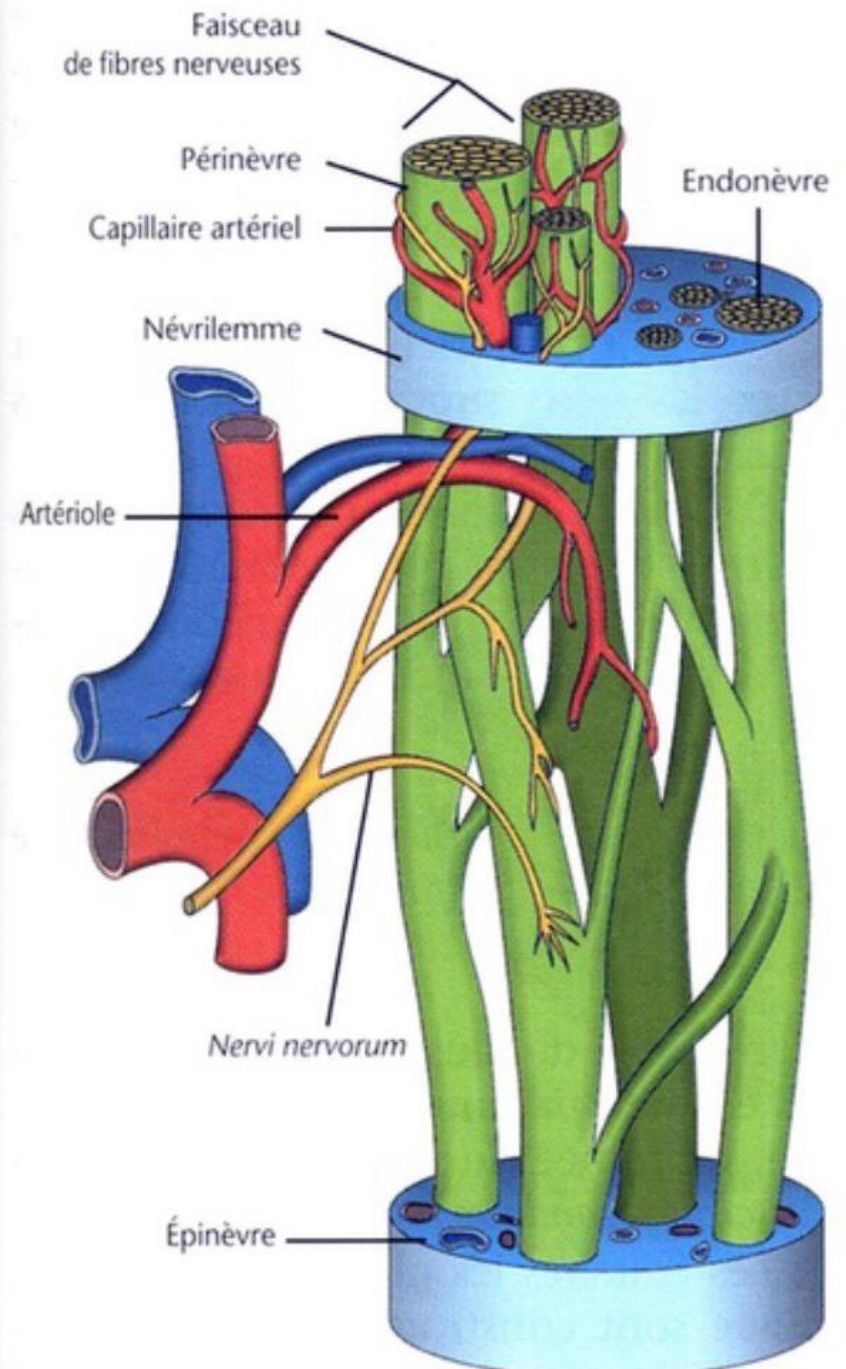
Points of Compression (proximal to distal)

Cubital Tunnel Syndrome

1. Medial intermuscular septum
2. Medial head of triceps
3. Arcade of Struthers aka aponeurosis from medial head of triceps to medial intermuscular septum (not to be confused with ligament of Struthers)
4. Medial epicondyle (wall of tunnel with olecranon laterally)
5. Osborne's ligament (roof of cubital tunnel)
6. Anconeus epitrochlearis (accessory muscle)
7. Aponeurosis of FCU (between two heads, part of roof of tunnel)
8. Ligament of Spinner (between FCU and FDS D4)
9. Elbow joint pathology

Guyon's Canal

10. Zone I - proximal to bifurcation of motor and sensory
11. Zone II - after division, along deep motor branch (motor only)
12. Zone III - after division, along superficial sensory branch (sensory only)



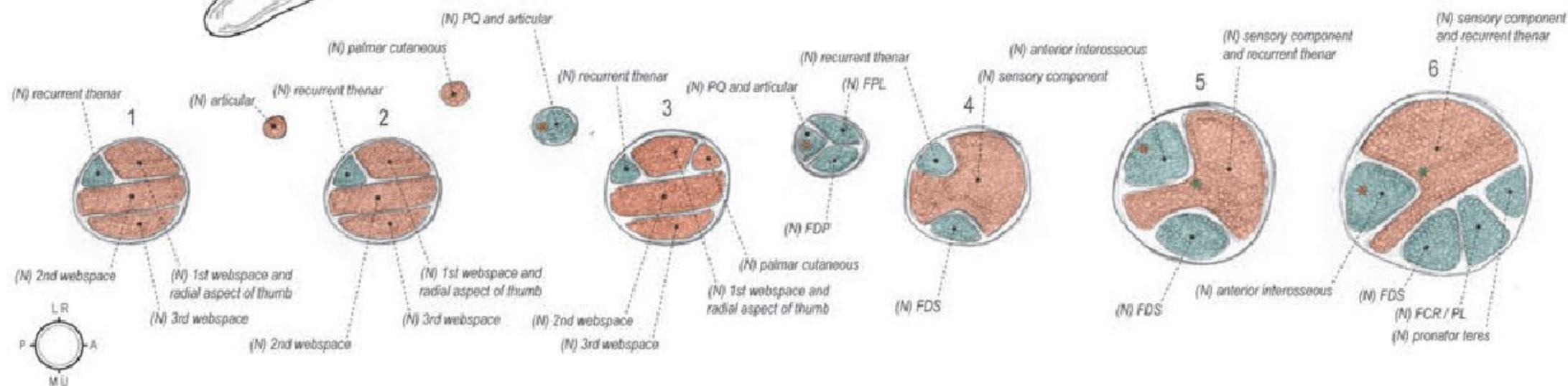
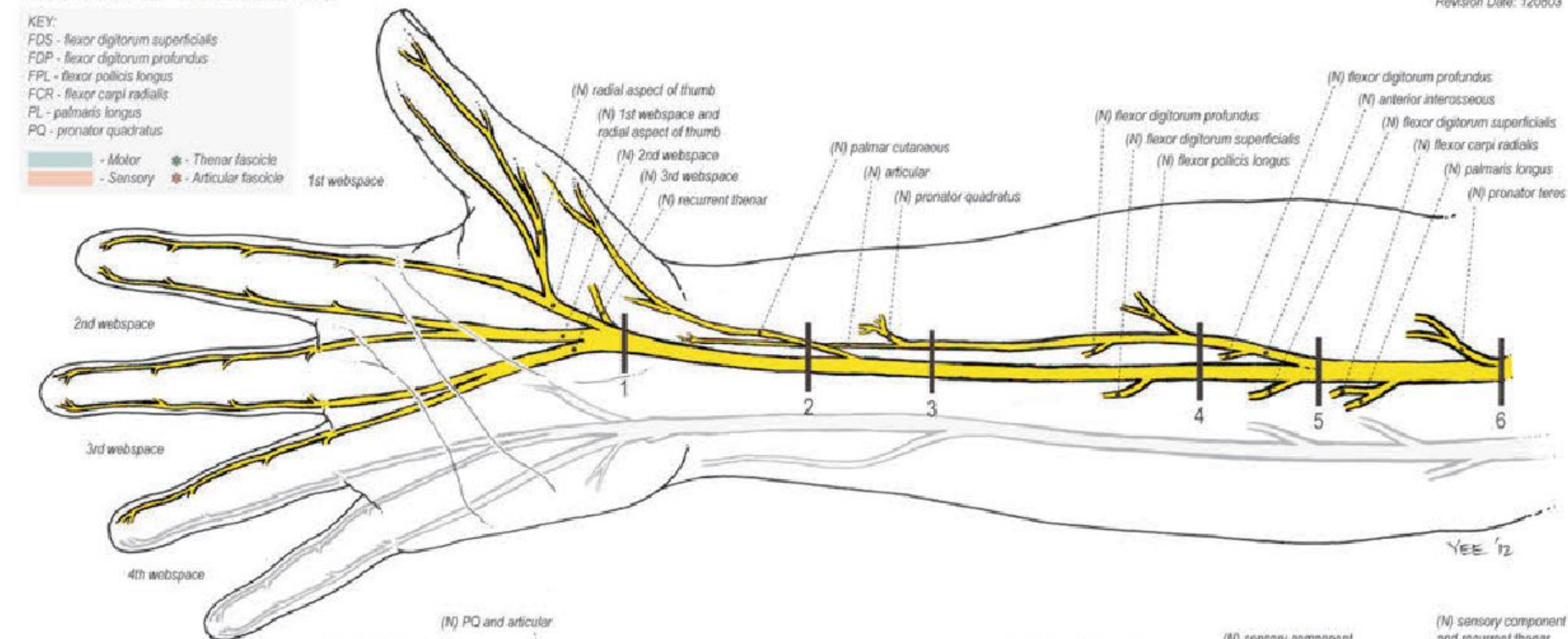
MEDIAN NERVE - Forearm and Hand

Revision Date: 120803

KEY:

- FDS - flexor digitorum superficialis
- FDP - flexor digitorum profundus
- FPL - flexor pollicis longus
- FCR - flexor carpi radialis
- PL - palmaris longus
- PQ - pronator quadratus

- Motor
- Sensory
- Thenar fasciole
- Articular fasciole

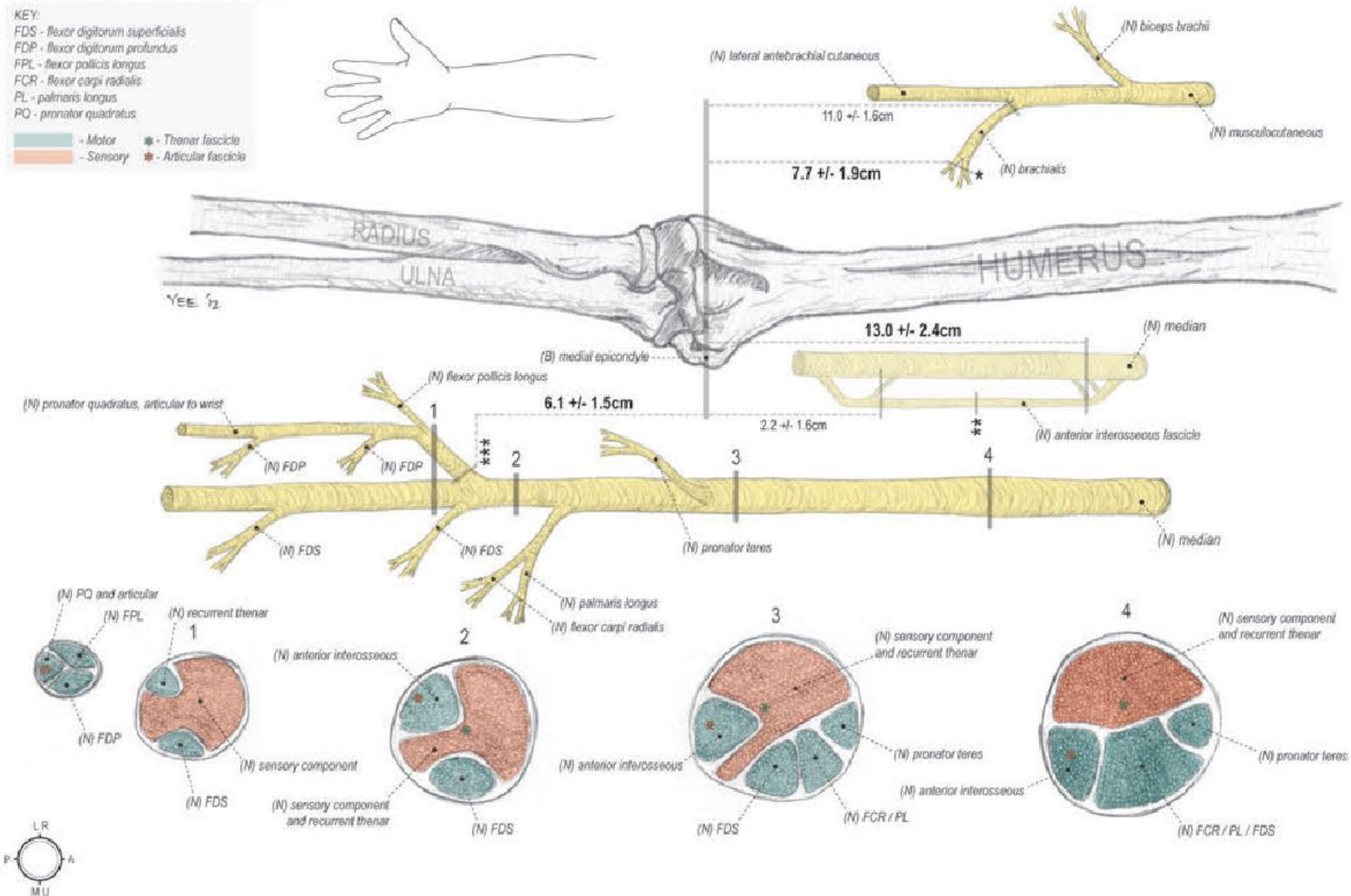


MEDIAN NERVE - Arm and Forearm

KEY:

FDS - flexor digitorum superficialis
 FDP - flexor digitorum profundus
 FPL - flexor pollicis longus
 FCR - flexor carpi radialis
 PL - palmaris longus
 PQ - pronator quadratus

■ - Motor ● - Thenar fascicle
■ - Sensory ● - Articular fascicle

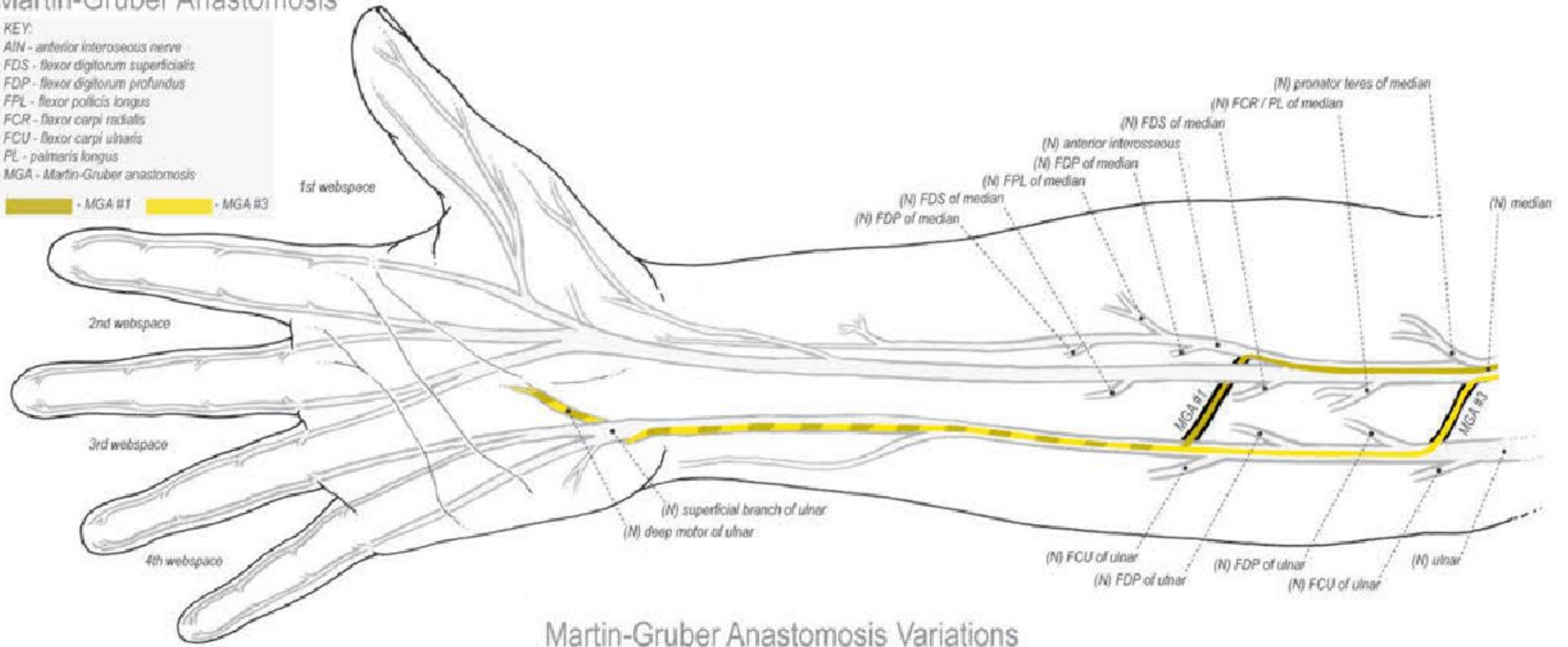


Martin-Gruber Anastomosis

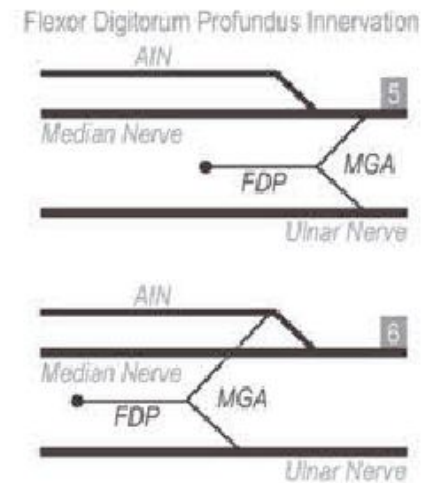
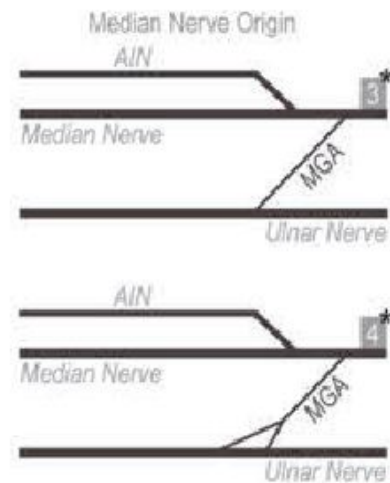
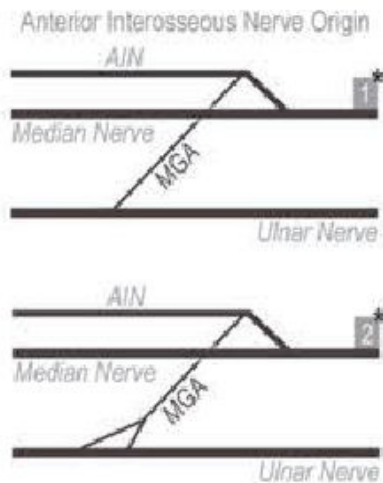
KEY:

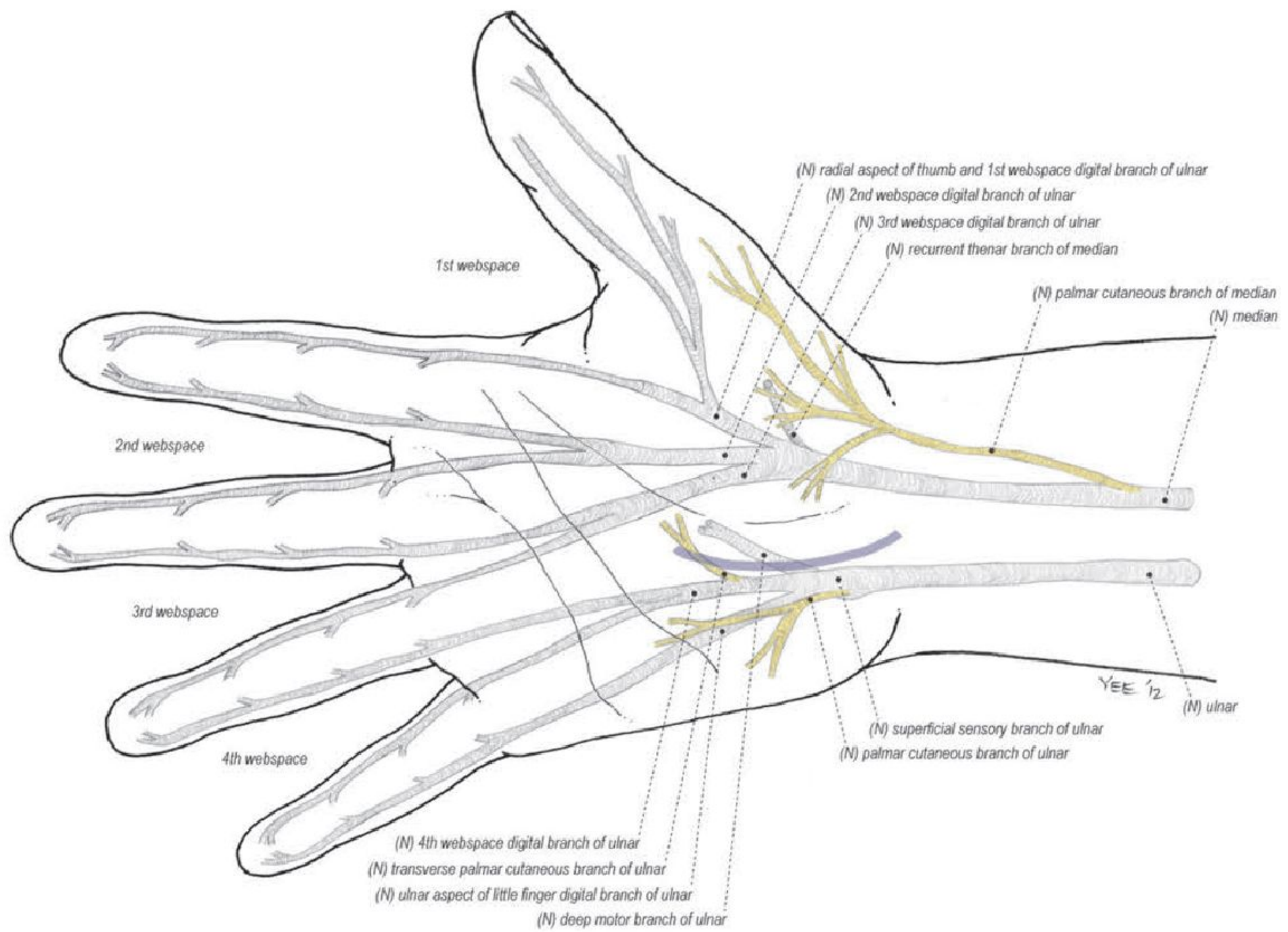
- AIN - anterior interosseous nerve
- FDS - flexor digitorum superficialis
- FDP - flexor digitorum profundus
- FPL - flexor pollicis longus
- FCR - flexor carpi radialis
- FCU - flexor carpi ulnaris
- PL - palmaris longus
- MGA - Martin-Gruber anastomosis

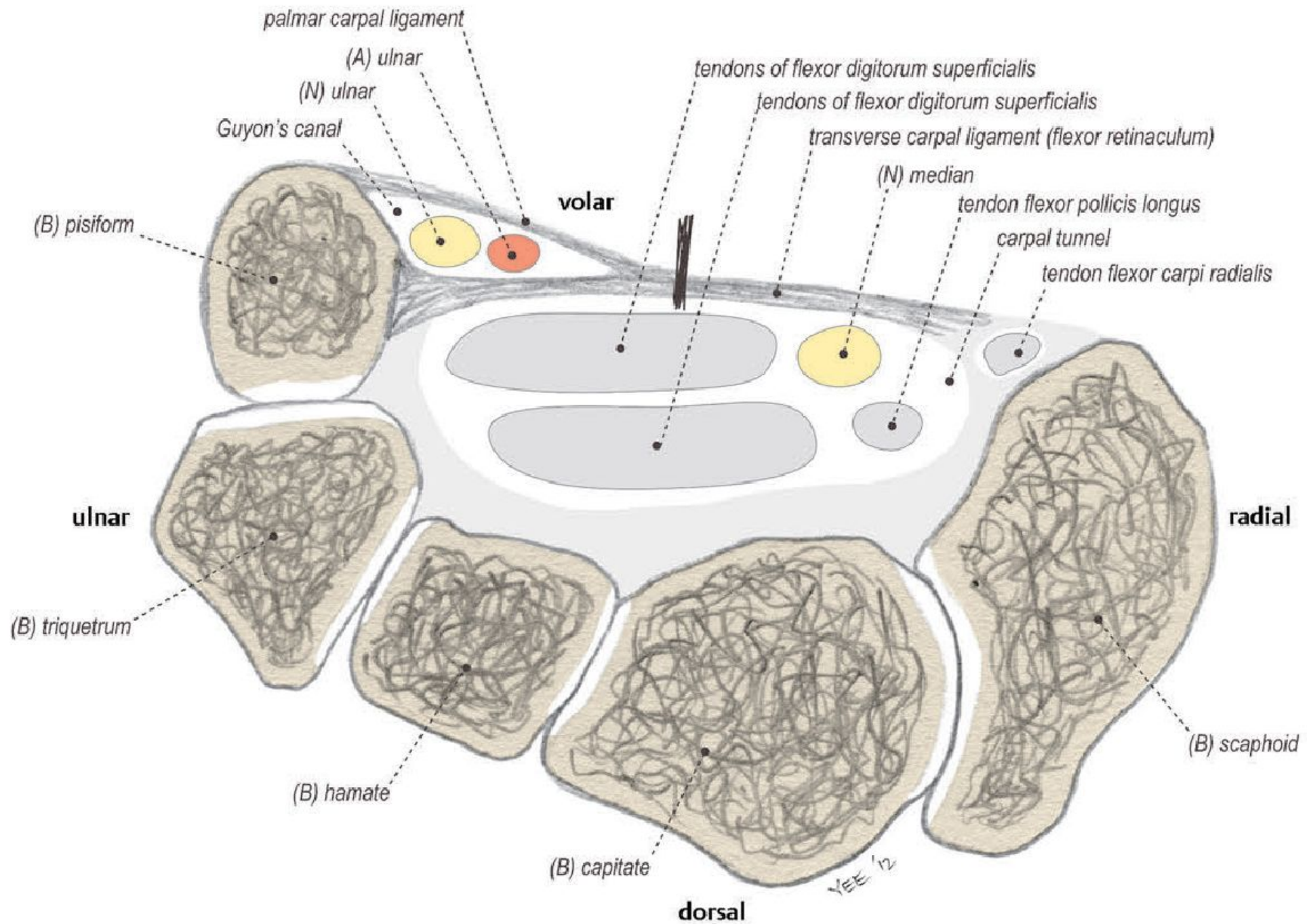
■ MGA #1 ■ MGA #3



Martin-Gruber Anastomosis Variations







Направления хирургического лечения

- Травмы нервов
- Туннельные синдромы
- Опухоли периферических нервов
- Болевые синдромы

Виды оперативных вмешательств:

Невролиз

Нейроррафия

Пластика нерва

Невротизация

Виды травмы периферических нервов

Открытые повреждения:

- **Резаные, колотые, рубленые, рваные, разможенные**
- **Огнестрельные**
- **Ранения нервов в сочетании с повреждением костей, суставов, сухожилий**

Закрытые повреждения:

- **Сотрясение, ушиб, сдавление, тракция**
- **Повреждения нервов в сочетании: с переломом, вывихом, повреждением сосудов, массивным разможением мышц**
- **Жгутовые повреждения**
- **Ишемические**
- **Холодовые**

Формы повреждения нерва

**Анатомический
перерыв
нервного ствола:**

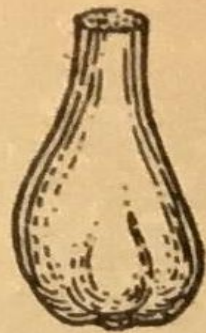
- **Полный**
- **Частичный**

**Внутриствольные
повреждения нерва:**

- **Гематома**
- **Инородные тела**
- **Разрывы пучков**

22. Формы повреж- дения нерва:

а — полный анатомический перерыв нерва, неврома центрального конца; б — частичный перерыв нерва, образование боковой невромы; в — почти полный анатомический перерыв нерва; г — внутриствольное повреждение нерва, рубцовые изменения нерва на месте повреждения



а



б



в



г

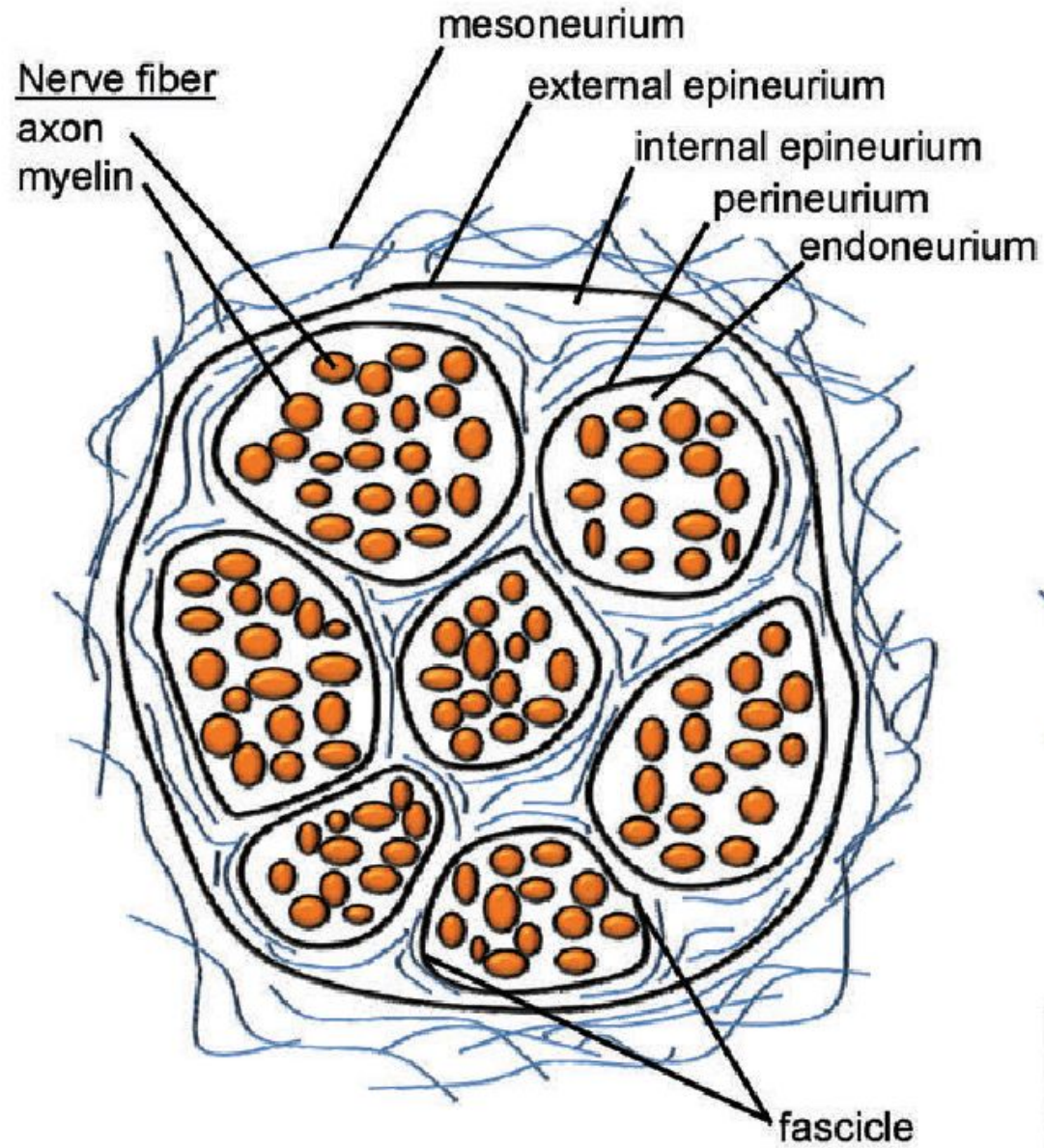
Классификация повреждений периферической нервной системы

Seddon	Sunderland (Degree)	favorable	recovery rate
Neurapraxia	I	+	quick
Axonotmesis	II	+	slow
	III	+	partial slow
	IV	-	-
Neurotmesis	V	-	-
	VI (combination of any of Sunderland (I-V))	+ / -	+ / -

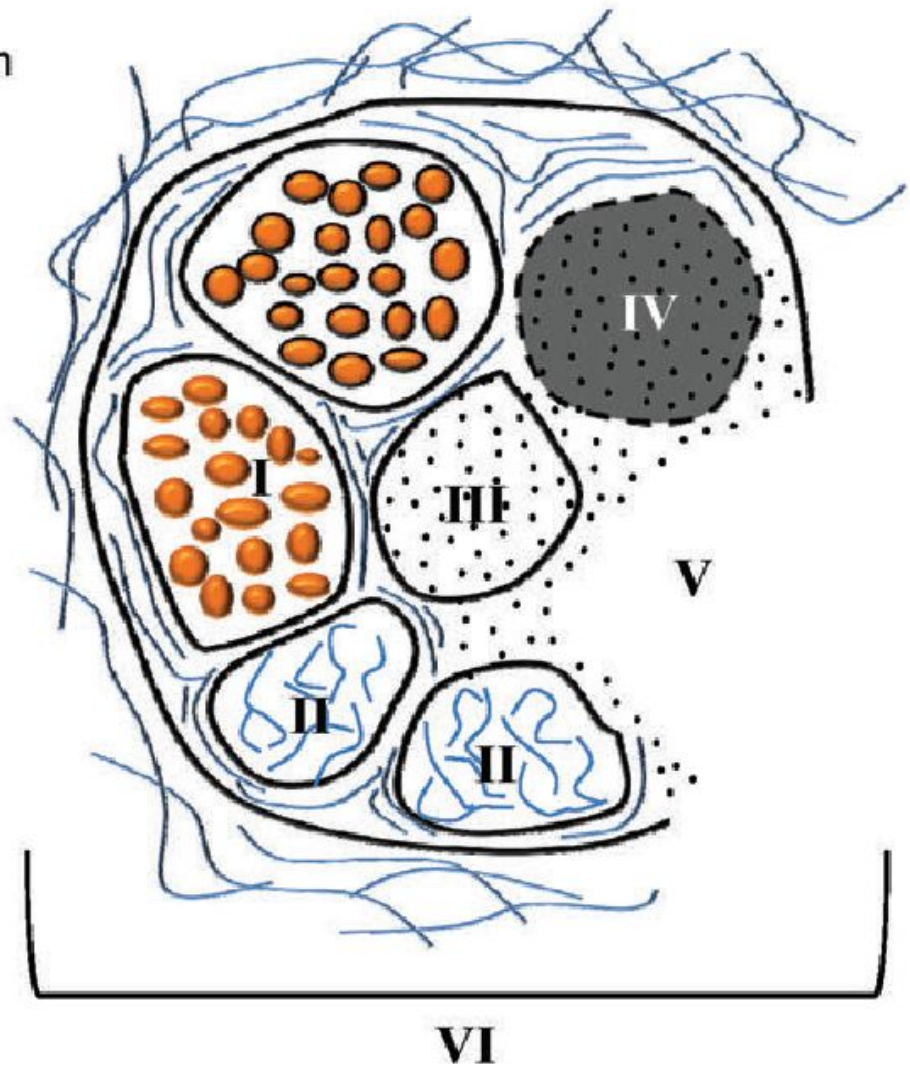
Классификация	Классификация	Патология	Восстановление
Нейропраксия	1	Блок проведения, лёгкое повреждение с чувствительными и двигательными нарушениями. Анатомически страдают миелиновые оболочки	Полное
Аксонотмезис	2	Разрушение аксонов и миелиновых оболочек. Эндоневрий интактный. ВД. Последующий рост аксонов вдоль интактных эндоневральных трубок.	Полное
Аксонотмезис	3	Повреждение эндоневрия, его рубцевание. Регенерация затруднена	Вариабельно, неполное.
Аксонотмезис	4	Повреждены аксоны, пери- и эндоневрий. Целостность поддерживается рубцовой тканью и эпиневрием	Вариабельно, неполное.
Нейротмезис	5	Полный перерыв нерва или значительная его дезорганизация рубцовой тканью	Отсутствует

Table 1.2 Classification of Nerve Injury

Degree of Injury	Histopathologic Changes					Tinel Sign	
	Myelin	Axon	Endoneurium	Perineurium	Epineurium	Present	Progresses Distally
I Neurapraxia	+ /-					-	-
II Axonotmesis	+	+				+	+
III	+	+	+			+	+
IV	+	+	+	+		+	-
V Neurotmesis	+	+	+	+	+	+	-
VI	Various fibers and fascicles demonstrate various pathologic changes					+	+ /-

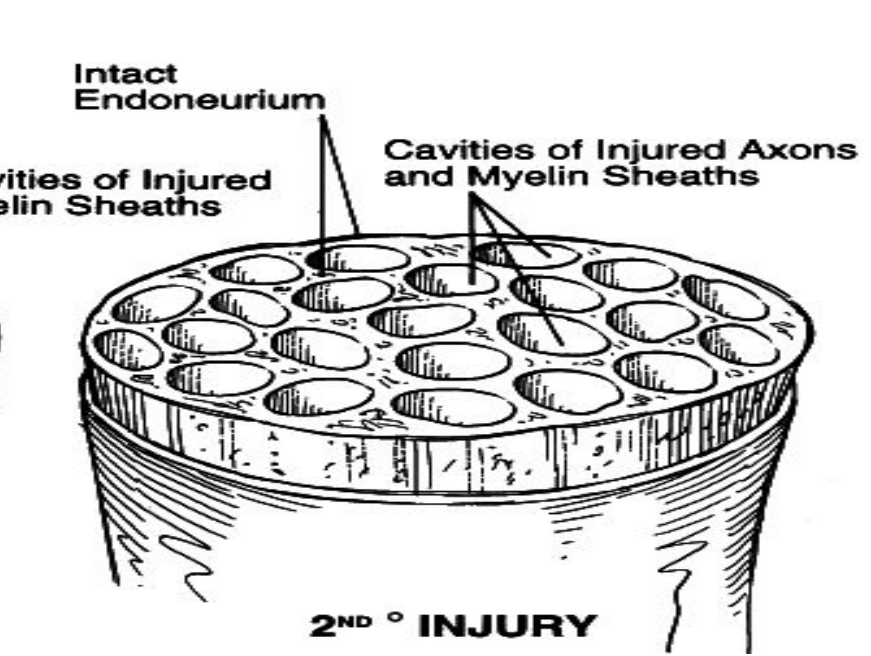
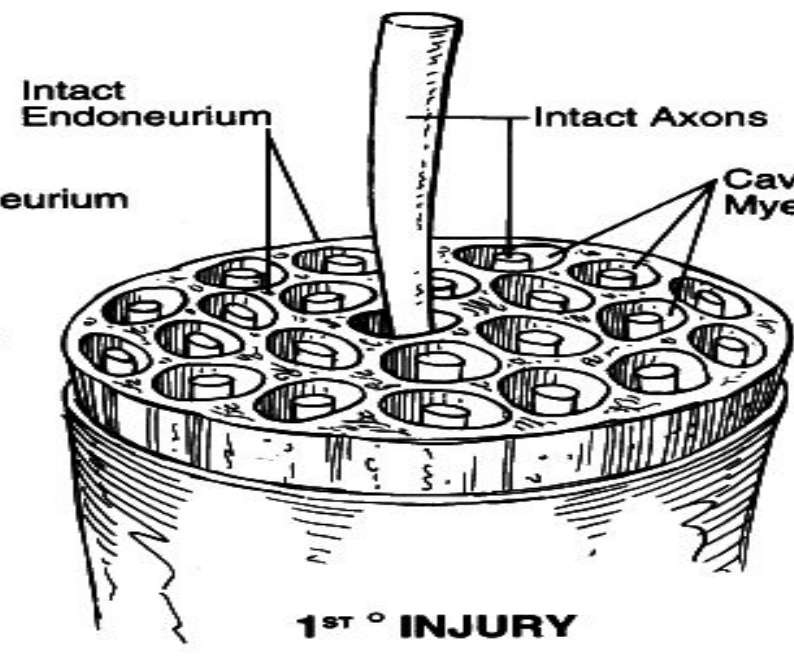
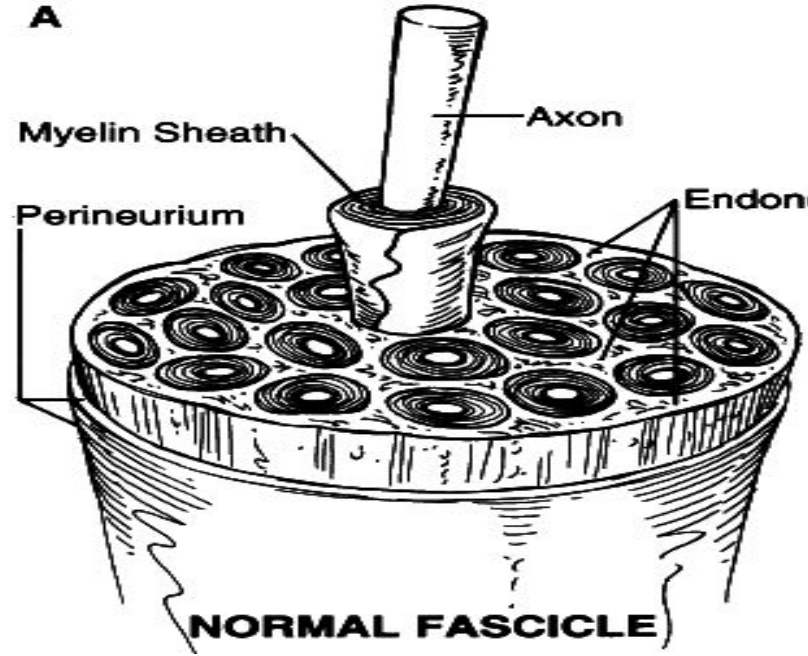


a Normal Nerve



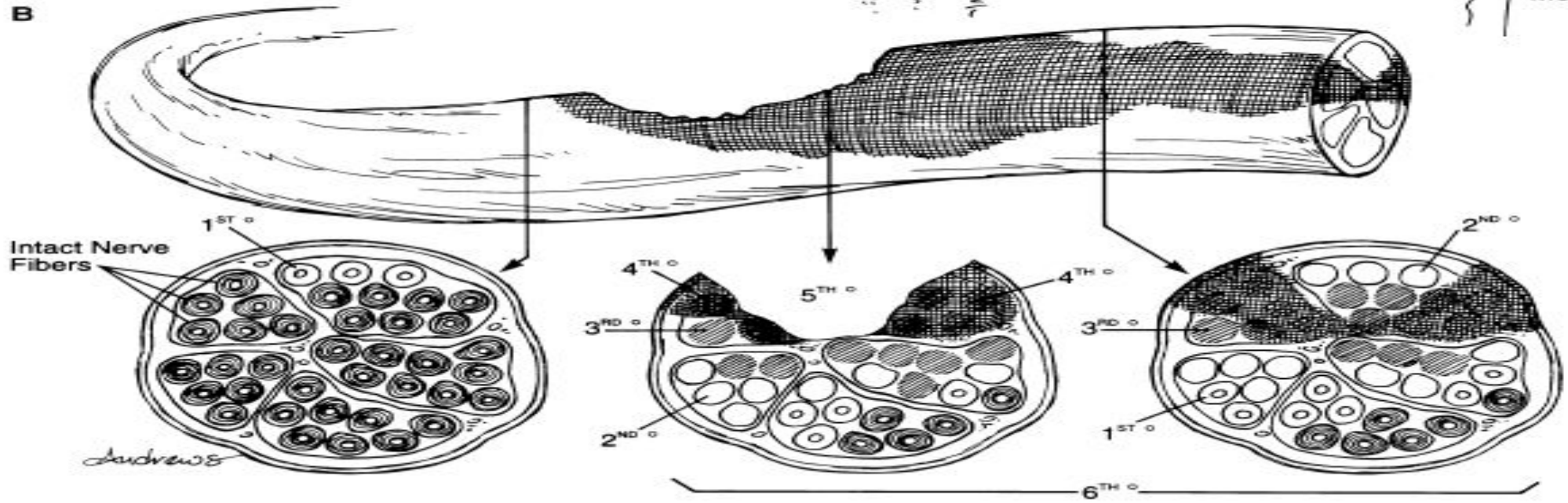
b Classification of Nerve Injury

A





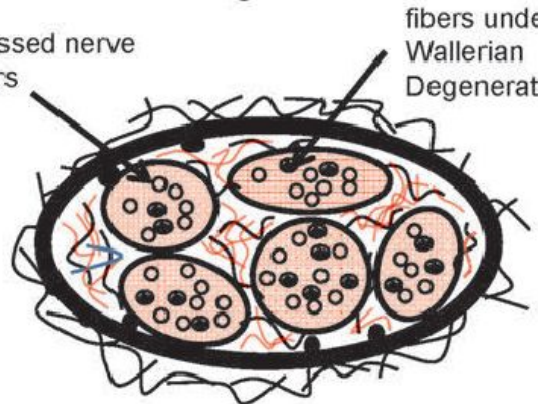
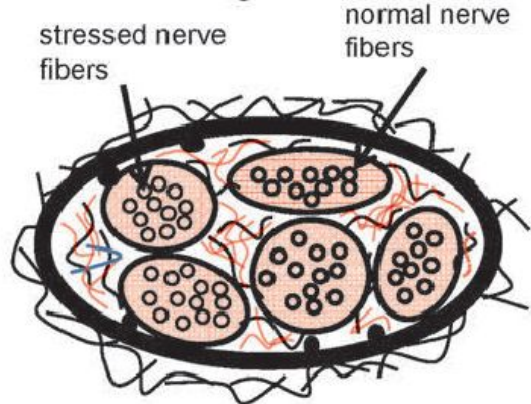
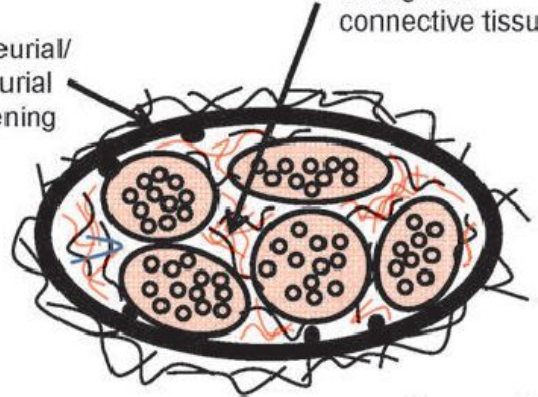
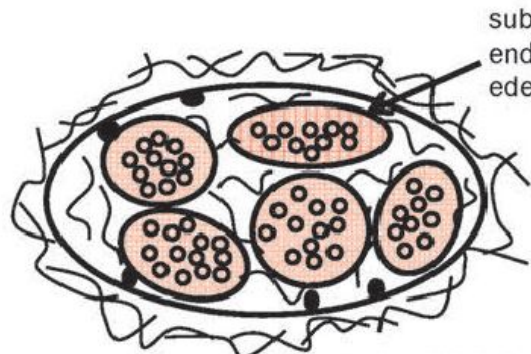
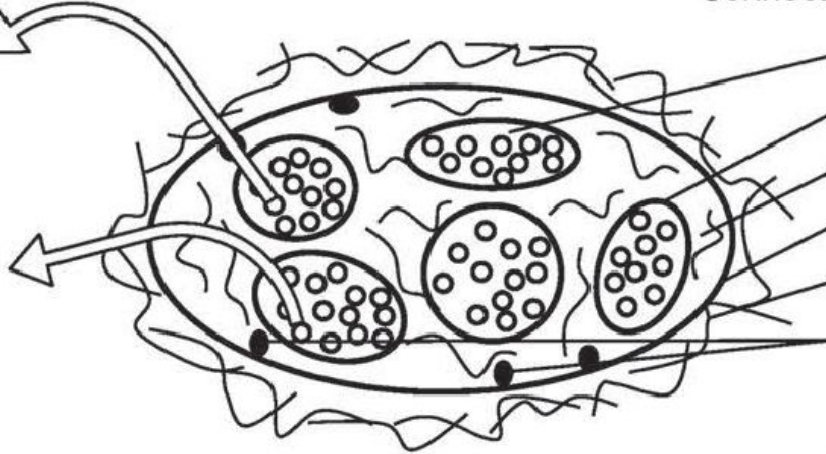
B

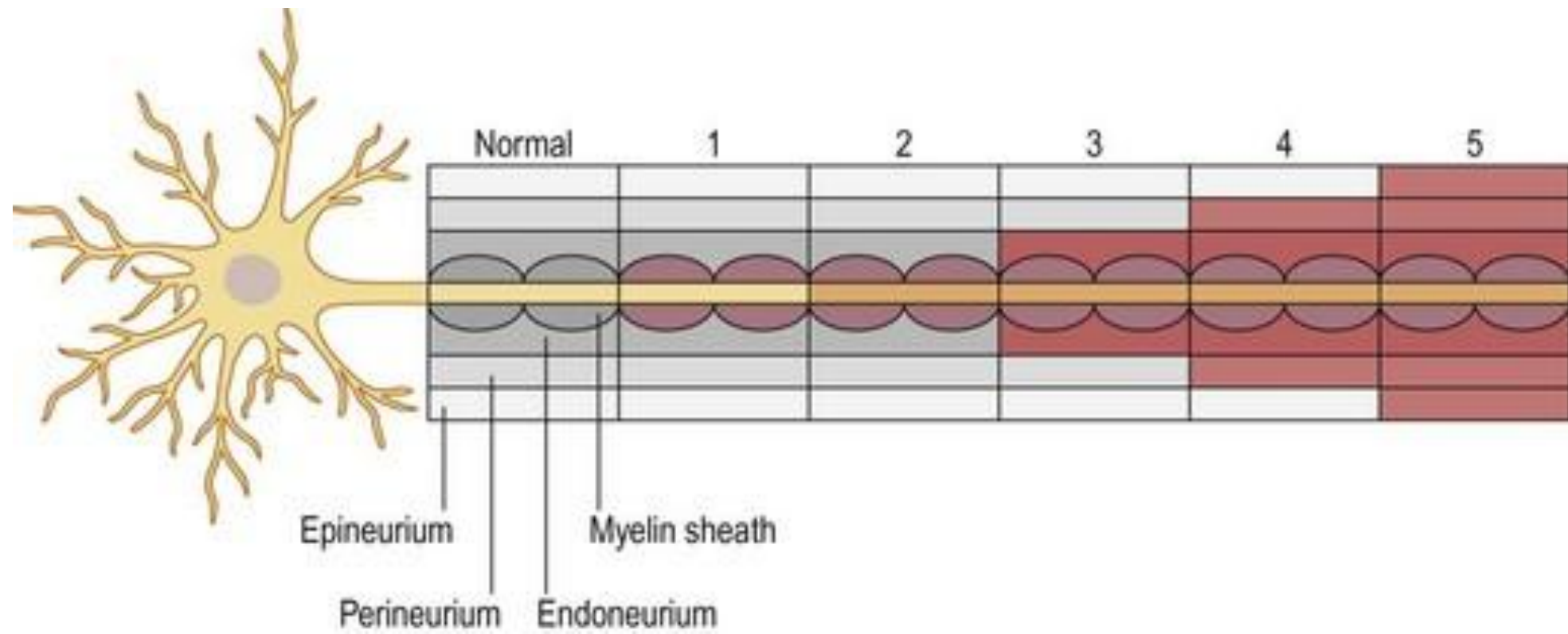


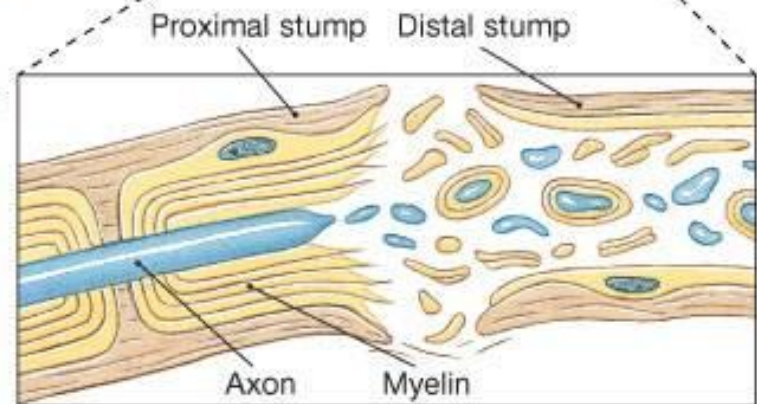
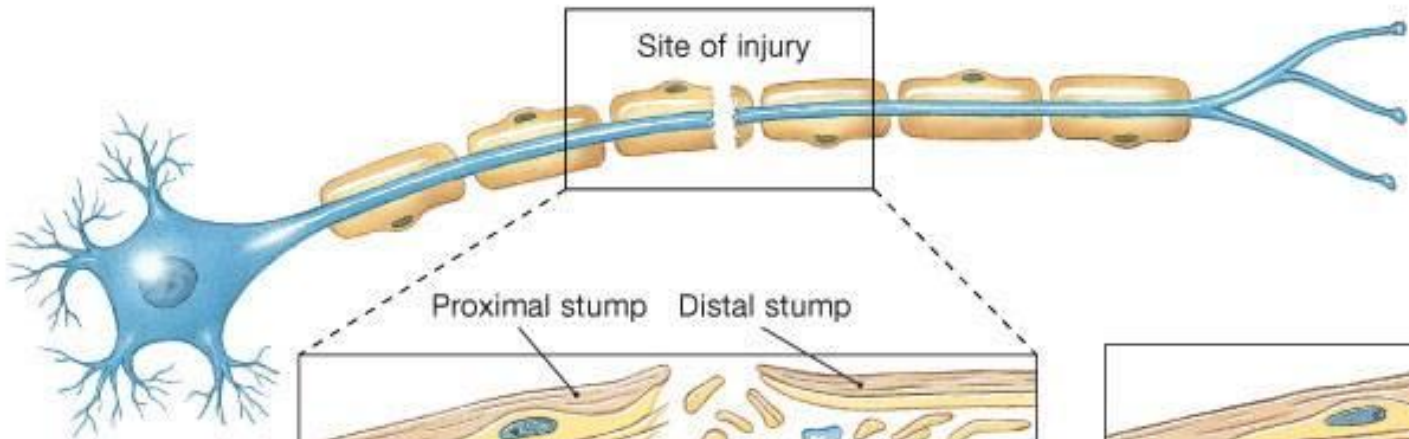
Normal Nerve

Neural Components

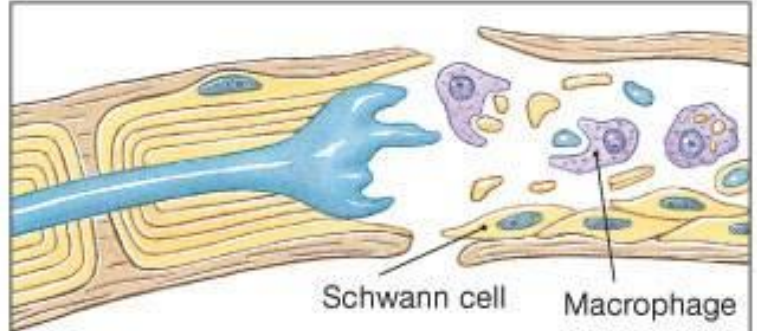
Connective Tissue Components





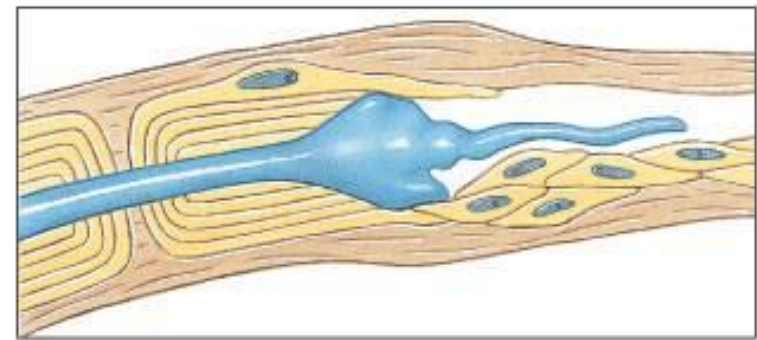


STEP 1:
Fragmentation of axon and myelin occurs in distal stump.

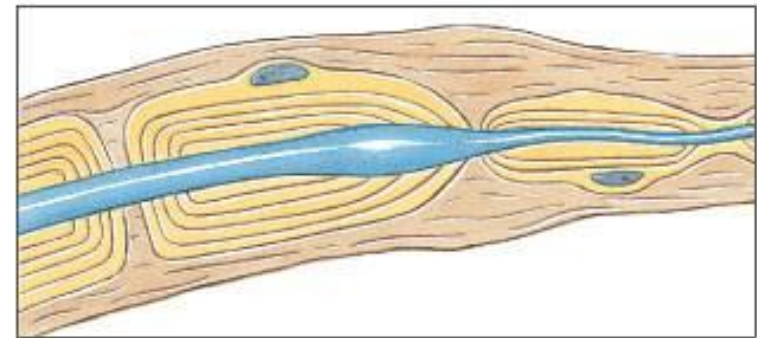


STEP 2:
Schwann cells form cord, grow into cut, and unite stumps. Macrophages engulf degenerated axon and myelin.

To Step 3



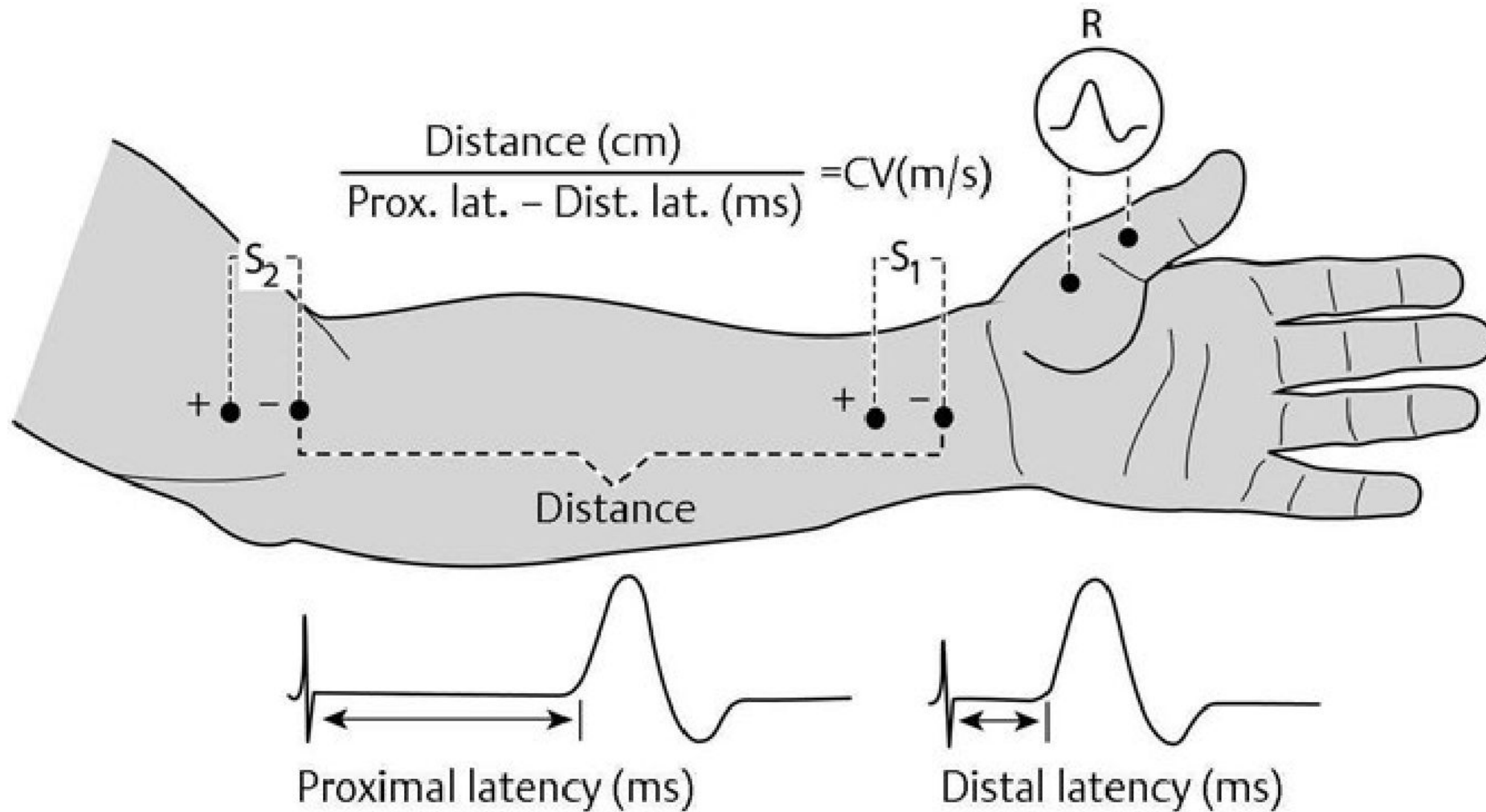
STEP 3:
Axon sends buds into network of Schwann cells and then starts growing along cord of Schwann cells.

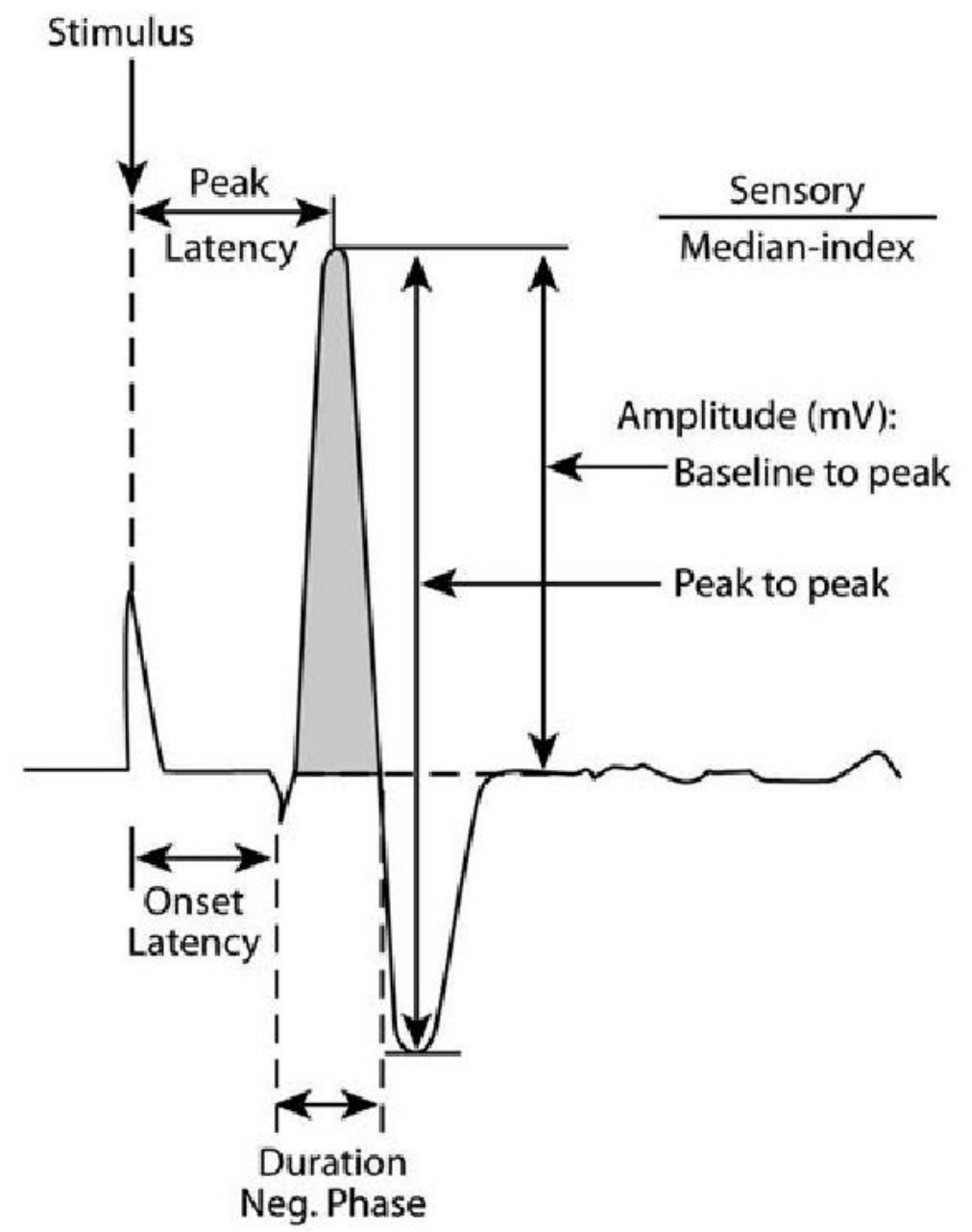
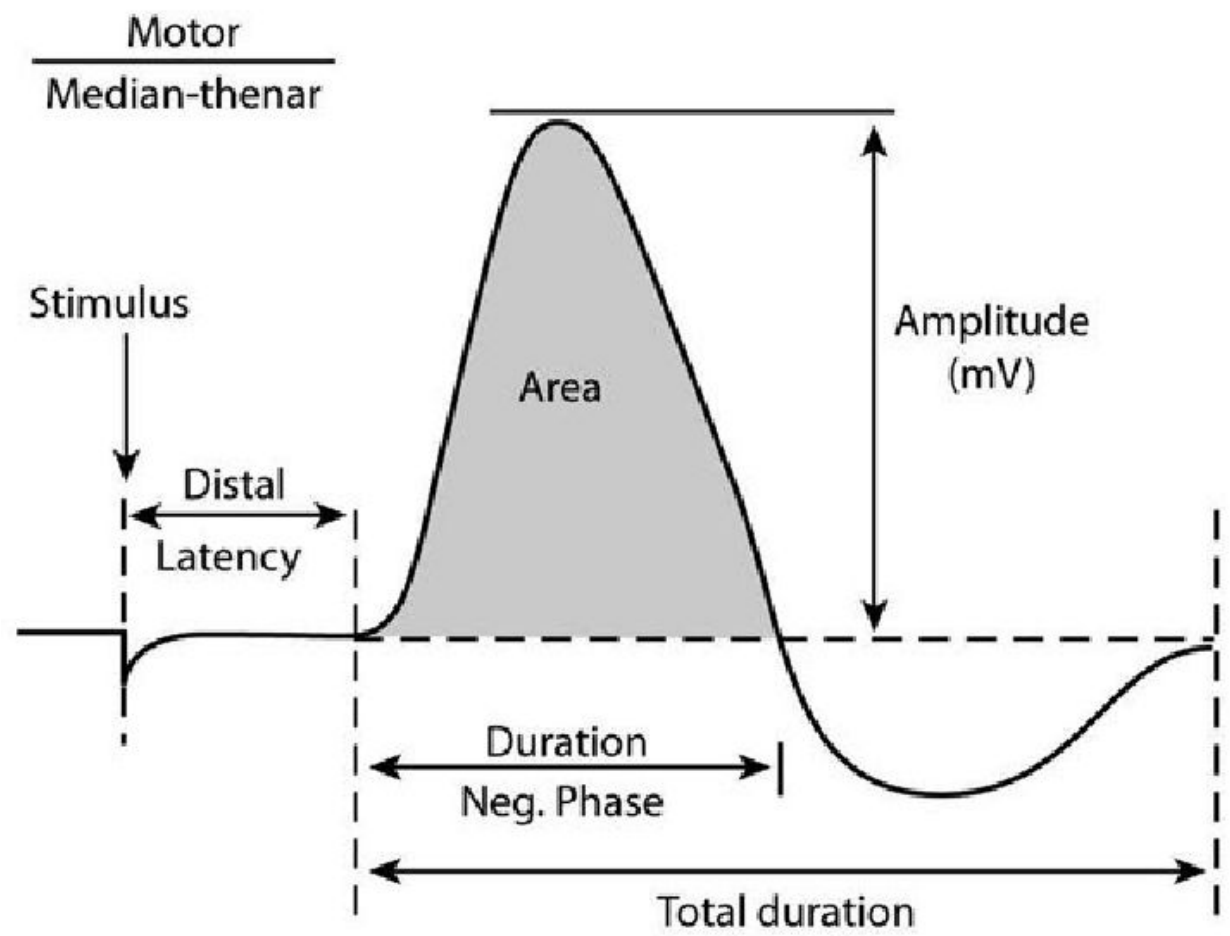


STEP 4:
Axon continues to grow into distal stump and is ensheathed by Schwann cells.

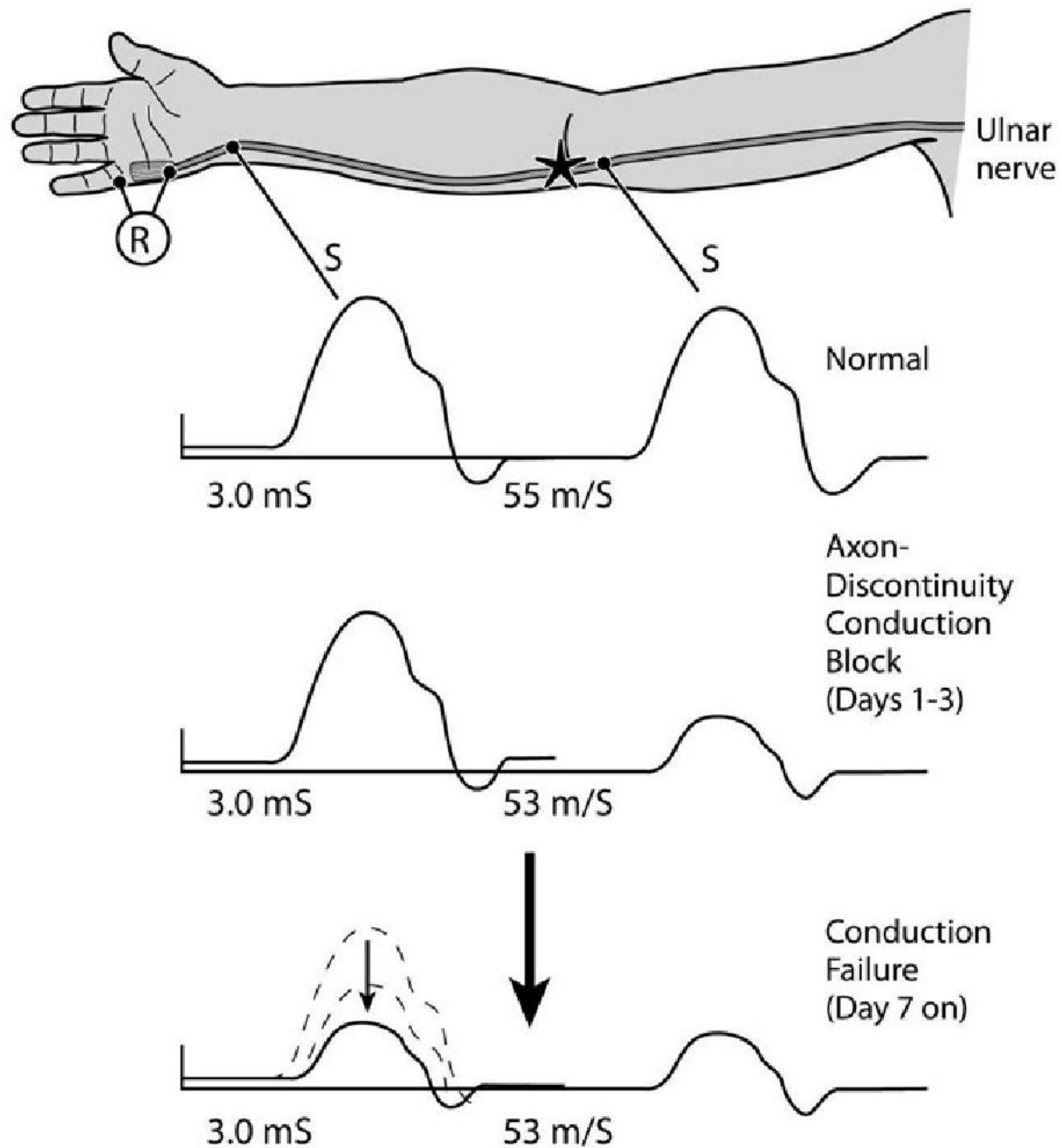
Принципы хирургического лечения:

- 1. Количественная до- и послеоперационная оценка чувствительности и двигательной функции**
- 2. Микрохирургия**
- 3. Отсутствие натяжения**
- 4. Если без натяжения невозможно – устанавливают межпучковый трансплантат**
- 5. Нейтральное положение конечности**
- 6. Сопоставление групп пучков нервных волокон**
- 7. Послеоперационный курс реабилитации**

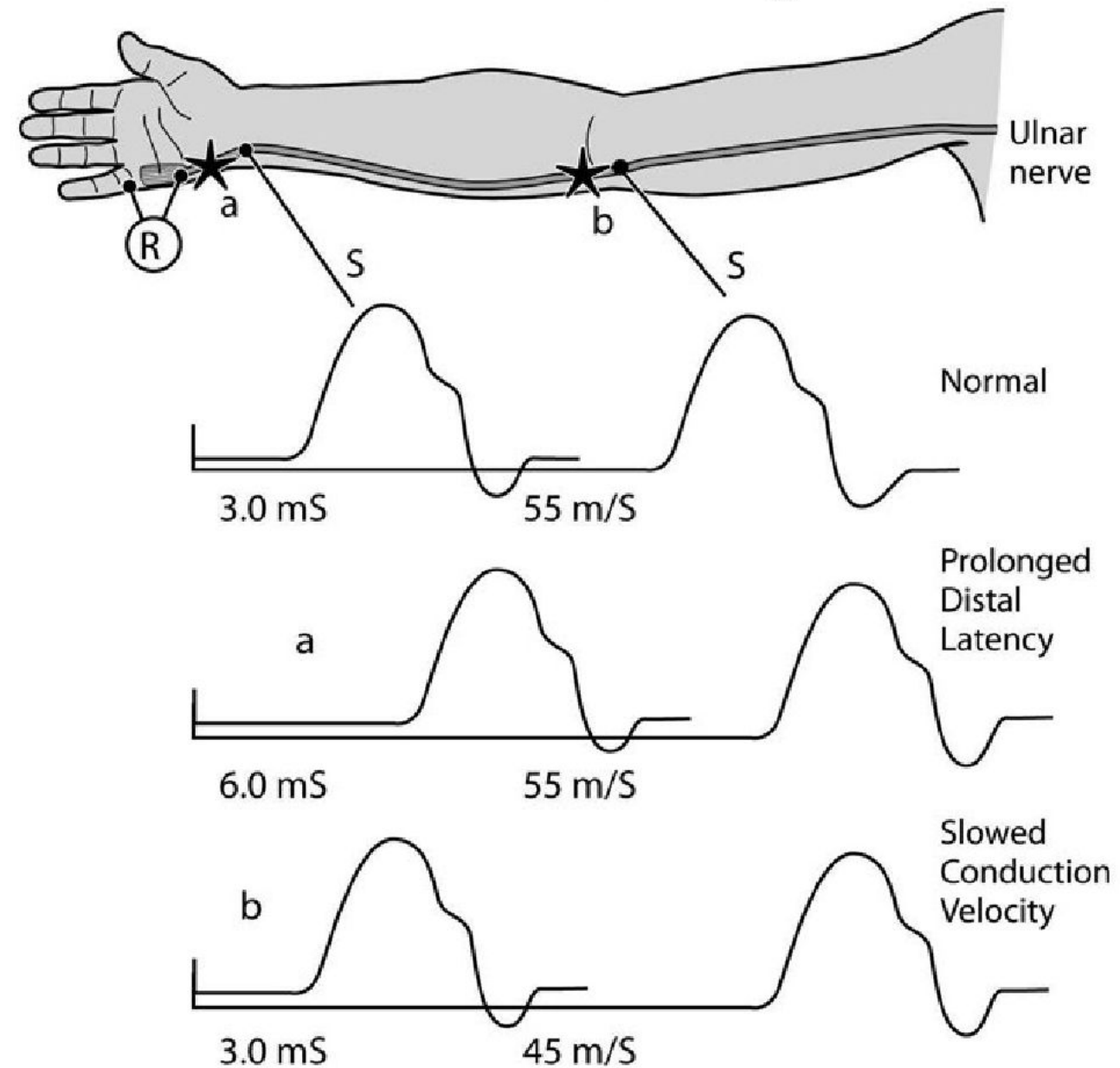




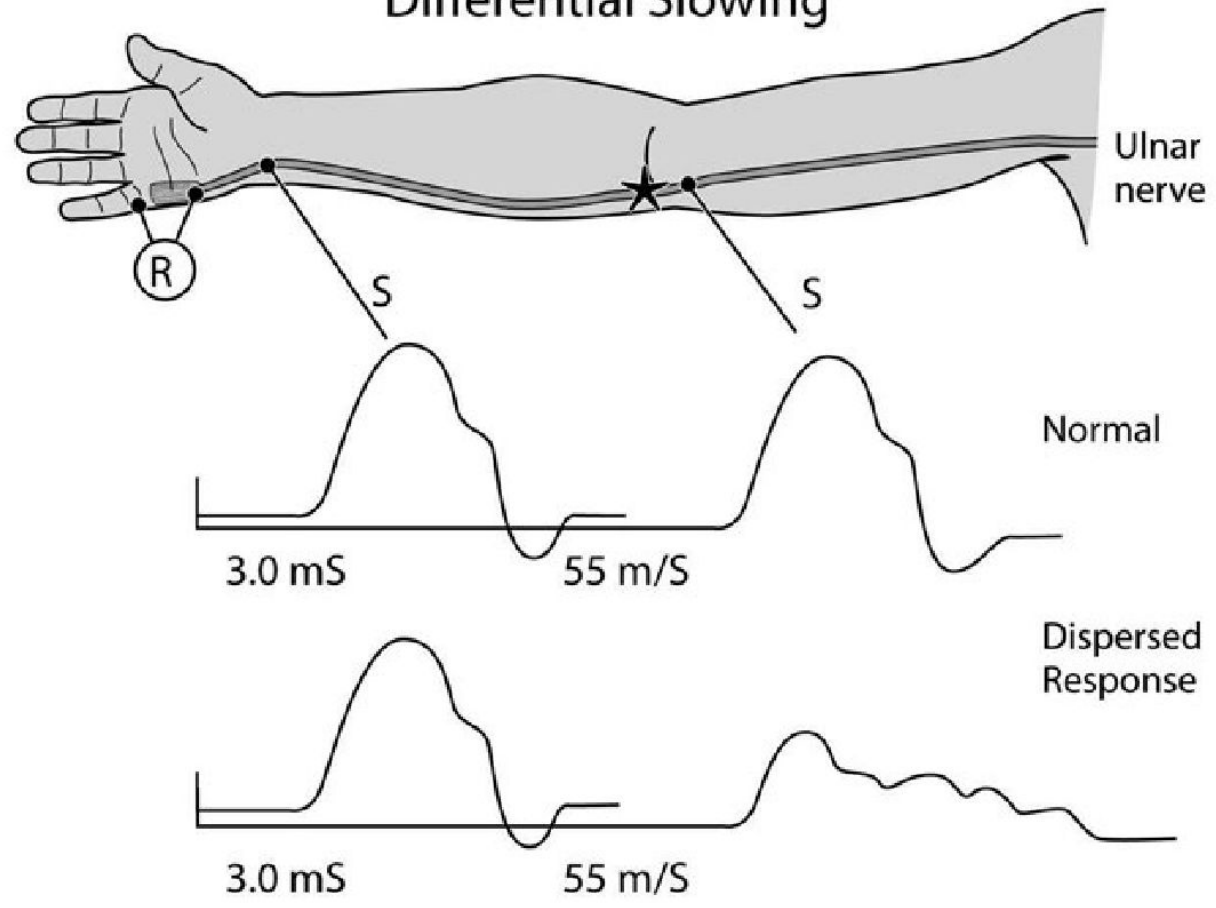
Axon Loss/Conduction Failure



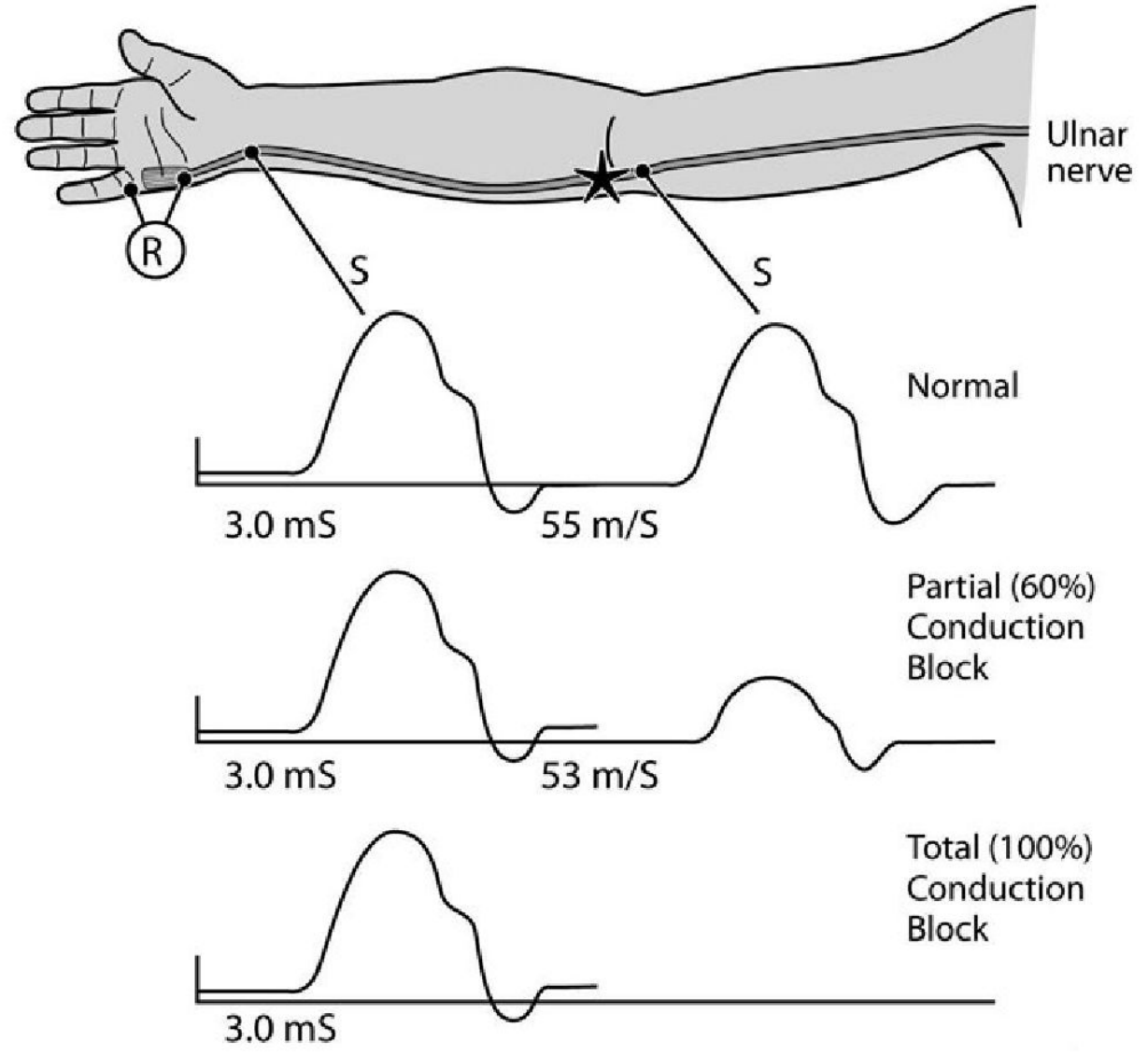
Demyelinating Focal Conduction Slowing

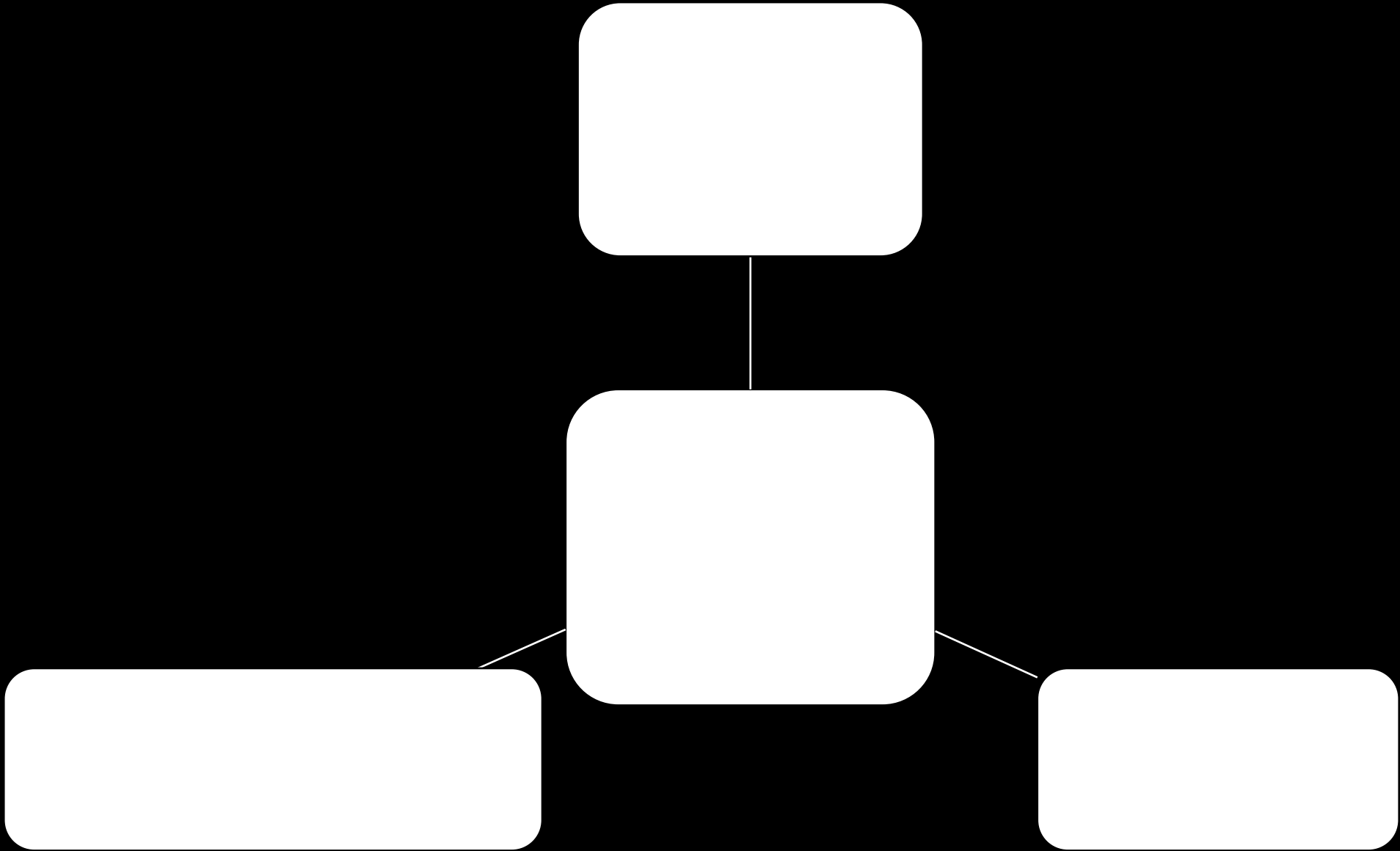


Demyelinating Differential Slowing



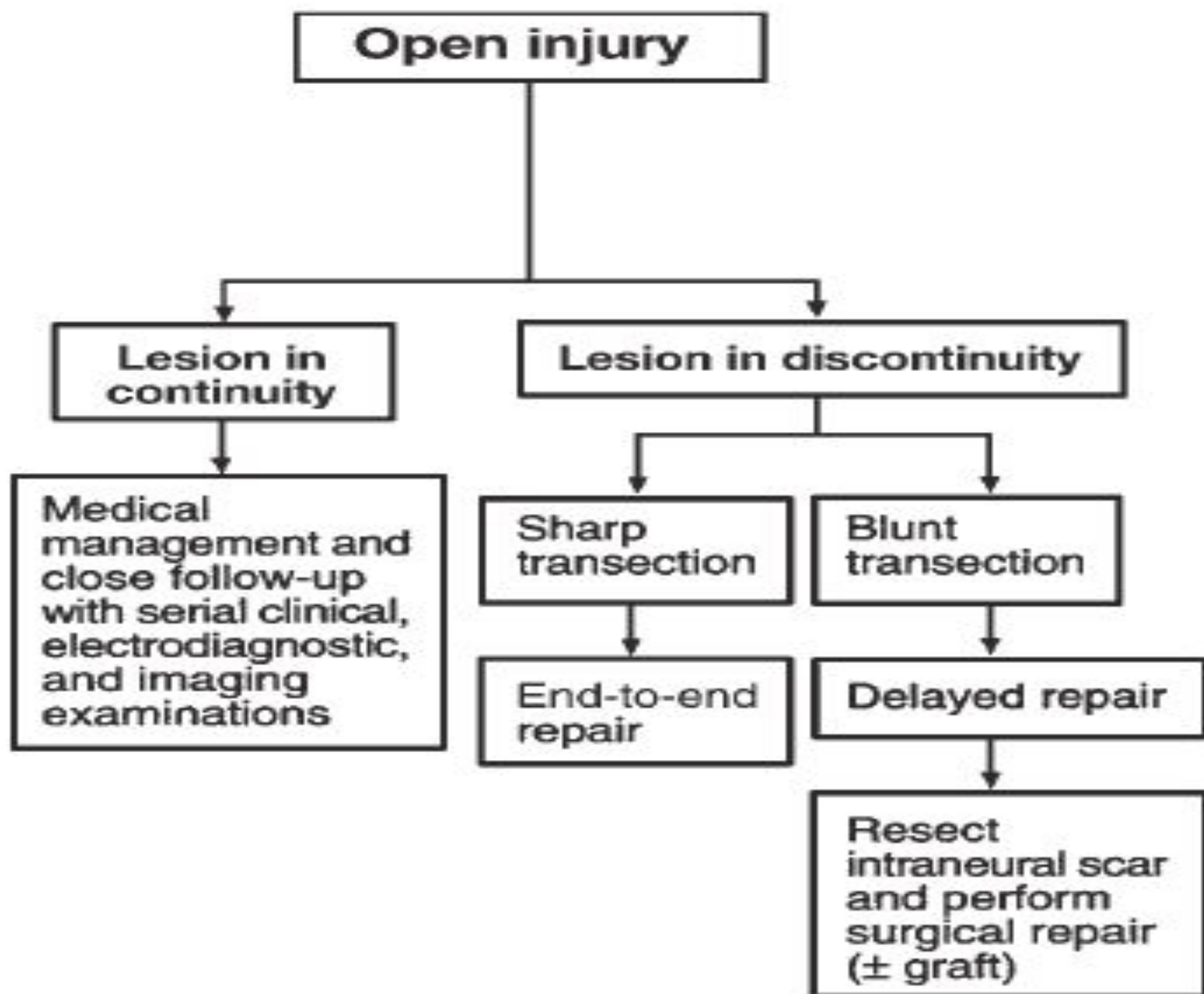
Demyelinating Conduction Block

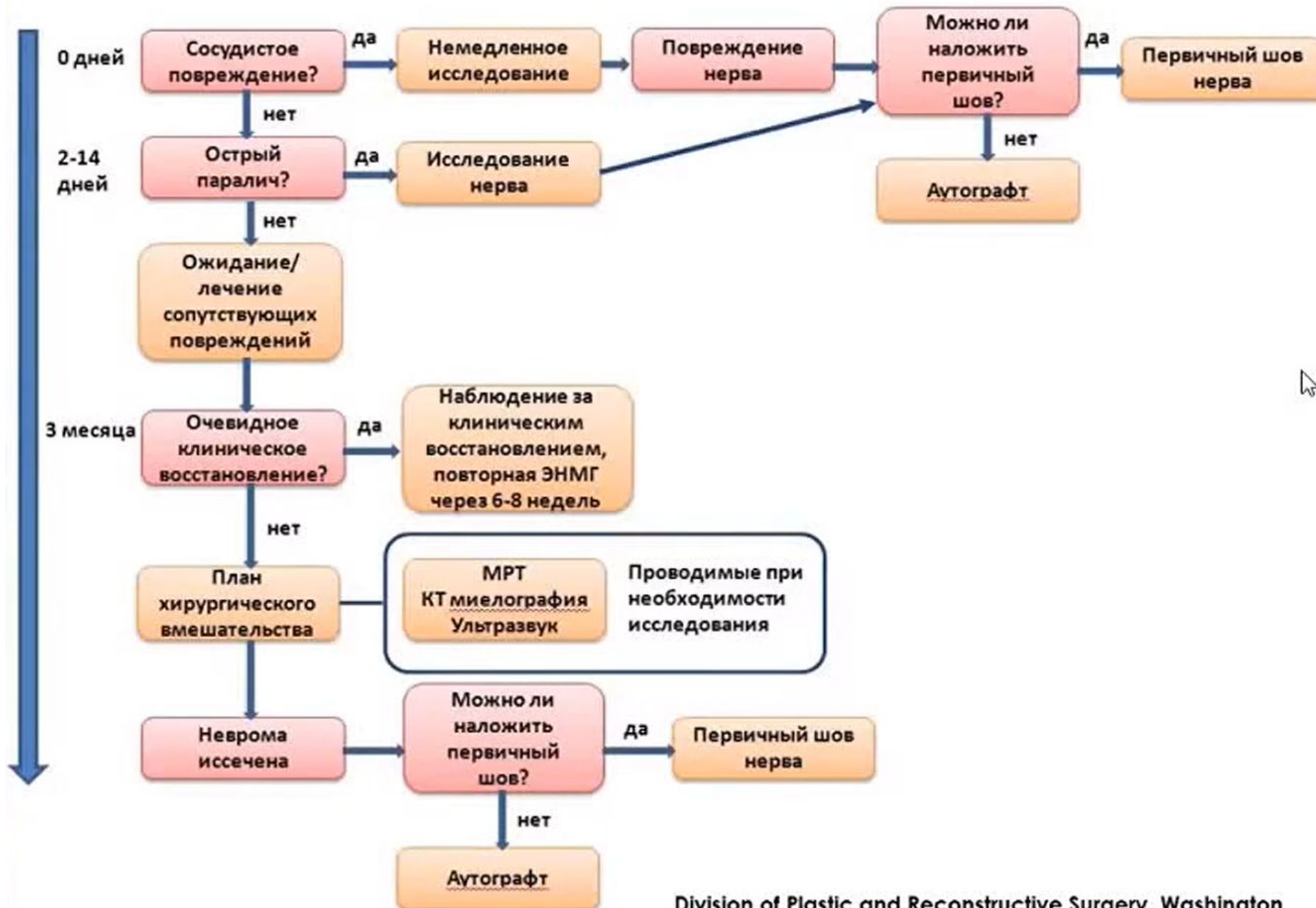




Сроки сопоставления нерва при утрате им непрерывности:

- **Первичный шов нерва: до 72 часов ?**
- **Первично-отсроченный шов нерва: 72 часа – 7 суток**
- **Вторичный шов нерва: после 7 суток.**





Strategies for Nerve Reconstruction

Experimental Neurology

Management of nerve gaps: Autografts, allografts, nerve transfers, and end-to-side neurotomy

William Z. Ray¹, Susan L. Mackinnon^{1*}

¹Department of Neurology, Brigham Young University School of Medicine, 400 West Main Street, Provo, Utah 84602, USA

*Correspondence: Susan L. Mackinnon, smackinn@byu.edu

Category	Characteristics
Nerve Repair	• ease of graft • tangibility
Nerve Grafting	• allow flexibility • anastomosis
Nerve Allografts	• anastomosis/innervation
Conduits	• length limitation <math>< 30\text{cm}</math> • no autografts
Acellularized Allografts	• length limitation <math>< 30\text{cm}</math> • no autografts
Nerve Transfers	• tangibility • anastomosis/innervation
End-to-side Nerve Transfers	• primary axonal sprouting • motor input to sensory
Supercharge Nerve Transfers	• anastomosis/innervation

Nerve Repair

Nerve Grafting

Nerve Allograft

Conduit and Acellularized Allograft

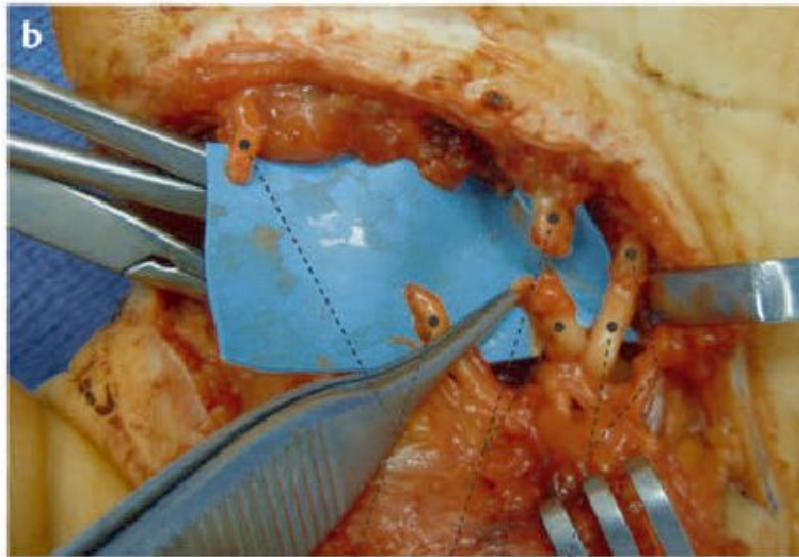
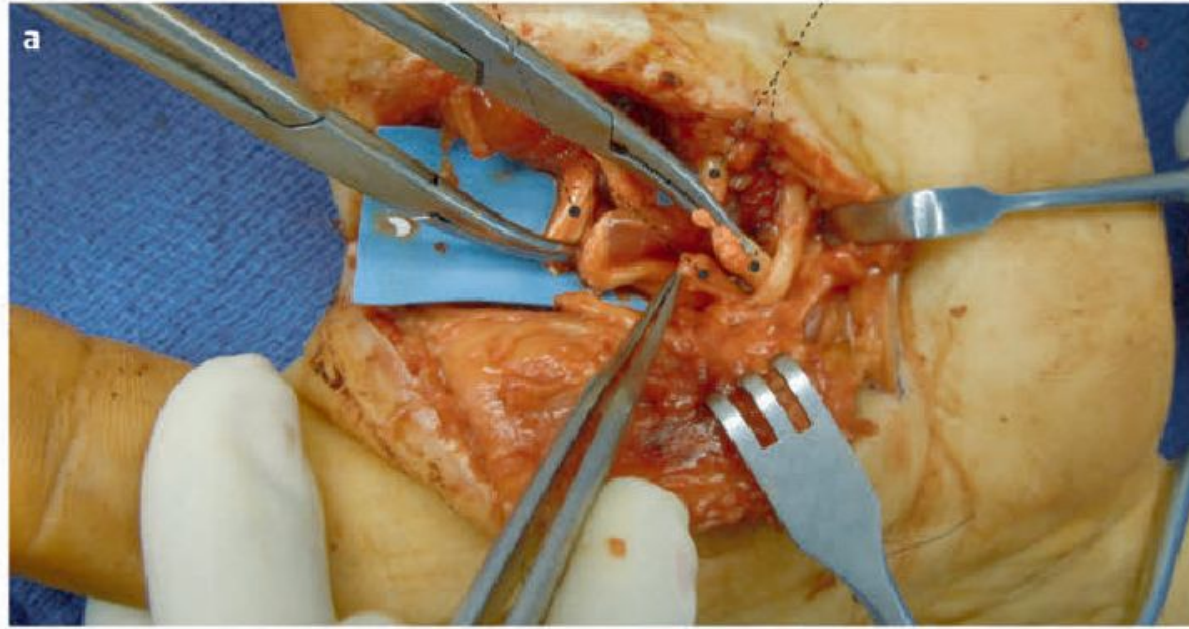
Nerve Transfers



Conduits < Allografts ≤ Grafts

(M) tendon of index flexor digitorum superficialis

(M) tendon of index flexor digitorum profundus



(N) proper digital branch of median to radial index

(N) common digital branch of median to 2nd webspace

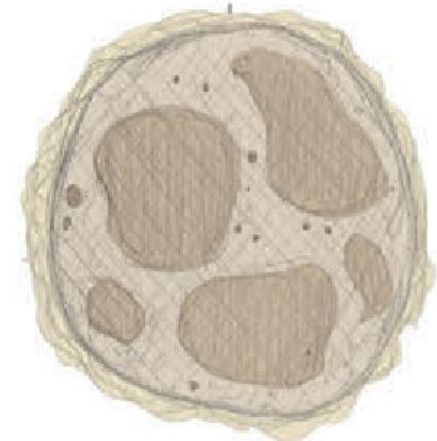
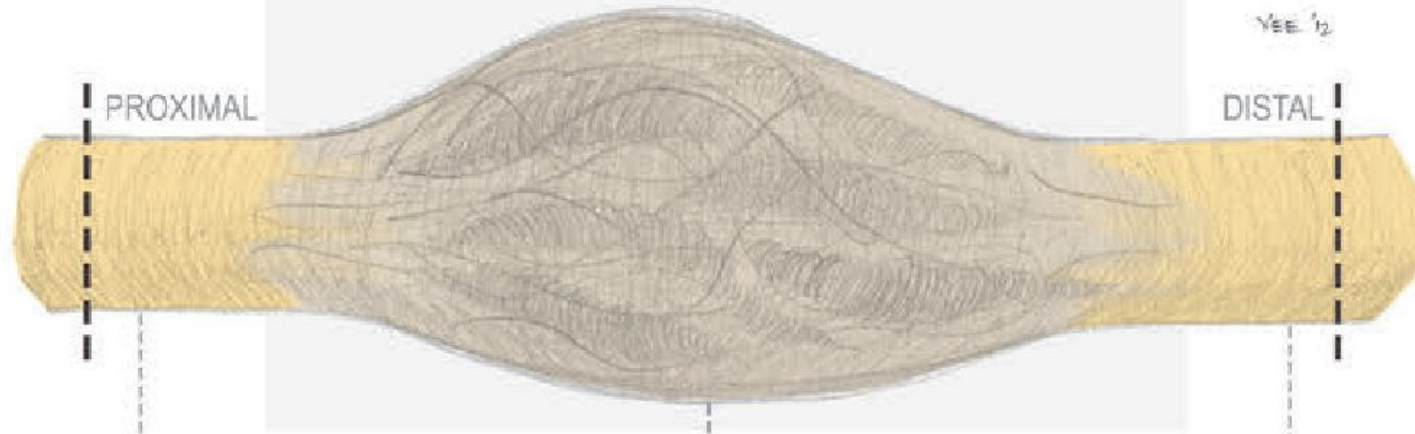
(N) common digital branch of median to 3rd webspace

(N) proper digital branch of median to radial index

(N) common digital branch of median to 2nd webspace

(N) common digital branch of median to 3rd webspace

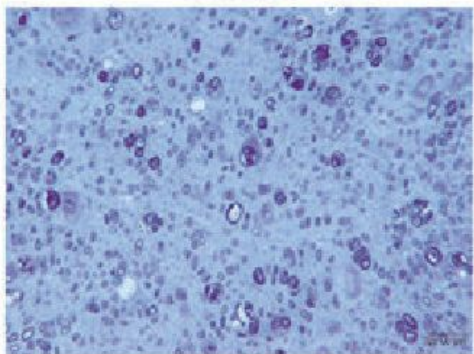
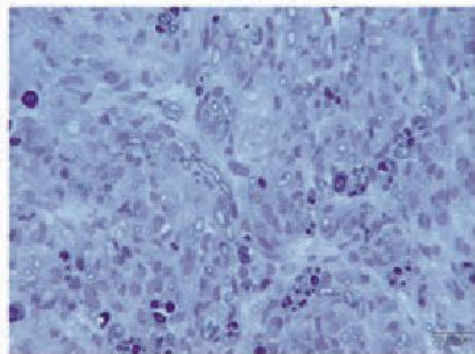
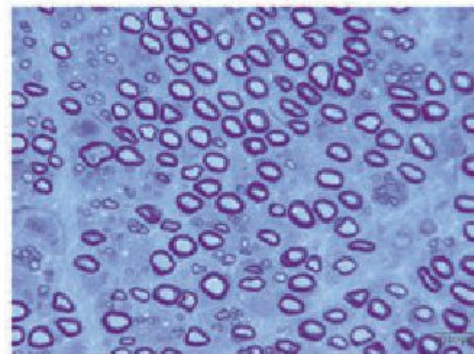
Zone of Injury



PROXIMAL

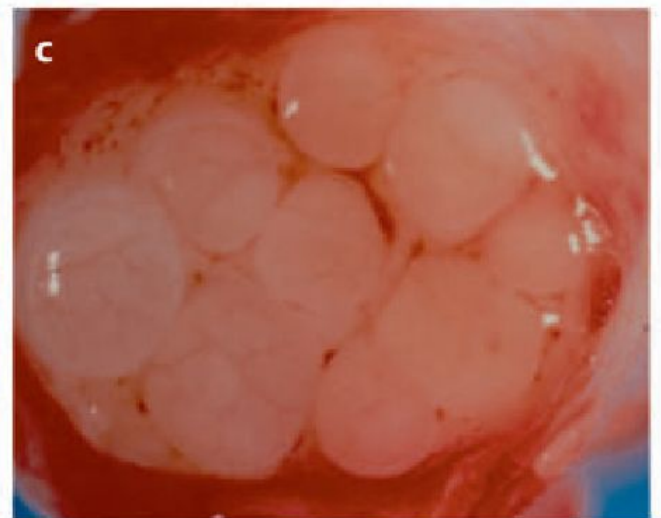
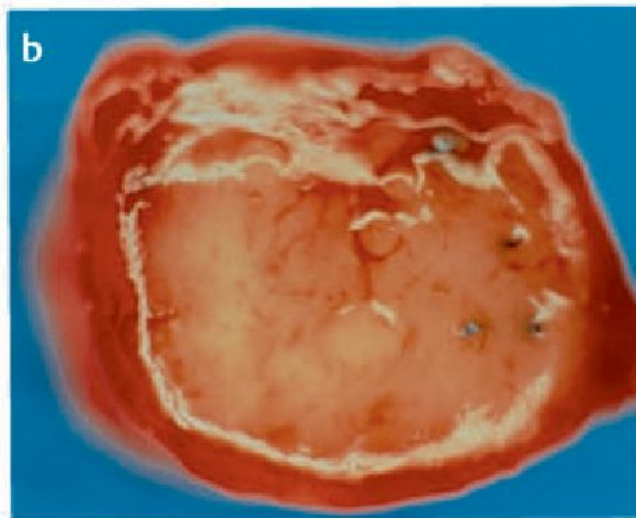
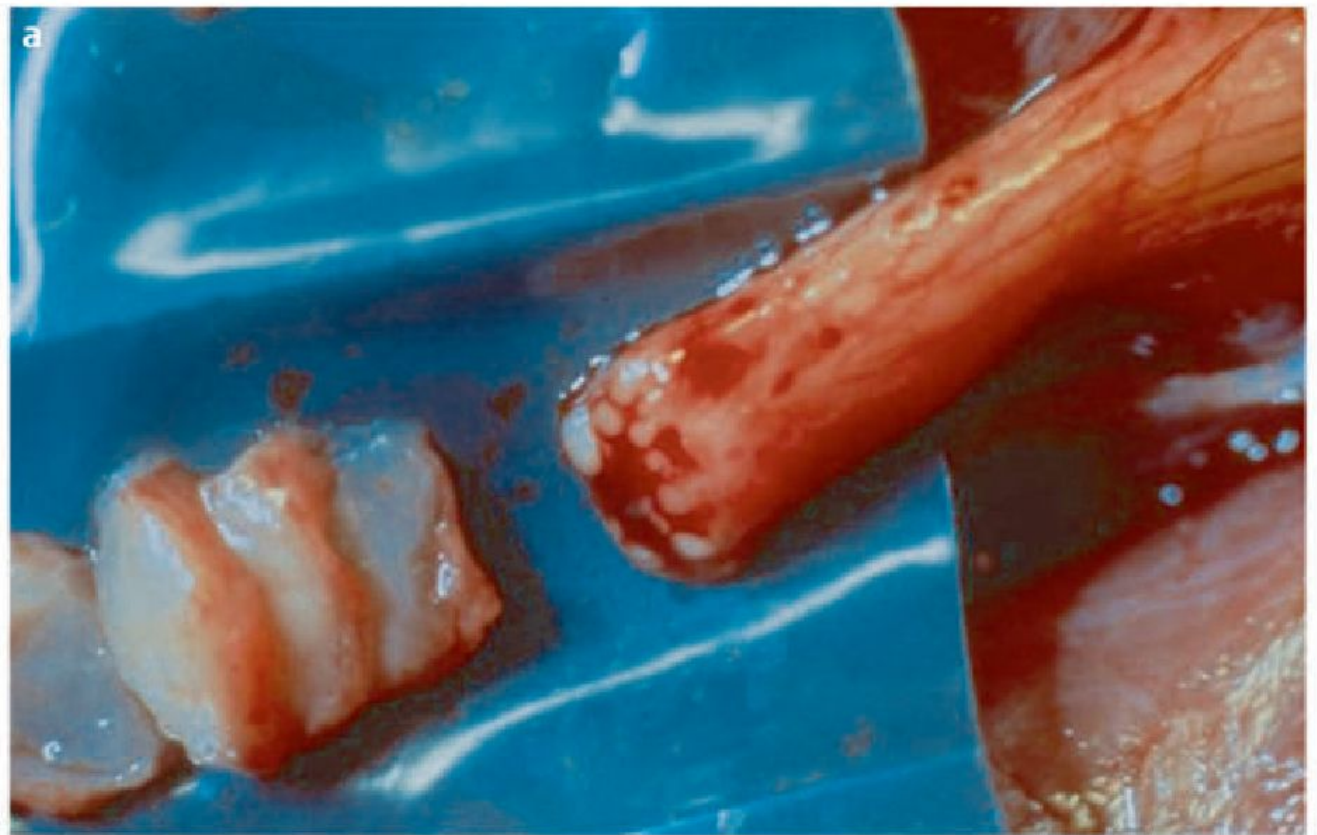
NEUROMA

DISTAL

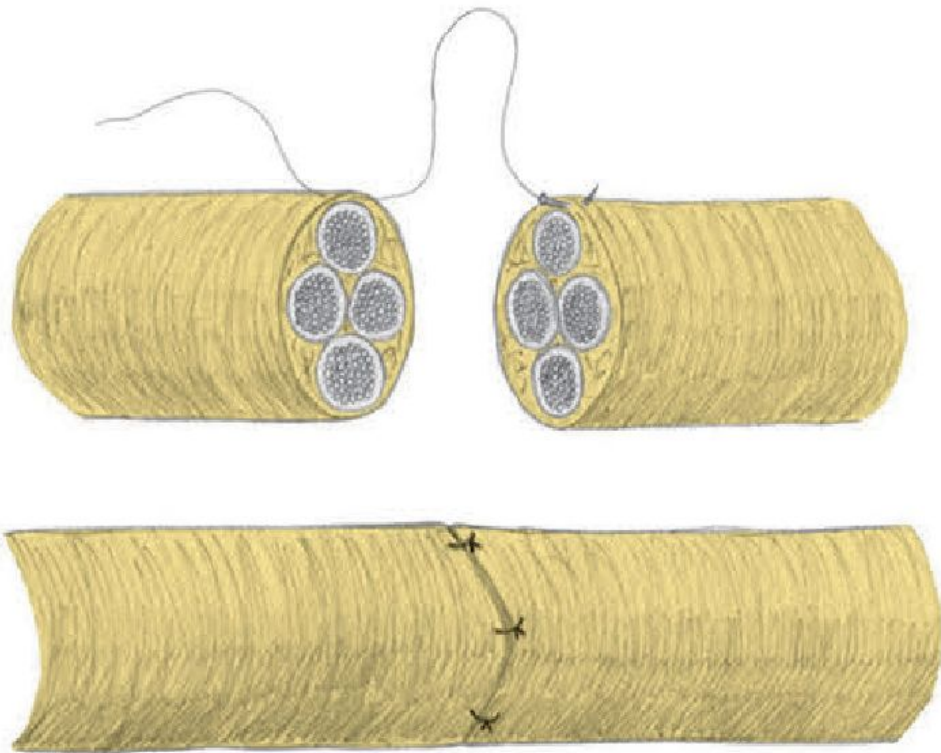


**Как узнать, что
дошли до живого
нерва?**

- 1) Красивые чёткие пучки**
- 2) Кровотечение**

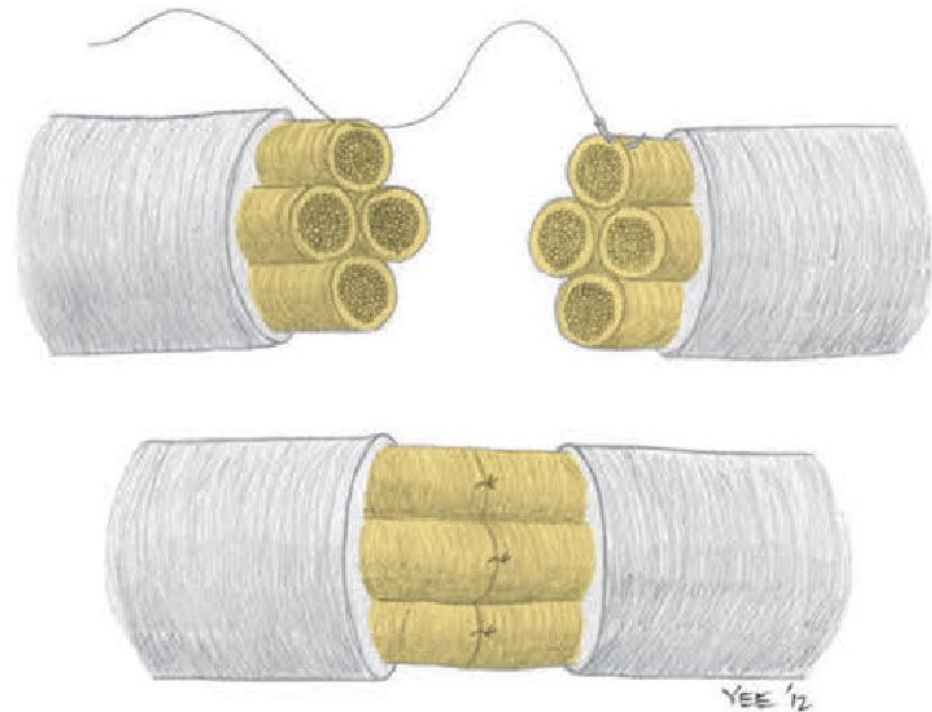


a Epineurial Nerve Repair



Эпиневральный шов

b Fascicular Nerve Repair



Периневральный шов

Можно так

- **Эпиневральный**
- **Периневральный**
- **Эпипериневральный**
- **Межпучковый**
- **Внутрипучковый**

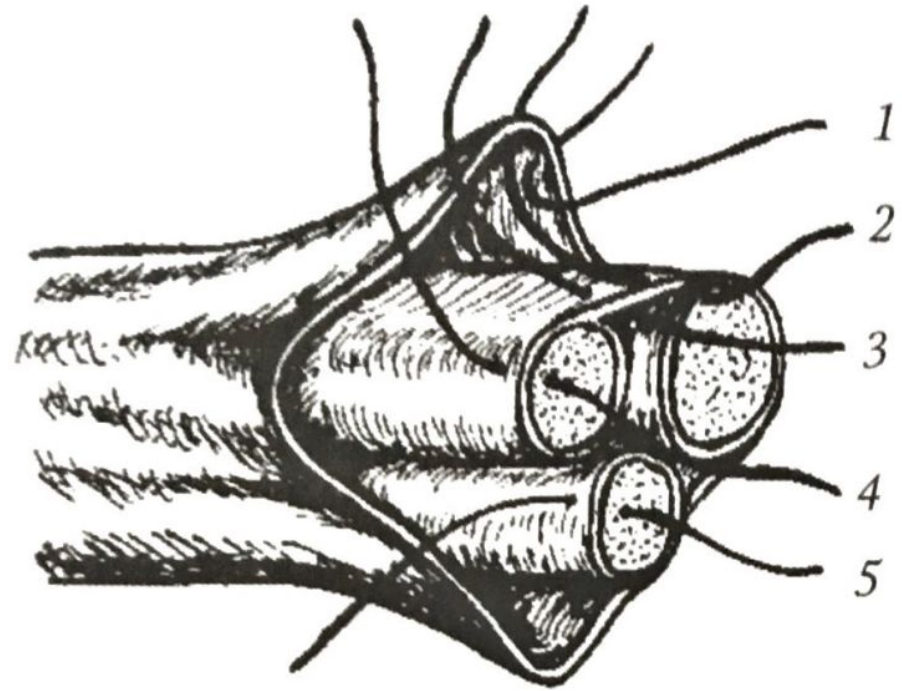
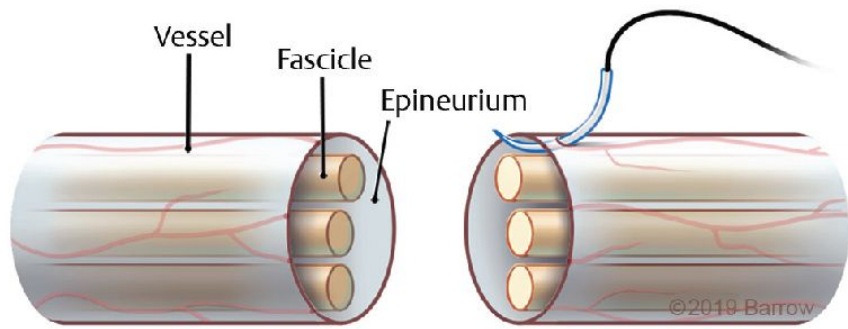
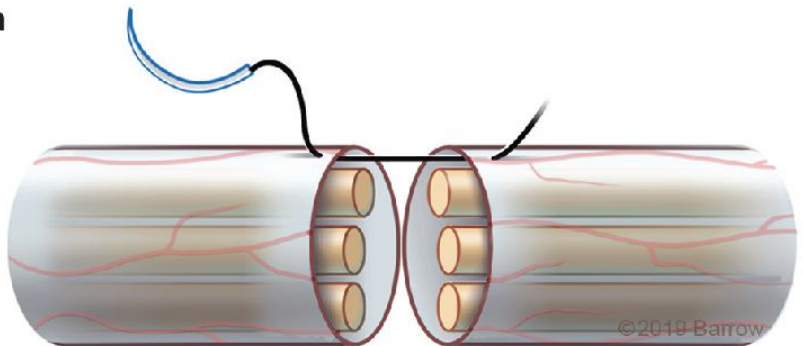


Рис. 58. Виды микрохирургических швов в зависимости от расположения шовной нити:

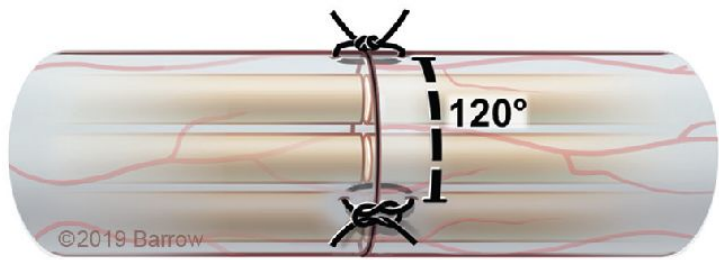
1 — эпиневральный; 2 — эпипериневральный; 3 — межпучковый; 4 — периневральный; 5 — интраневральный (по: Белоусов А. Е., 1984)



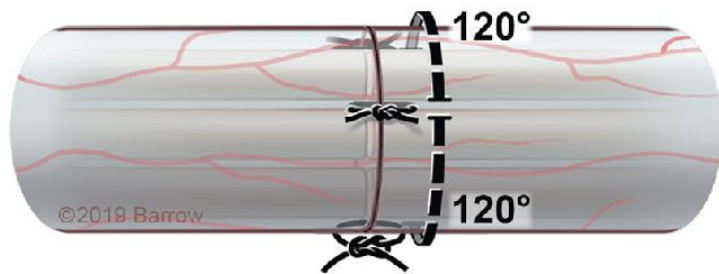
a



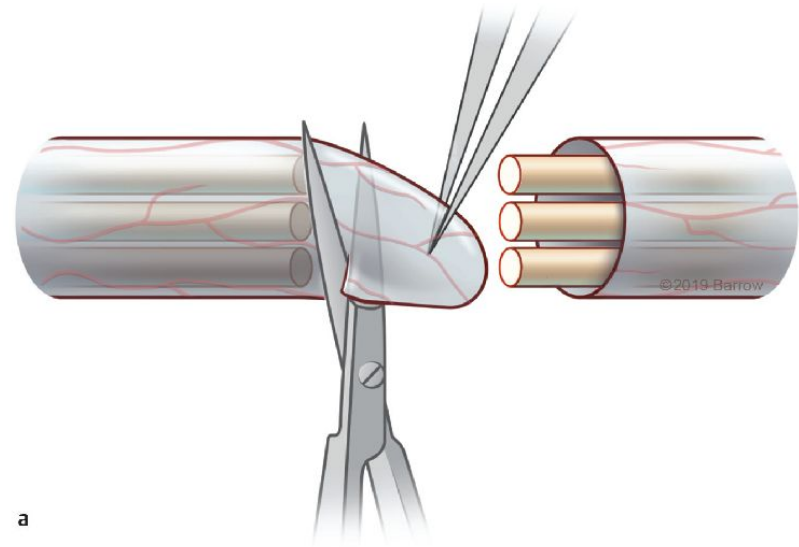
b



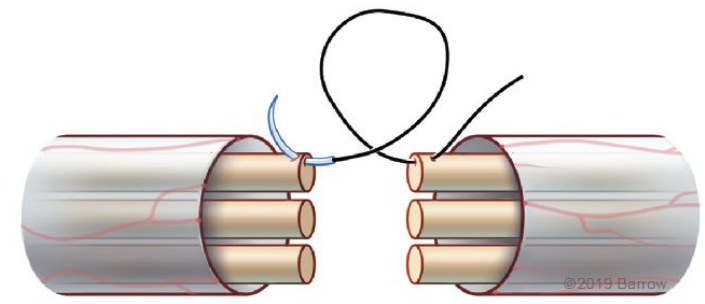
c



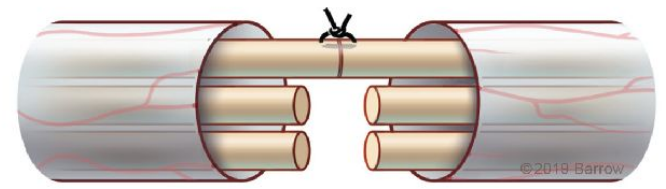
d



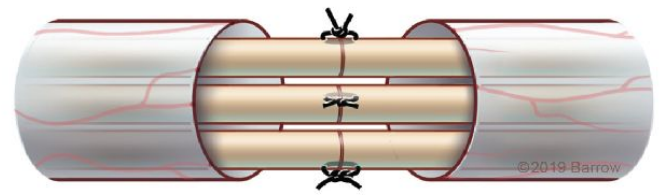
a



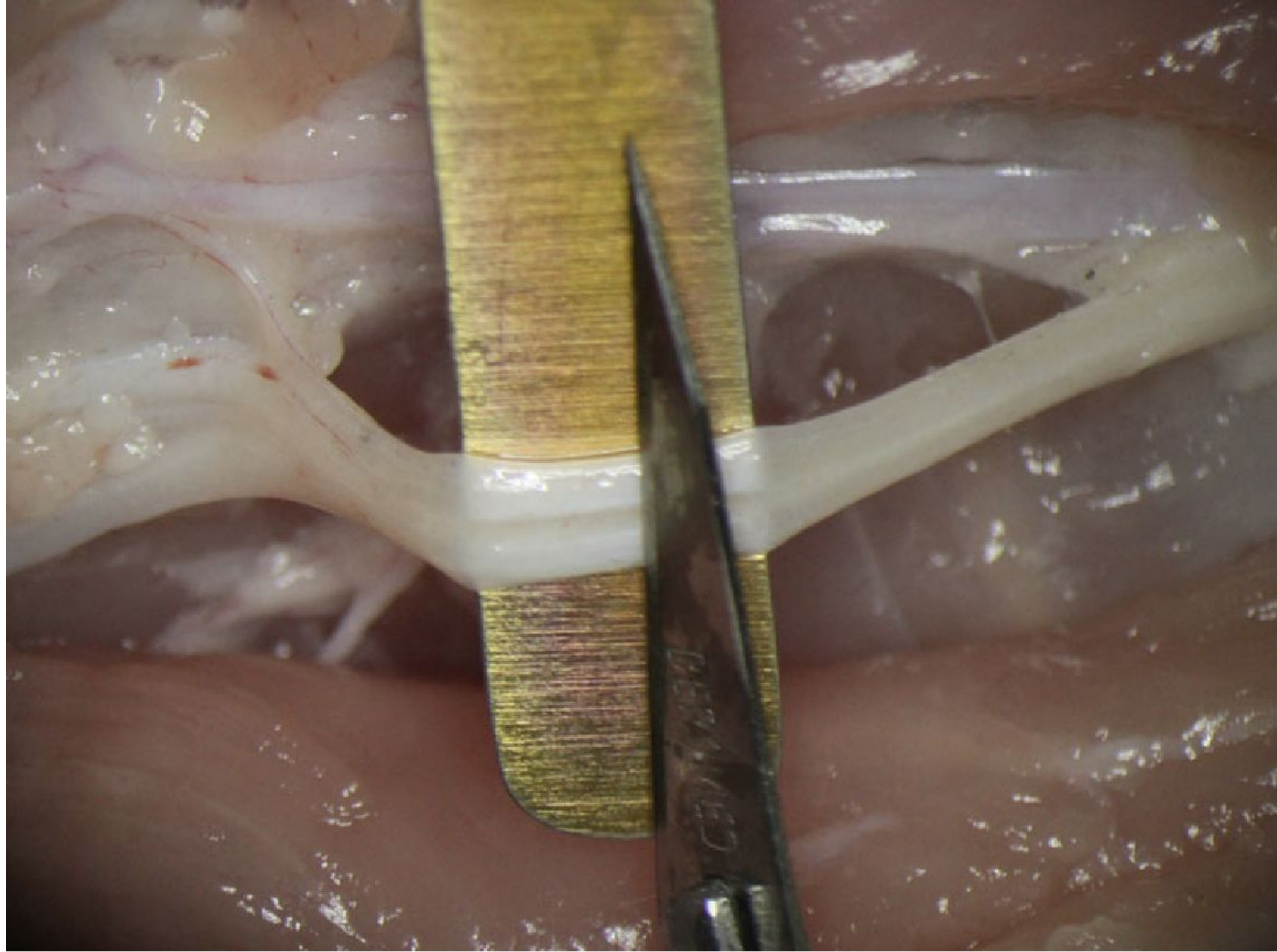
b



c

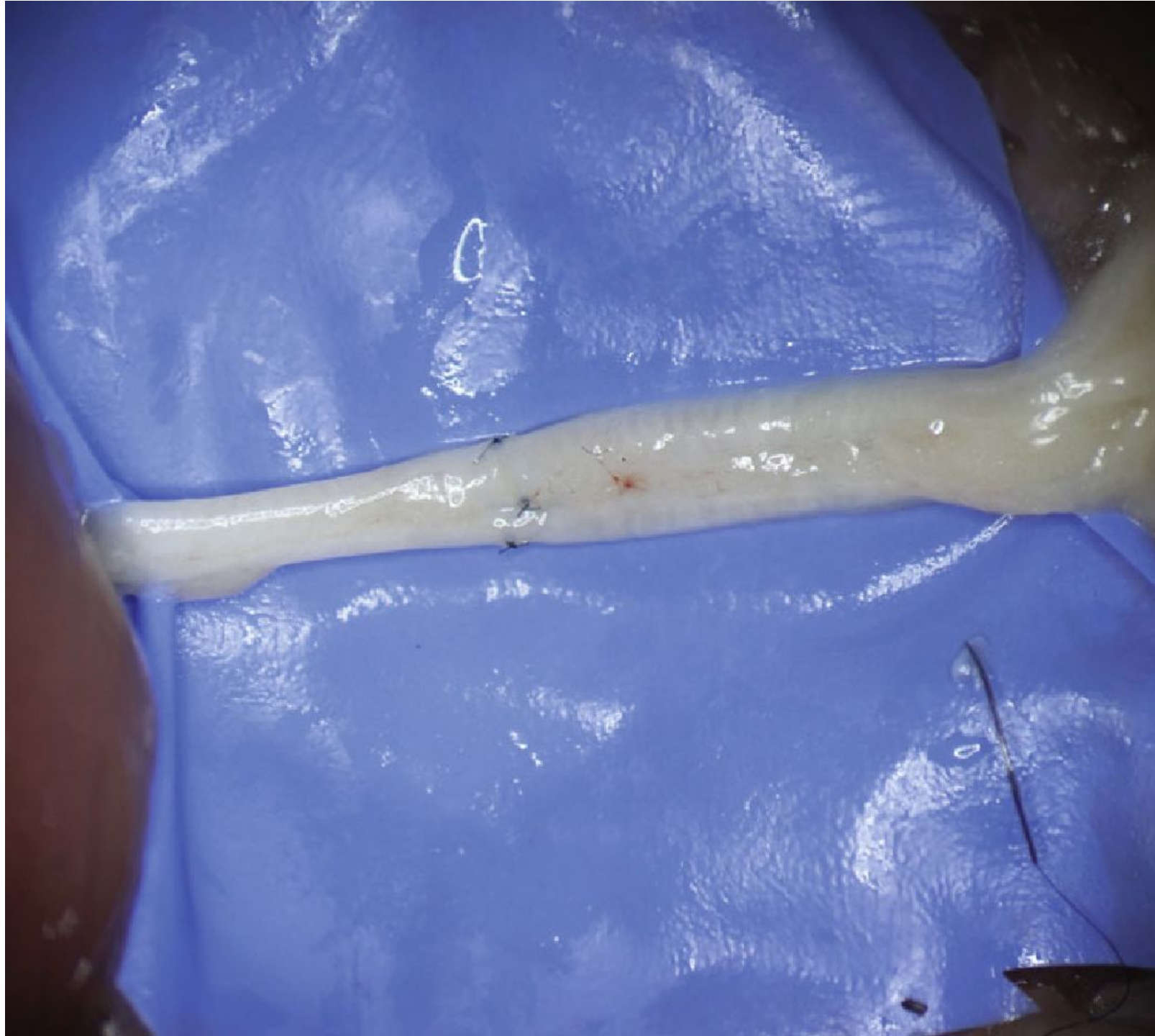


d









Как избежать натяжения:

Хорошее выделение нерва (мобилизация)

Транспозиция нерва

Пластика нерва

Strategies for Nerve Reconstruction

Experimental Neurology

Management of nerve gaps: Autografts, allografts, nerve transfers, and end-to-side neurotomy

William Z. Ray¹, Susan L. Mackinnon^{1*}

*Department of Neurology, Brigham Young University School of Medicine, 400 West 15th Street, Provo, Utah 84602, USA; ¹Department of Neurology, Brigham Young University School of Medicine, Provo, Utah 84602, USA

Category	Characteristics
Nerve Repair	• ease of graft • tangency
Nerve Grafting	• allow flexibility • anastomosis
Nerve Allografts	• anastomosis/immunosuppression
Conduits	• length limitation < 30cm • no autografts • 1
Acellularized Allografts	• length limitation < 30cm • no autografts • SIS
Nerve Transfers	• tangency • anastomosis/immunosuppression
End-to-side Nerve Transfers	• primary axonal sprouting • motor input to sensory
Supercharge Nerve Transfers	• anastomosis and 2nd degree repairs

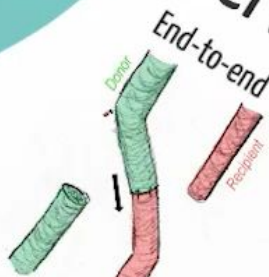
Nerve Repair

Nerve Grafting

Nerve Allograft

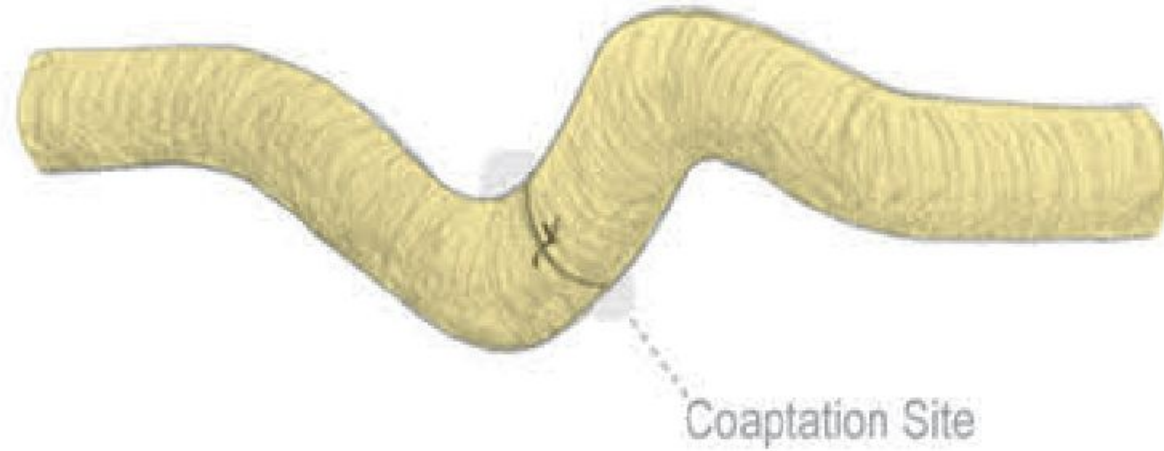
Conduit and Acellularized Allograft

Nerve Transfers

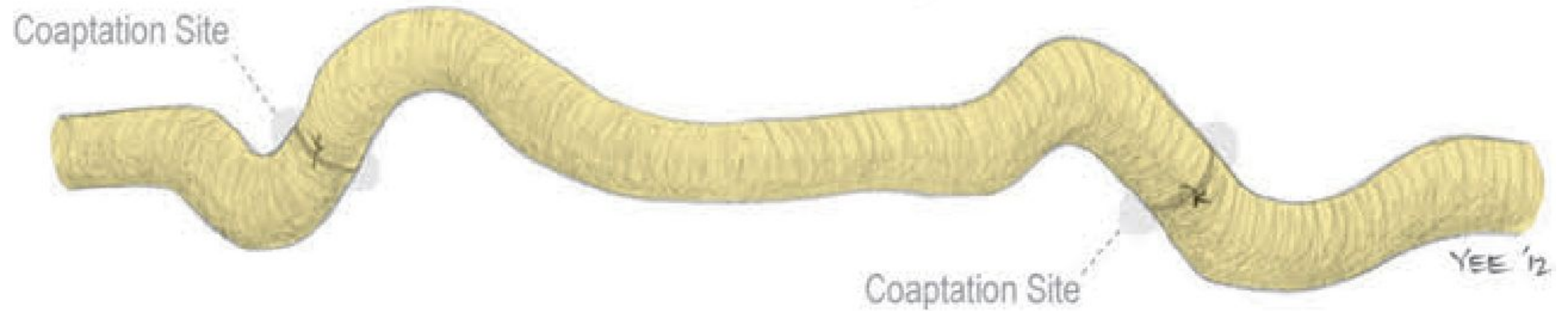


Conduits < Allografts ≤ Grafts

Nerve Repair



Nerve Grafting



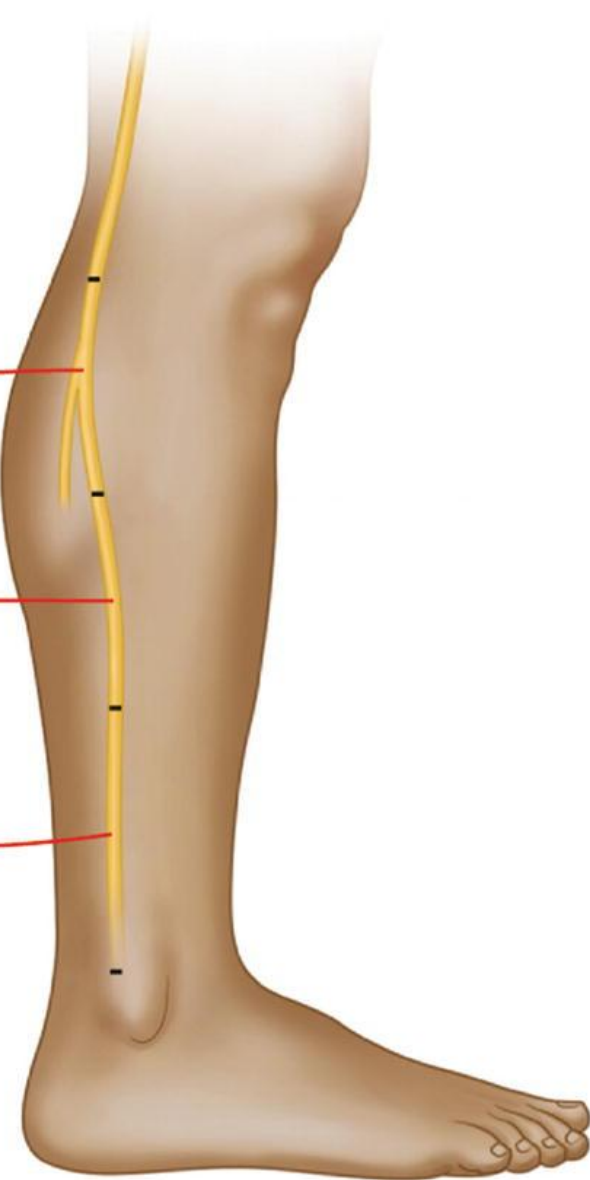
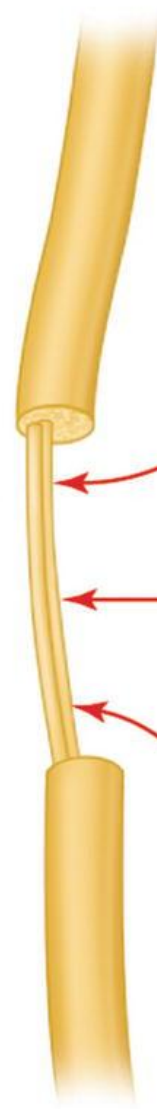
Injured
nerve



Damaged
segment
is removed



Pieces of the sural
nerve in the leg
are used to fill the
nerve gap



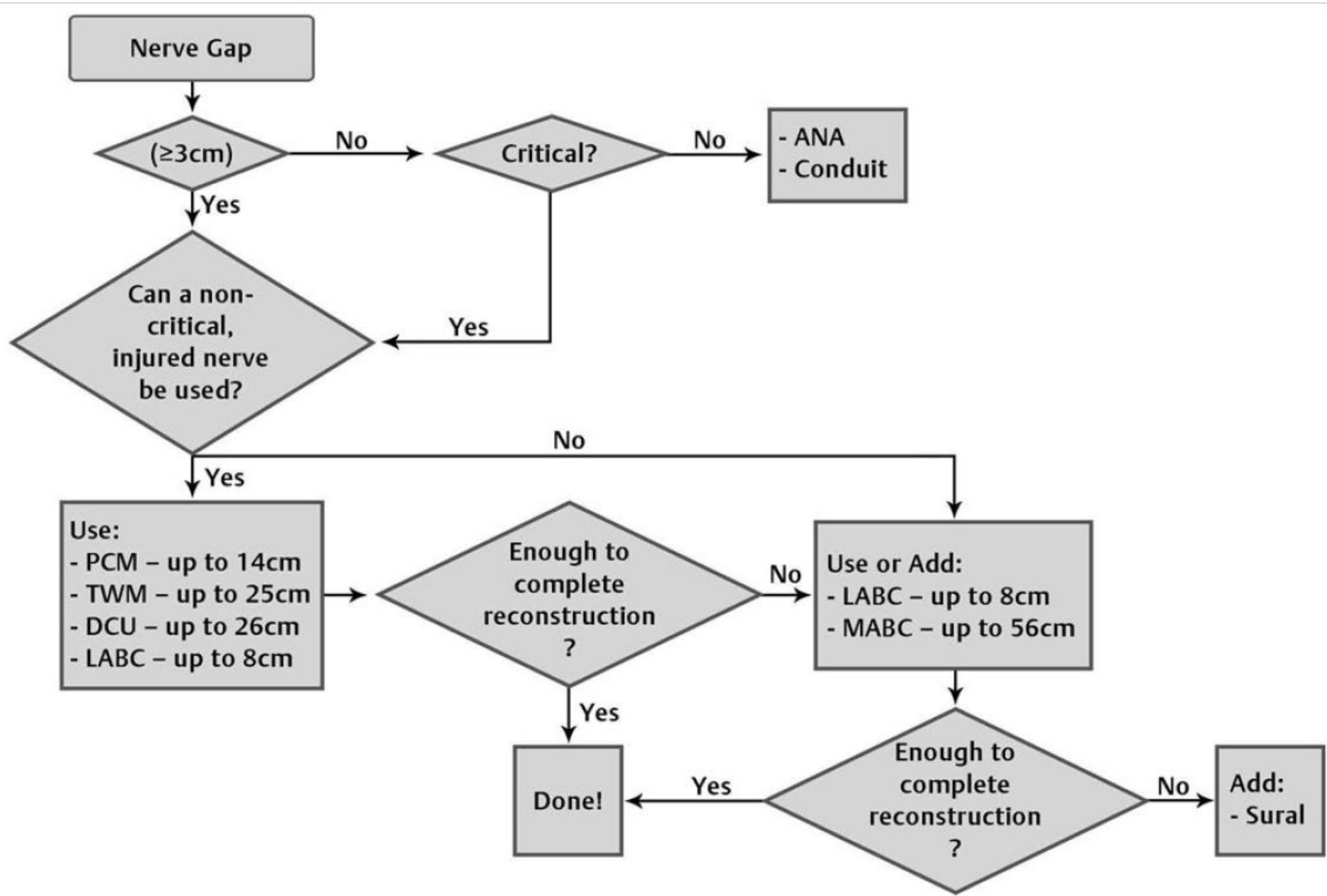


Fig. 4.14 Algorithm for sural alternatives. ANA, acellular nerve allograft; DCU, dorsal cutaneous branch of ulnar nerve; LABC, lateral antebrachial cutaneous nerve; MABC, medial antebrachial cutaneous nerve; PCM, palmar cutaneous branch of median nerve; TWM, Third webspace branch of median nerve.

Nerve Autograft



Nerve Allograft



Immunosuppression

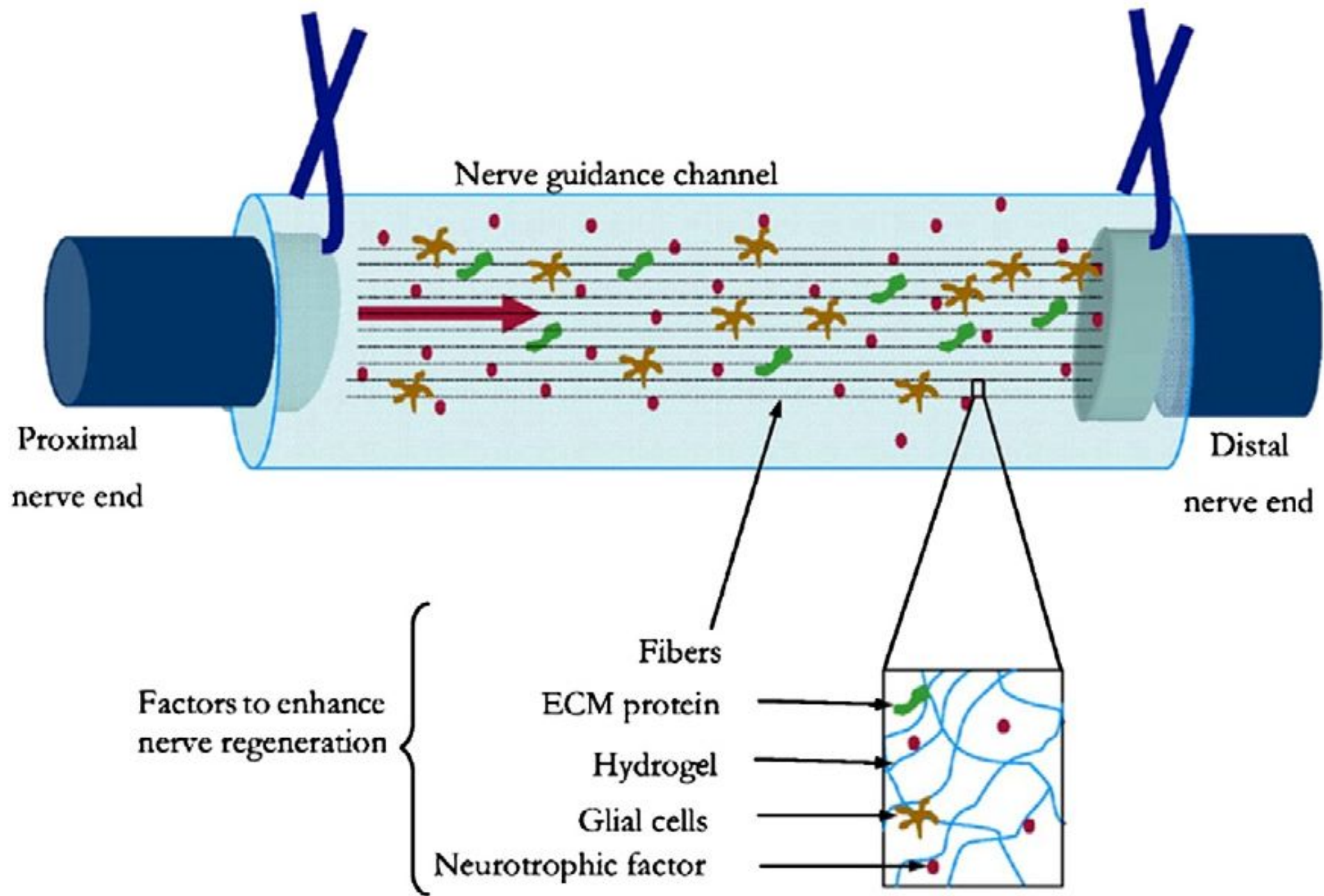
Autograft

Allograft

Schwann Cell Migration

Complete Host Cells Migration

Immunosuppression Withdrawal



Nerve Autograft

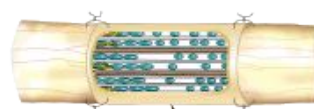
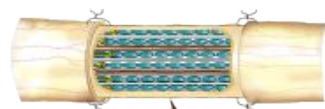
Avance Nerve Graft

Hollow Tube

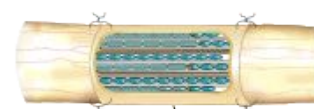
Hours



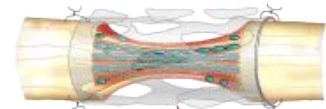
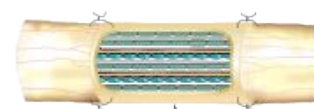
Days



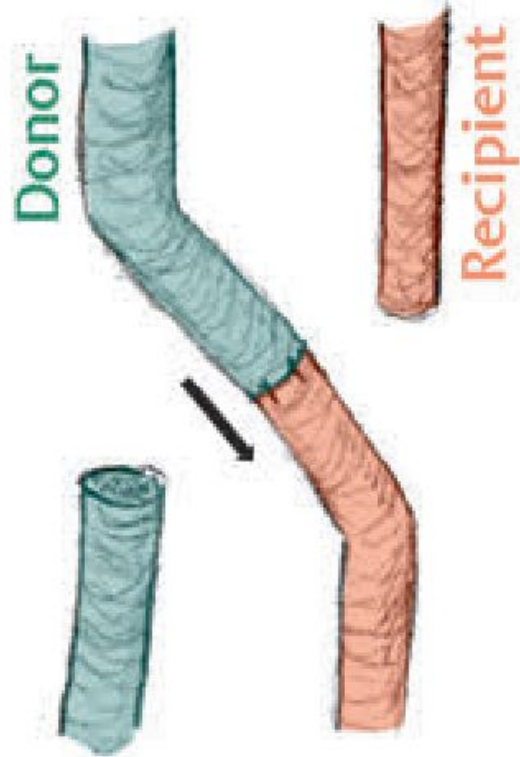
Weeks



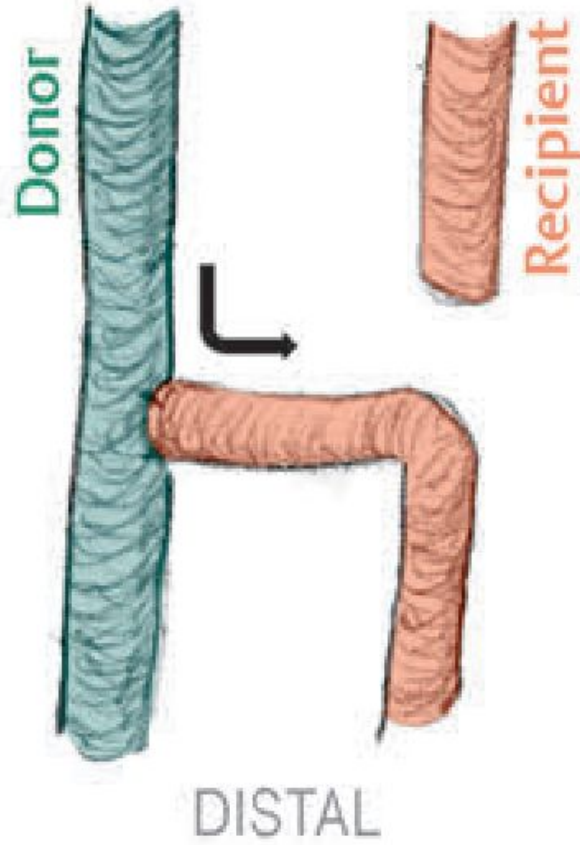
Months



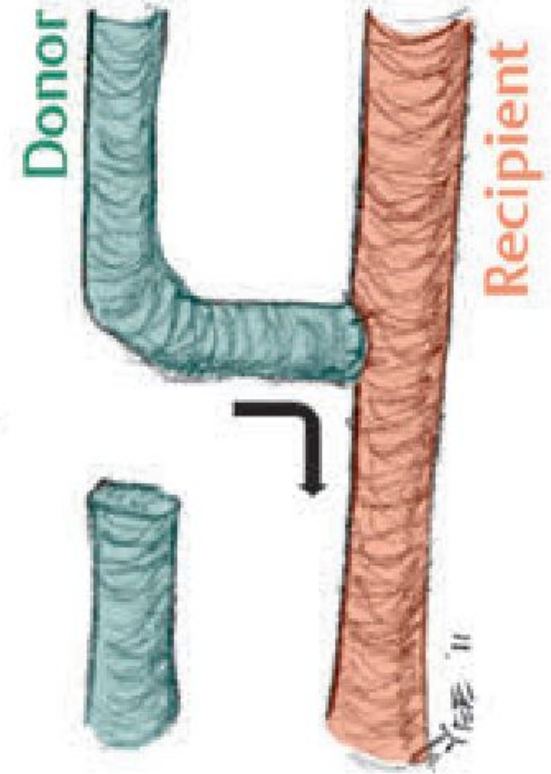
End-to-end
Nerve Transfer

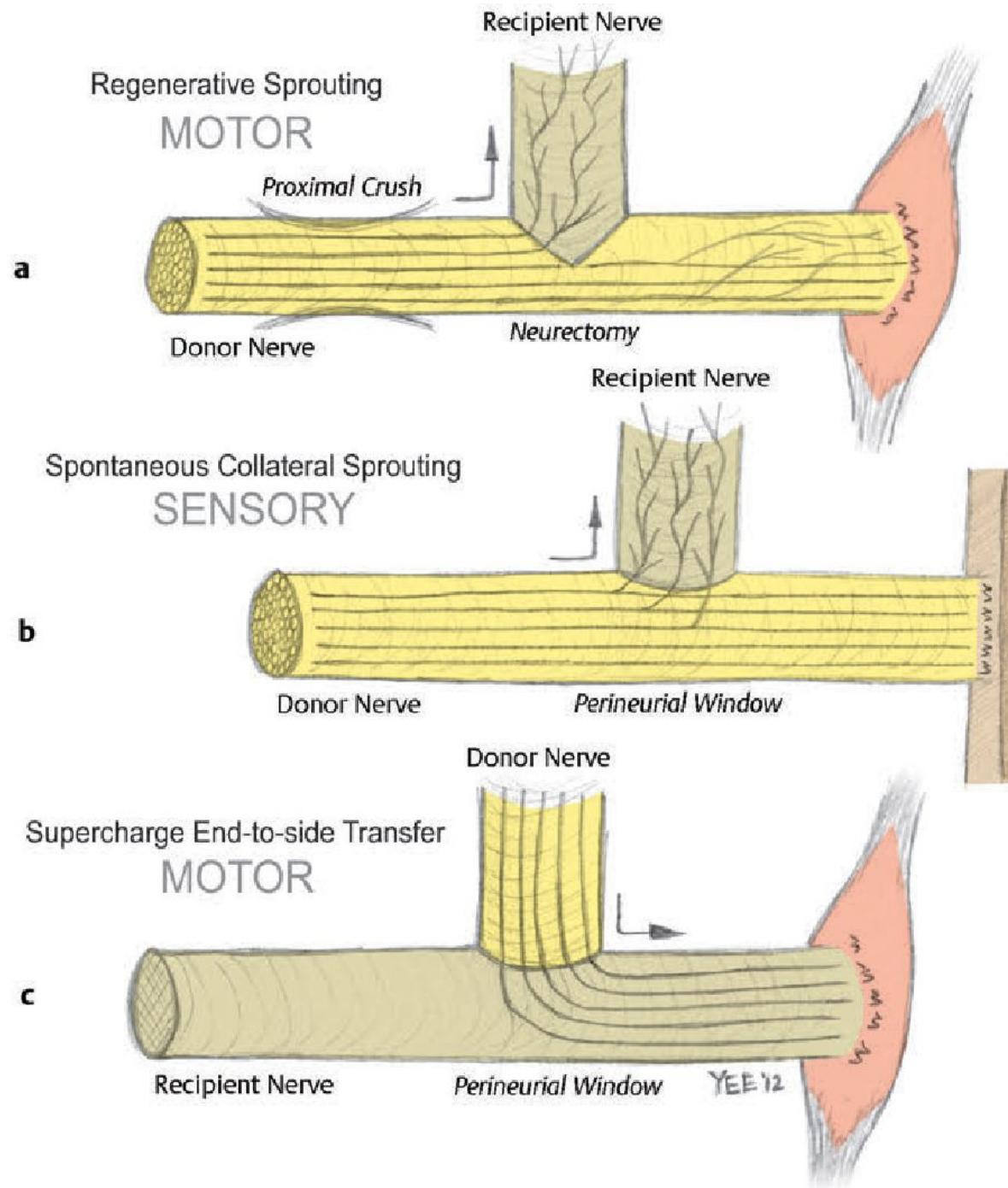


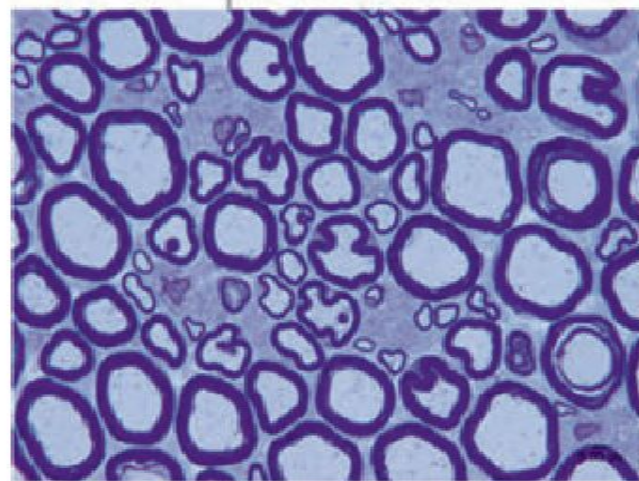
PROXIMAL
End-to-side
Nerve Transfer



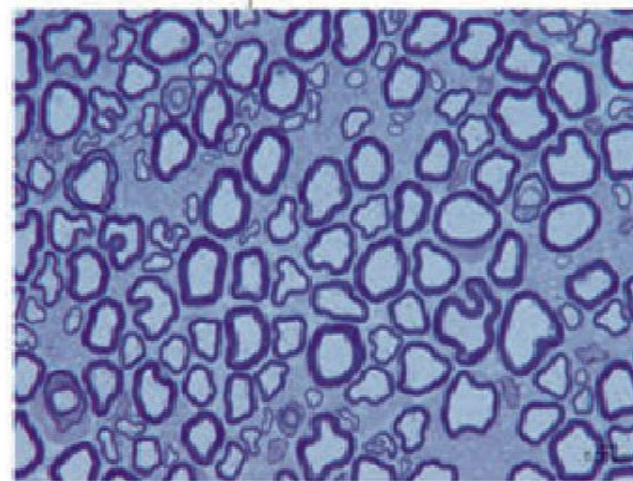
Supercharge End-to-side
Nerve Transfer





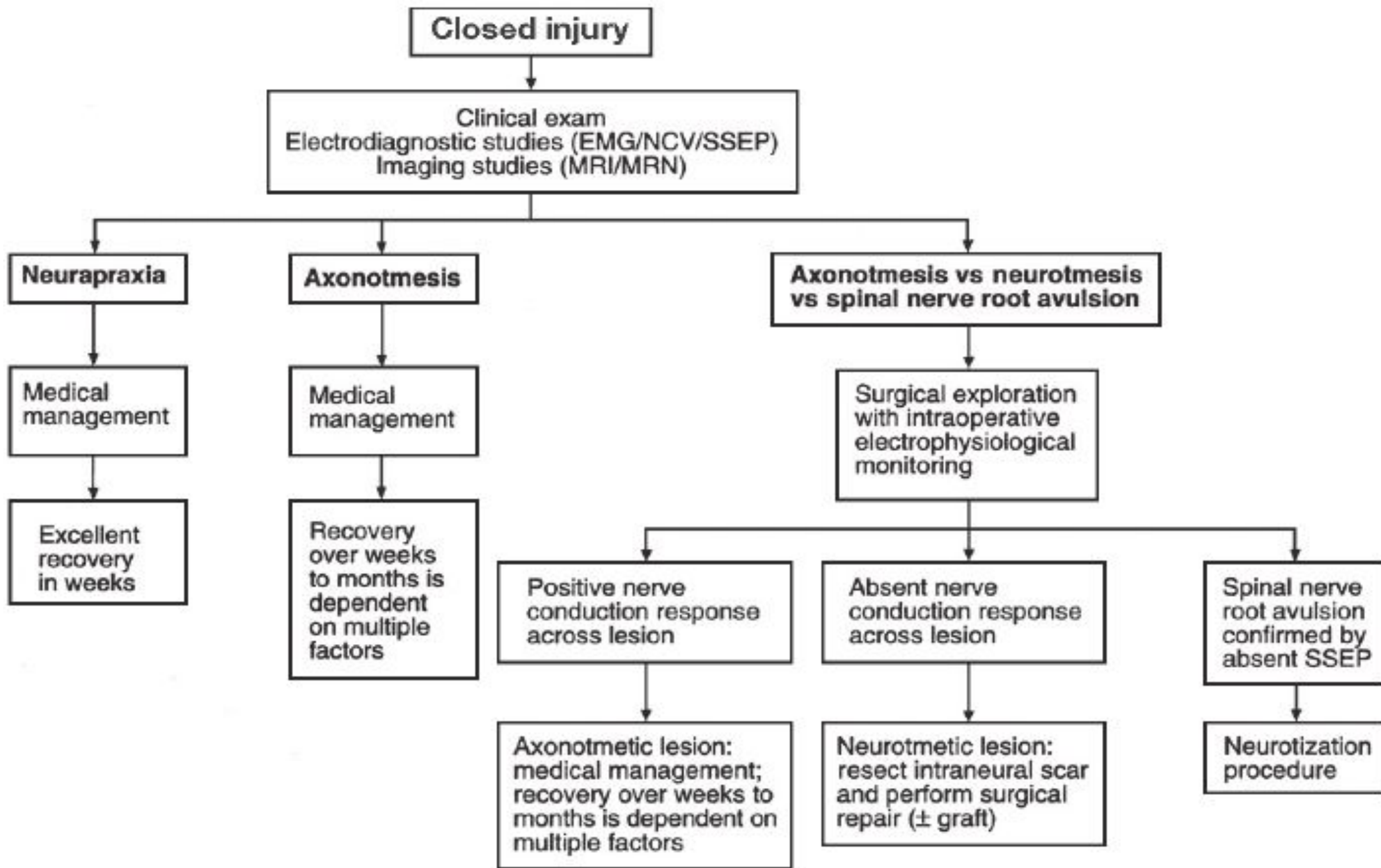
b**Motor Nerve Cable Grafts**

Motor Nerve Fibers

Sensory Nerve Cable Grafts

Sensory Nerve Fibers





Тип опухоли

I. Нейрогенные опухоли

А. Доброкачественные опухоли оболочки нерва

Шваннома (невринома), в одном случае при Б.Р. (Болезнь Реклингаузера).

Нейрофиброма (в одном при Б.Р.).

Б. Злокачественные опухоли оболочки нерва

злокачественная шваннома

фибросаркома

нейрофибросаркома

II. Опухоль из периферического нейрона

Ганглионеврома

Нейробластома

III. Опухоли не из оболочки нерва (доброкачественные)

фиброма

хондромиксоидная фиброма

фибролипома

фибромиолипома

хемодектома

В эту группу также входят десмоидная опухоль, миобластома, лимфангиома, гемангиома и сосудистые опухоли.

IV. Метастазы в периферические нервы

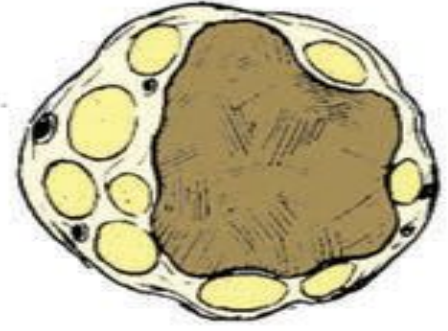
Лучевой фиброз после хирургического и лучевого лечения

рака молочной железы

Лимфома Карцинома

Опухоли ПНС

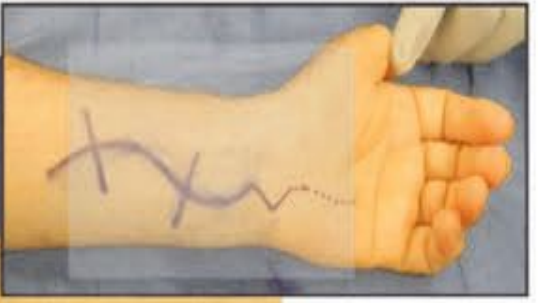
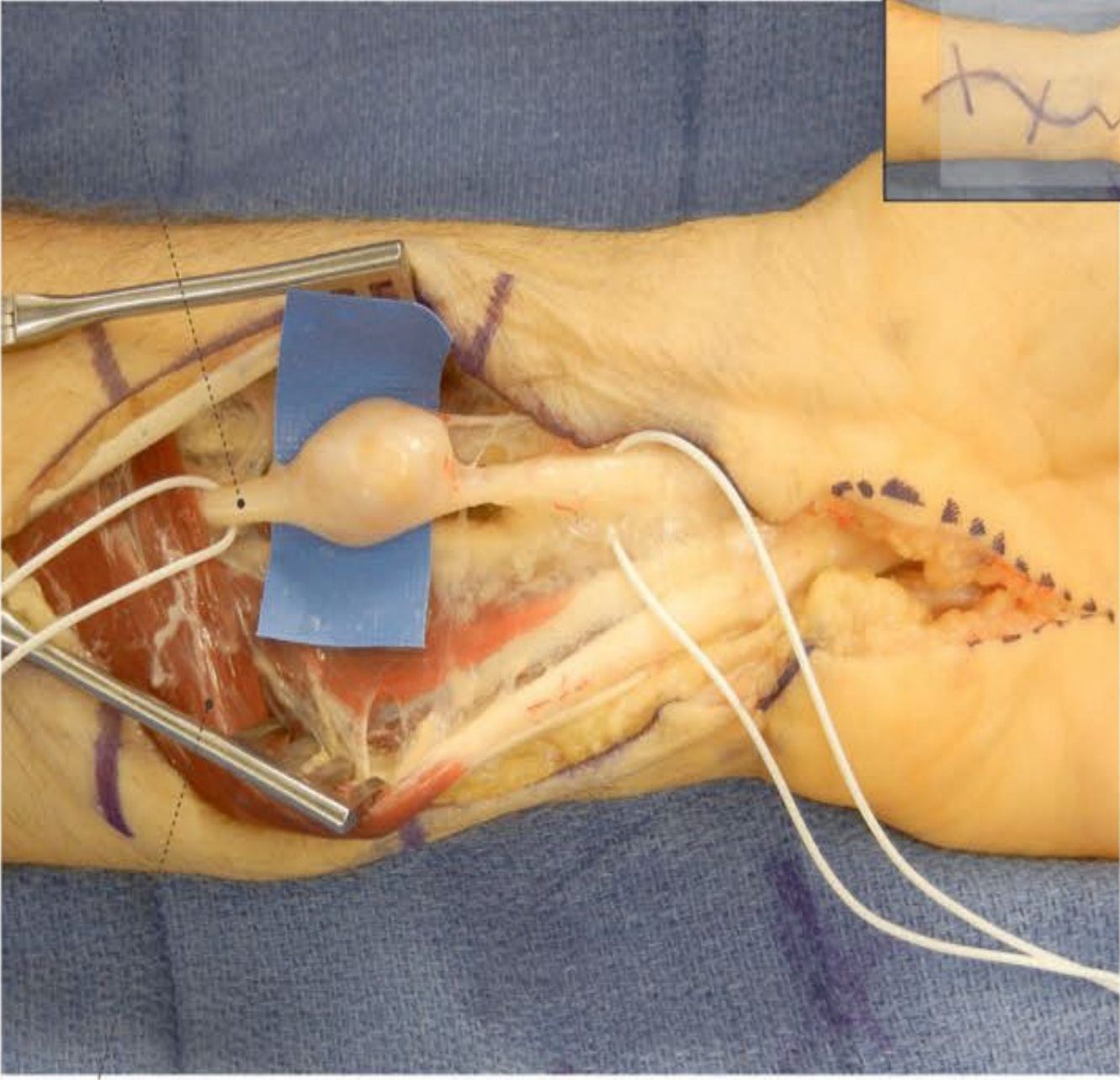
a



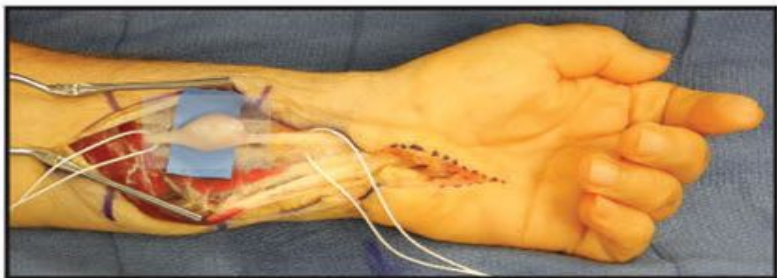
b



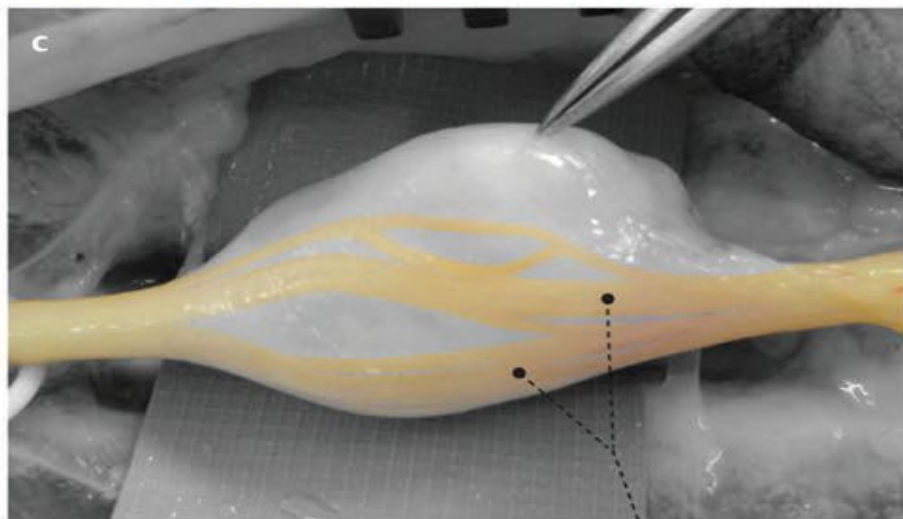
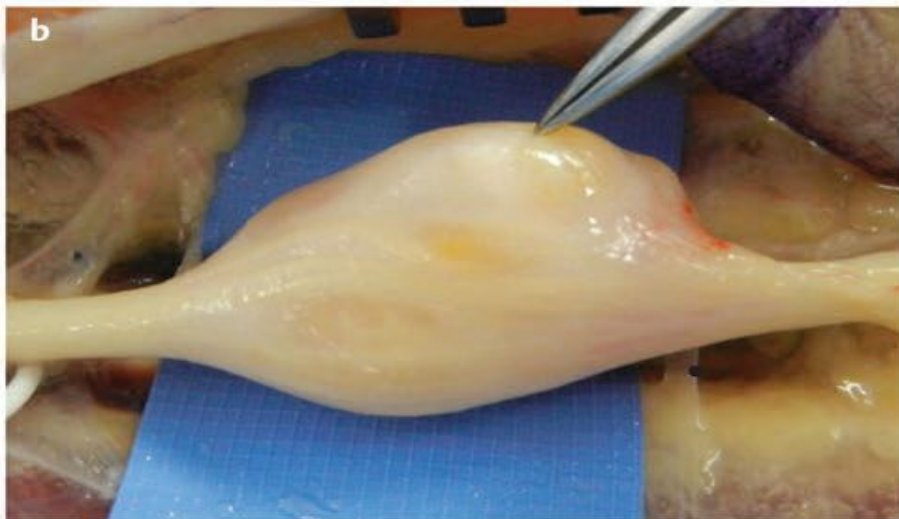
(N) median



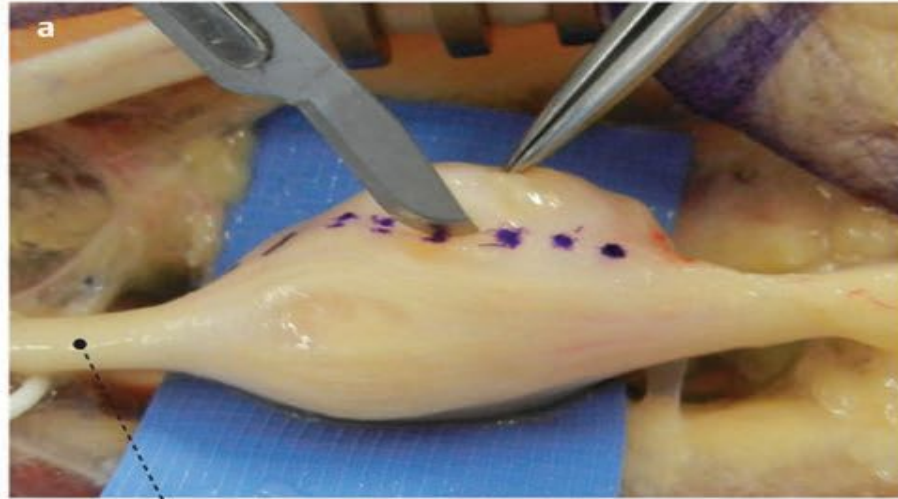
(M) flexor digitorum superficialis



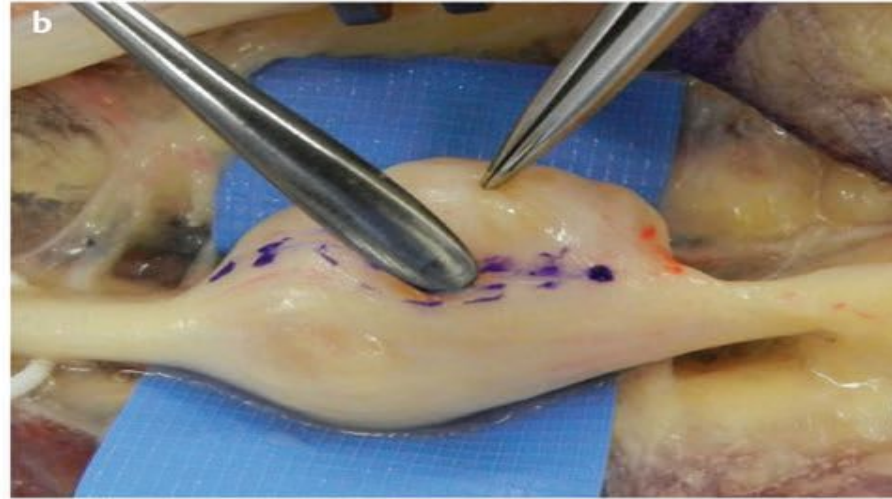
(N) median



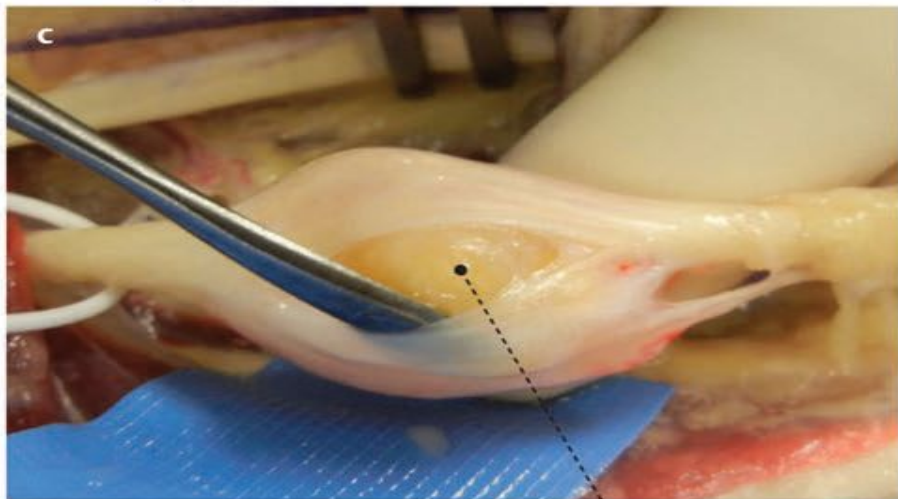
nerve fibers



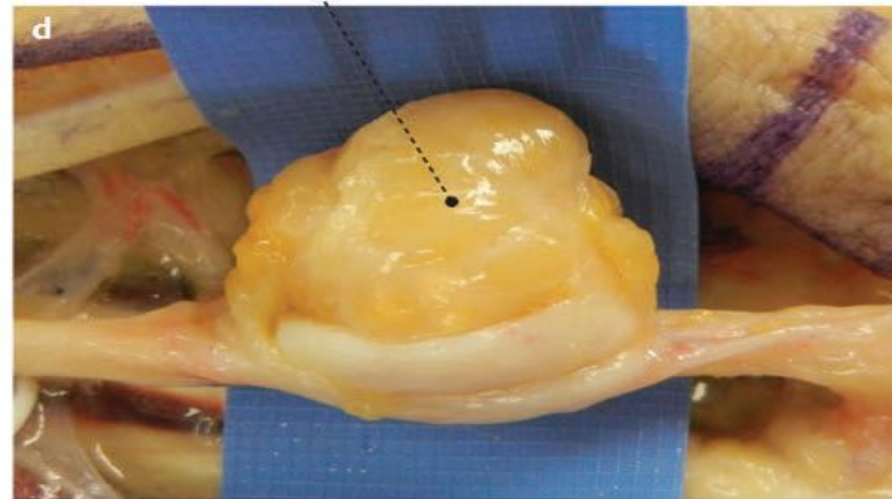
(N) median

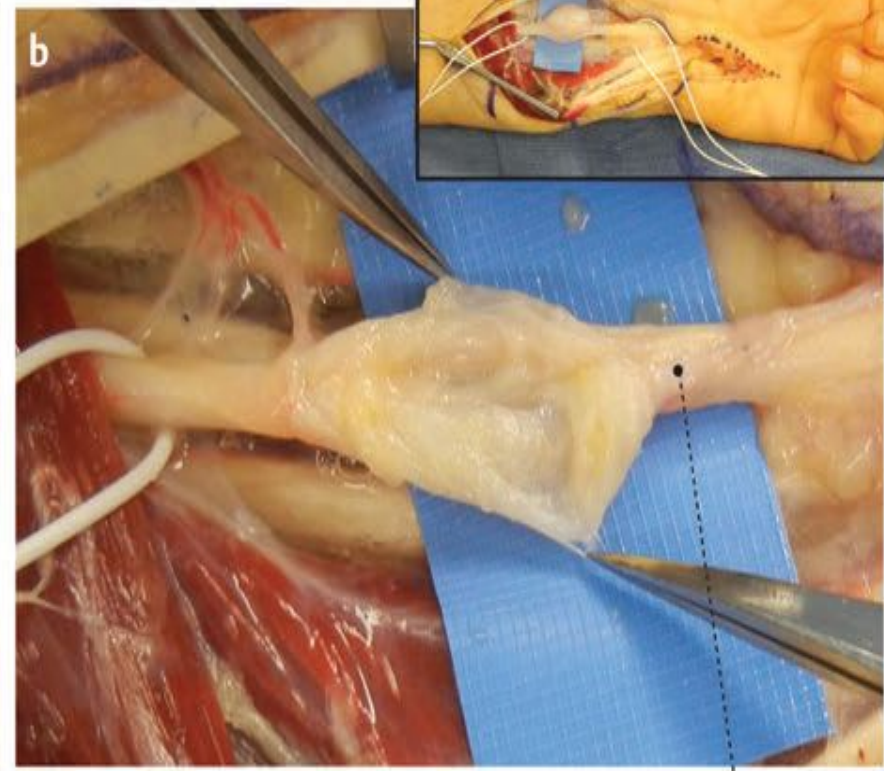
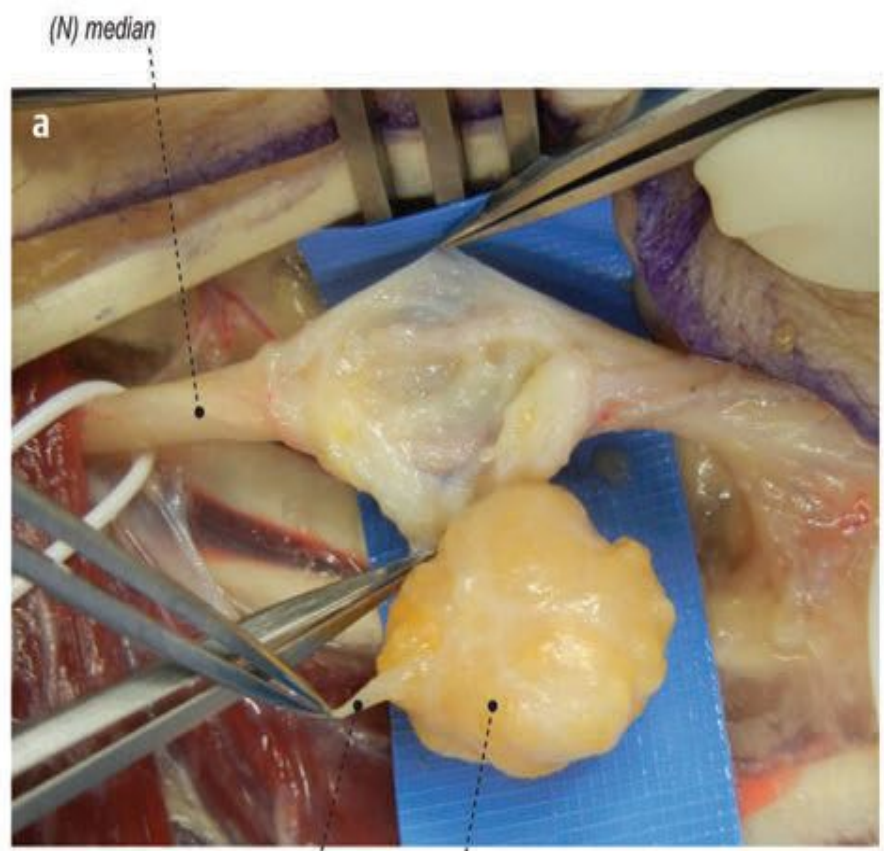


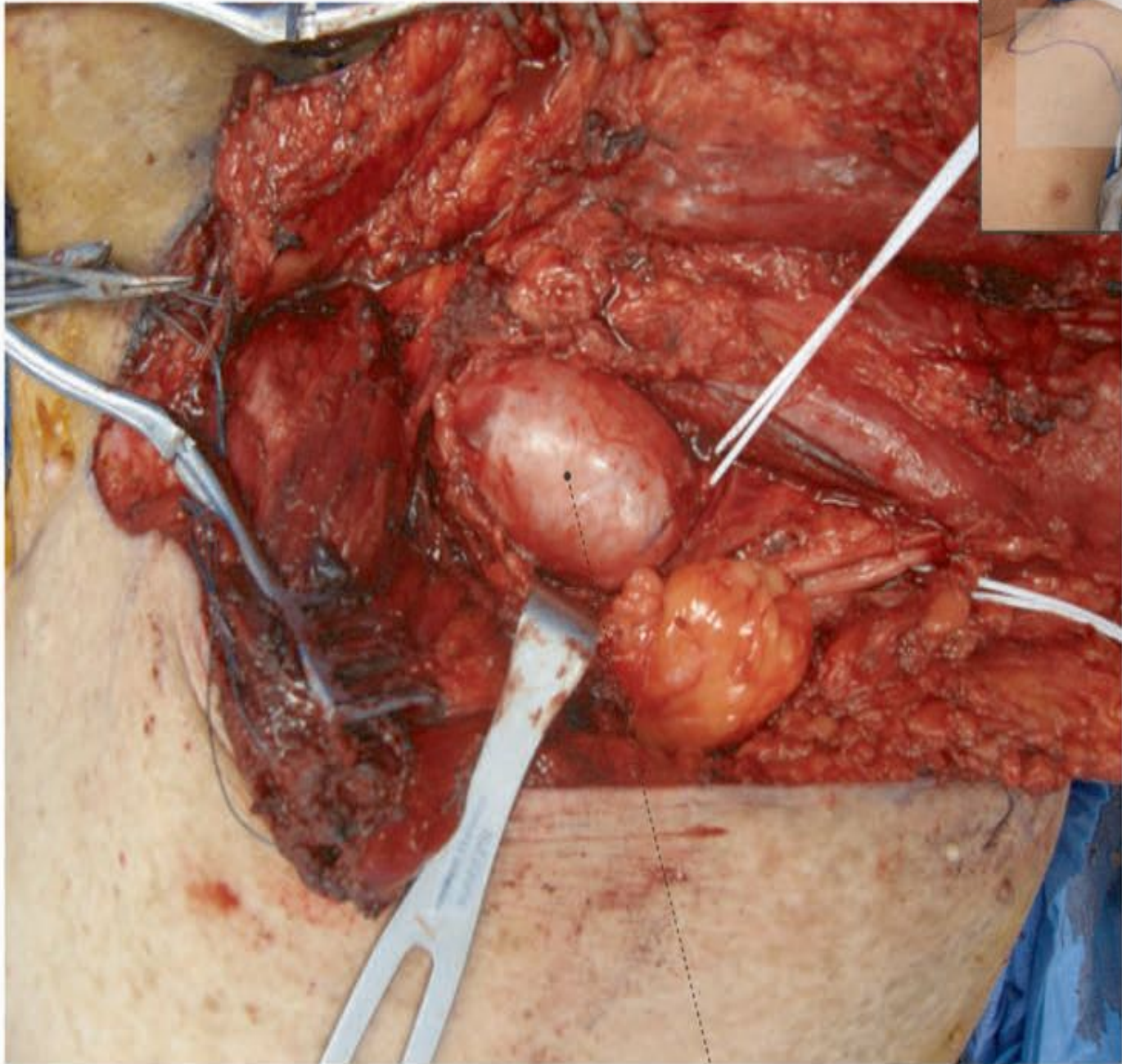
Schwannoma



Schwannoma







benign neurofibroma

Спасибо за внимание!