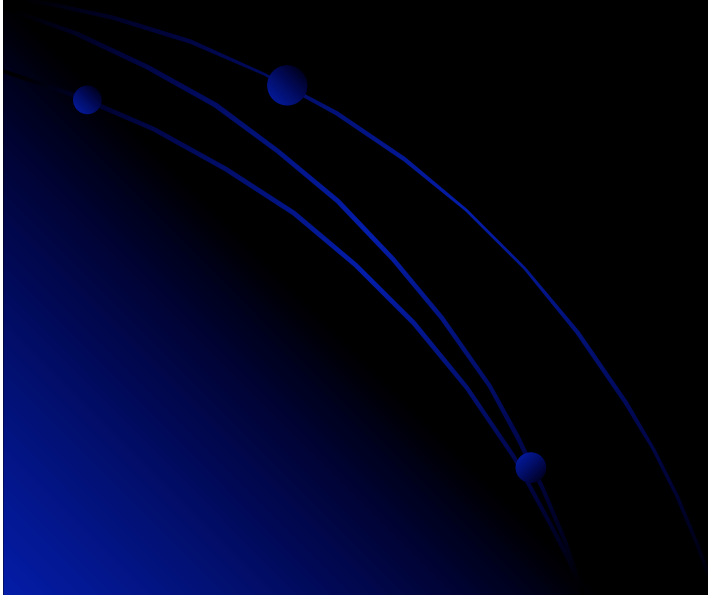
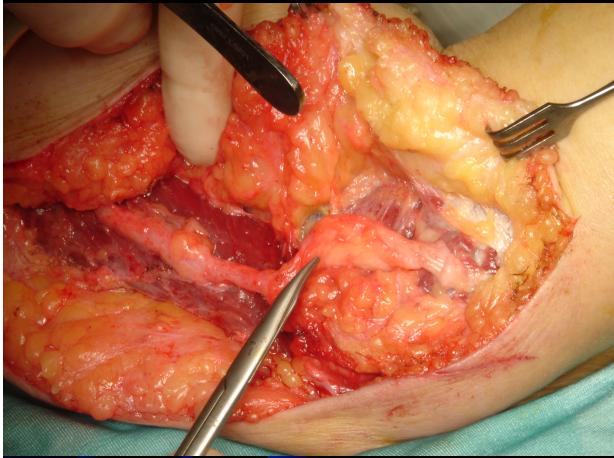
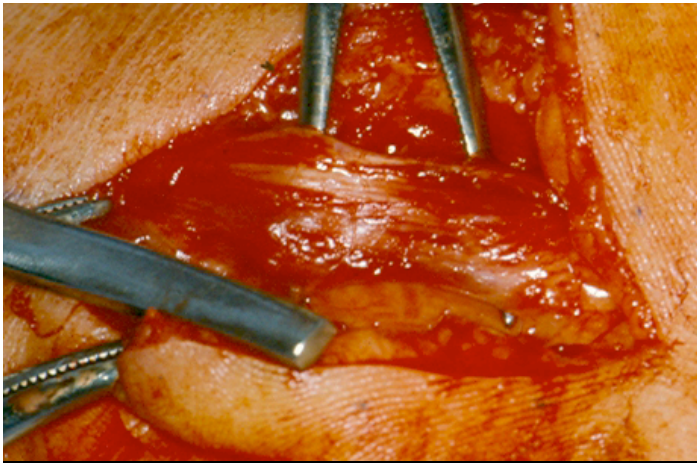


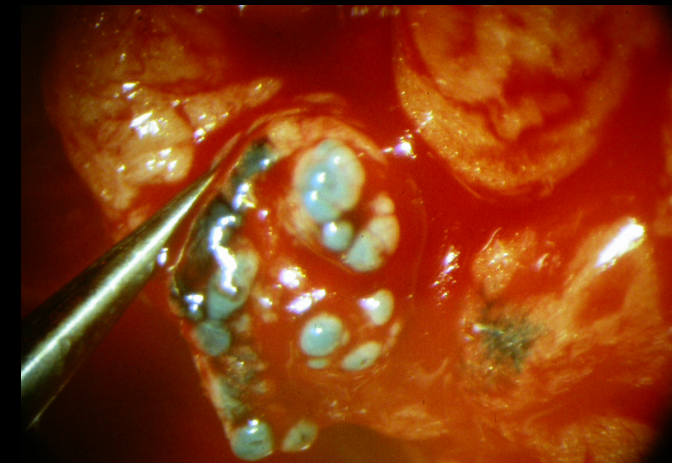
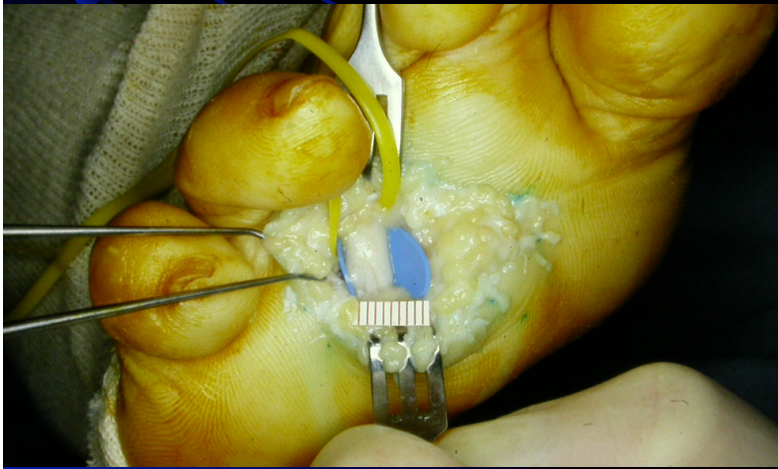
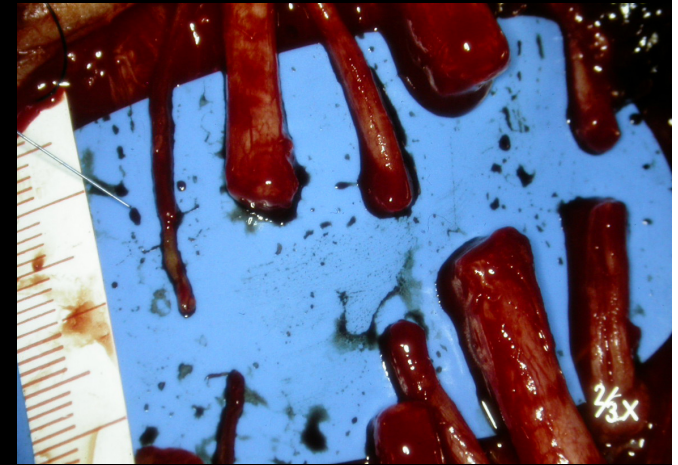
LES LESIONS DES

NERFS PERIPHERIQUES

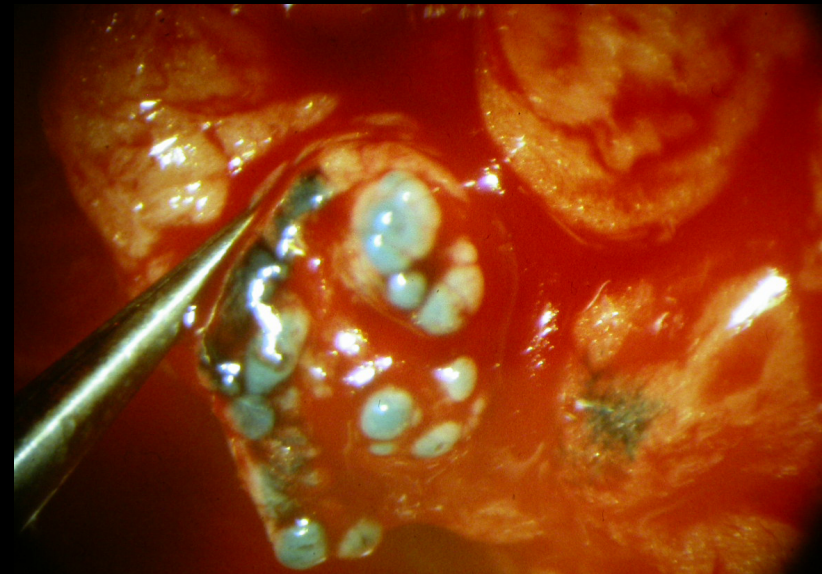
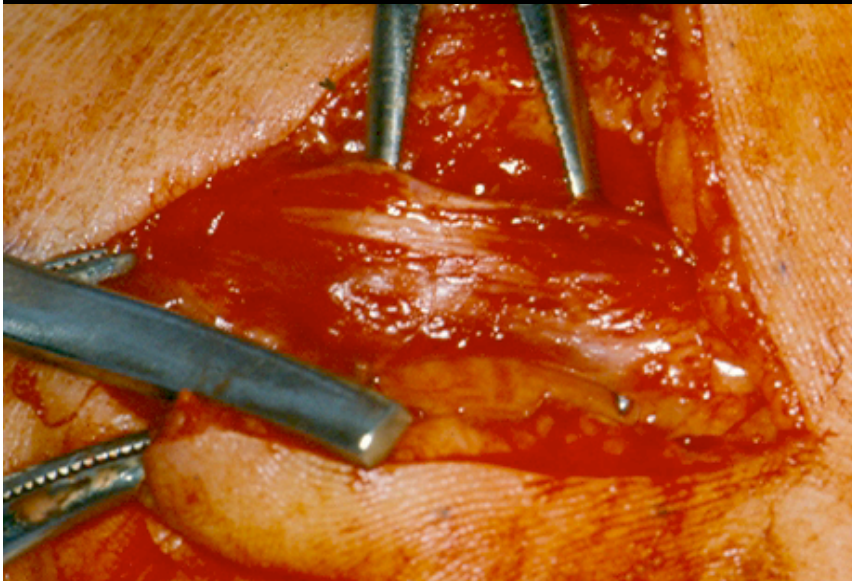




QUEL TYPE DE TRAUMATISME ?



3 GRANDS TYPES DE MECANISMES LESIONNELS



**LES COMPRESSIONS
INTERRRPTIONS DE
CONTINUITE**

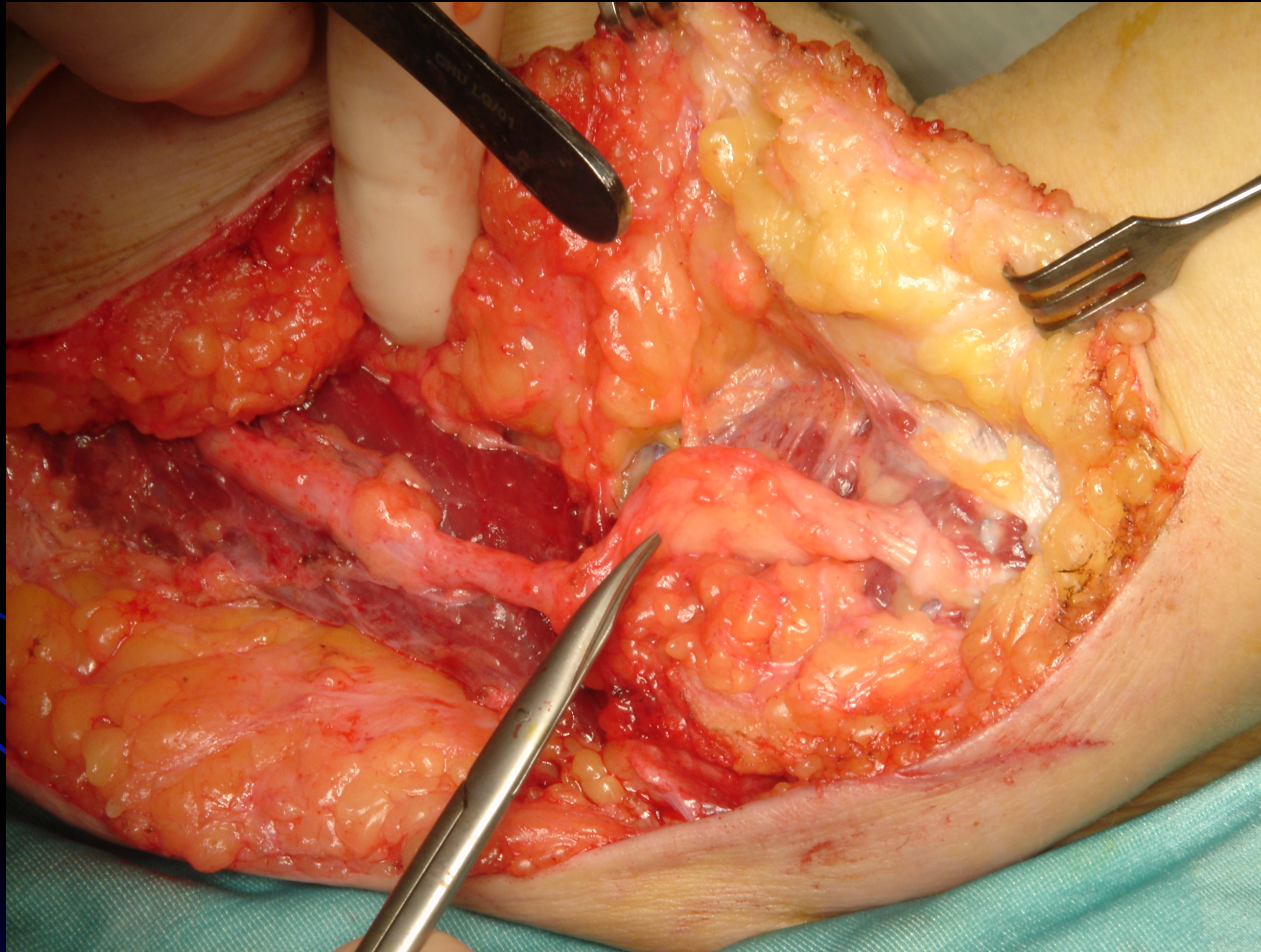
LES

LES DISTRACTIONS

Classification of Nerve Injury

Sunderland	Seddon	Mackinnon	Injury
Degree I	Neurapraxia	Degree I	Conduction block resolves spontaneously
Degree II	Axonotmesis	Degree II	Axonal rupture without interruption of the basal lamina tubes
Degree III		Degree III	Rupture of both axons and basal lamina tubes, some scarring
Degree IV		Degree IV	Complete scar block
Degree V	Neurotmesis	Degree V	Complete transection
		Degree VI	Combination of I through V and normal fascicles

LES ENTRAPPEMENTS



Les syndromes compressifs: causes ?

« mini syndrome de loge local »

Augmentation de la pression sur un nerf
ou ischémie du nerf en particulier si
espace naturellement étroit:

- **Compressions Aigues :**

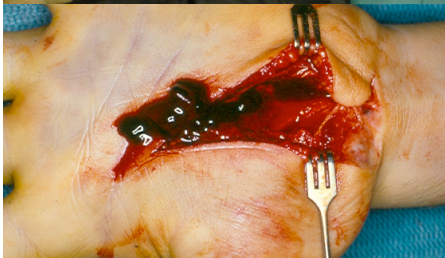
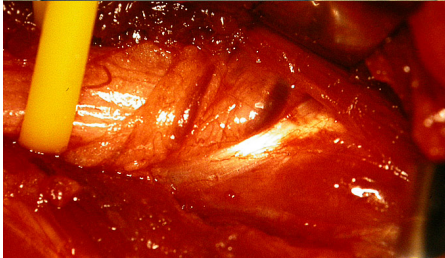
- Hématome
- Ischémie (thrombose artérielle)
- Pression externe (garrot, cyclisme,...)
- Injection « dans un nerf »

- **Compressions Chroniques :**

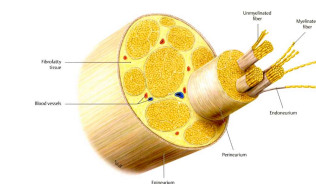
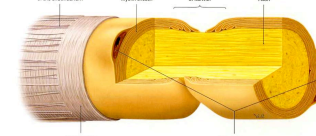
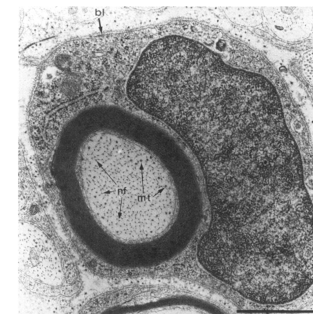
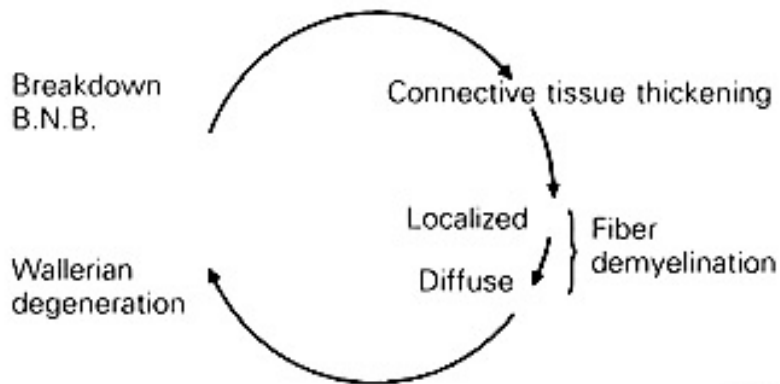
- Lipome
- Kyste arthrosyn.
- Bande tendineuse ou fascia
- Anomalies musculaires
- Utilisation d'engins vibrants (?)
- tophy goutteux, synovite rhum.
- Idiopathique

Causes favorisantes :

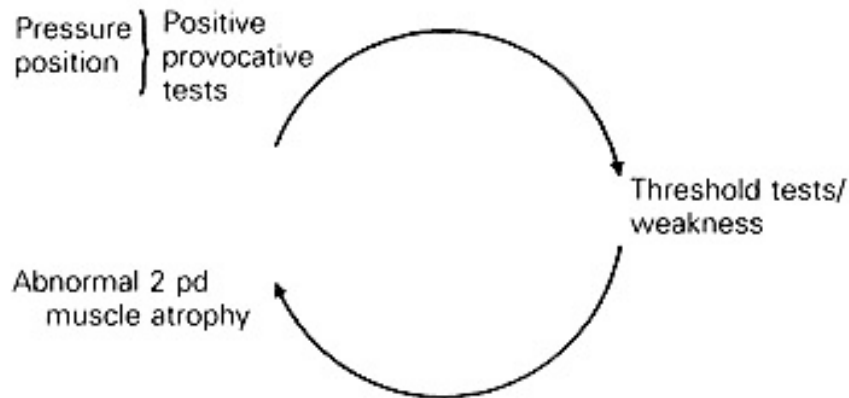
Diabète, PNP, déficit en vit B, troubles
thyroïdiens,



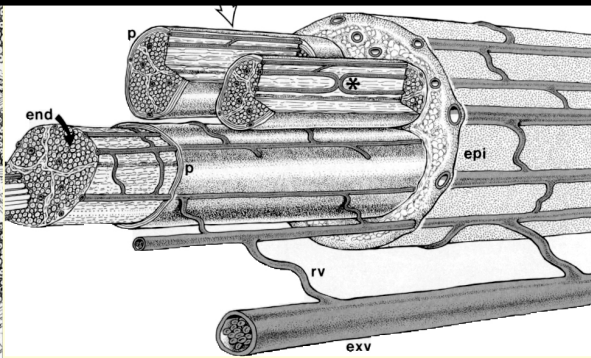
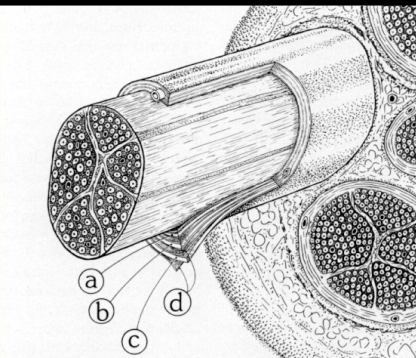
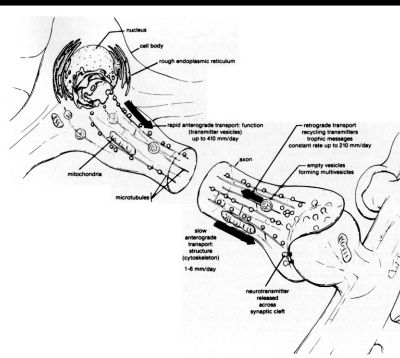
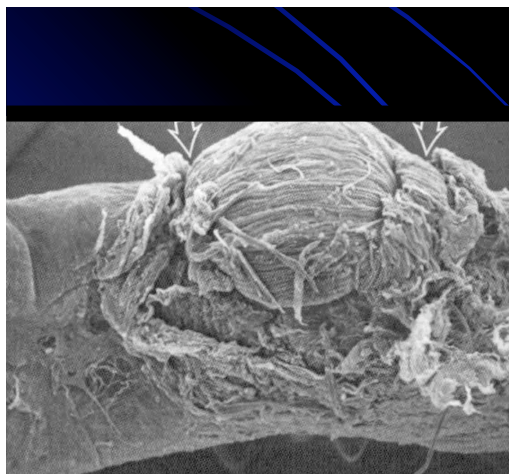
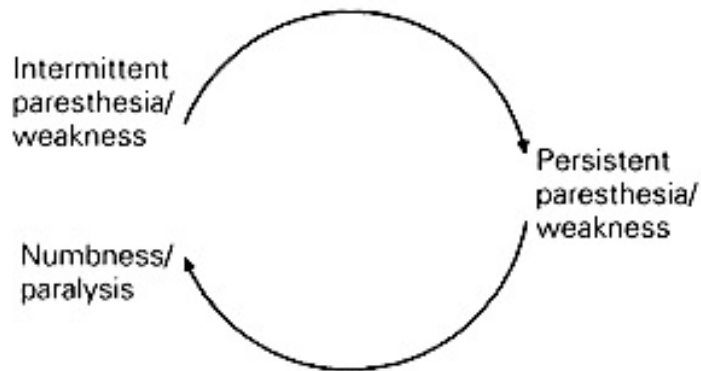
HISTOPATHOLOGY



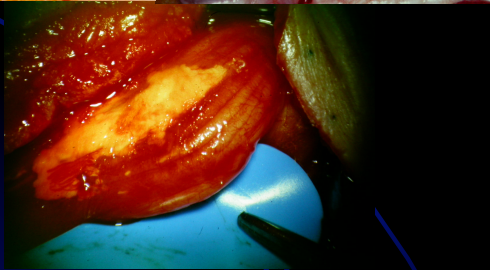
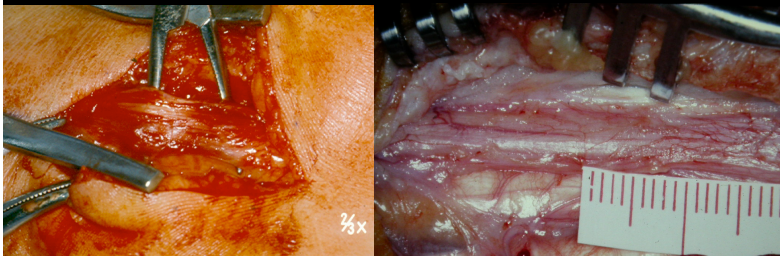
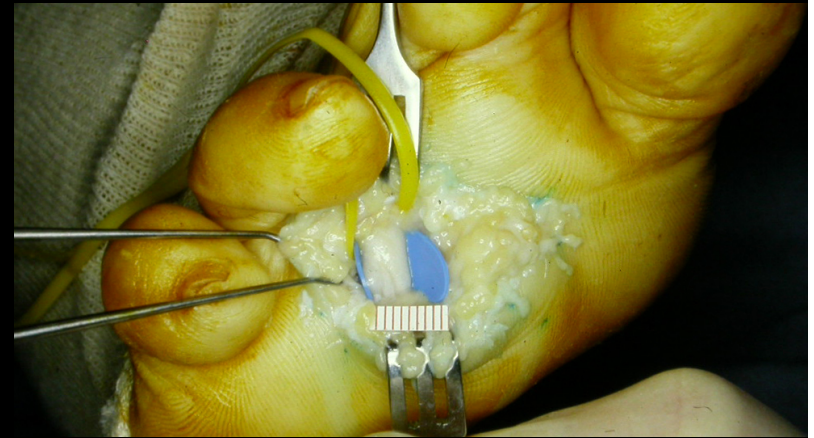
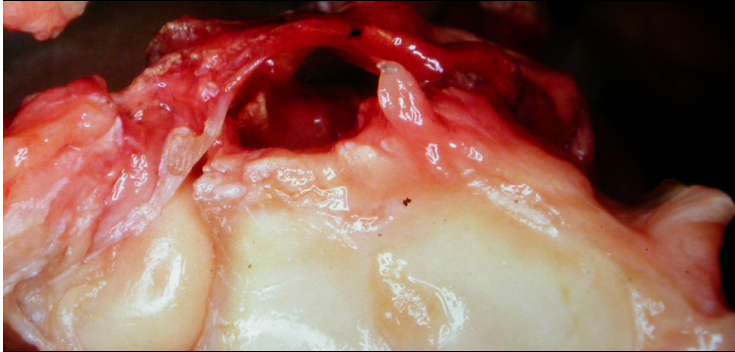
CLINICAL FINDINGS

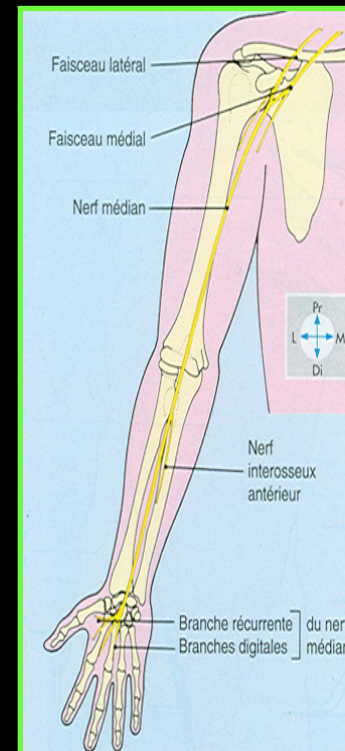
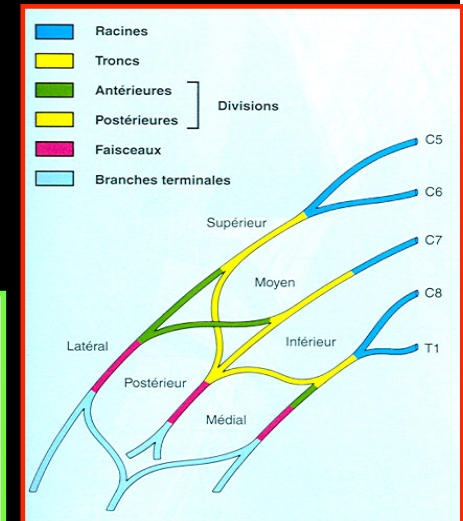
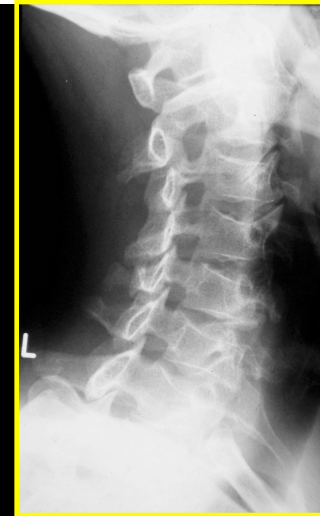
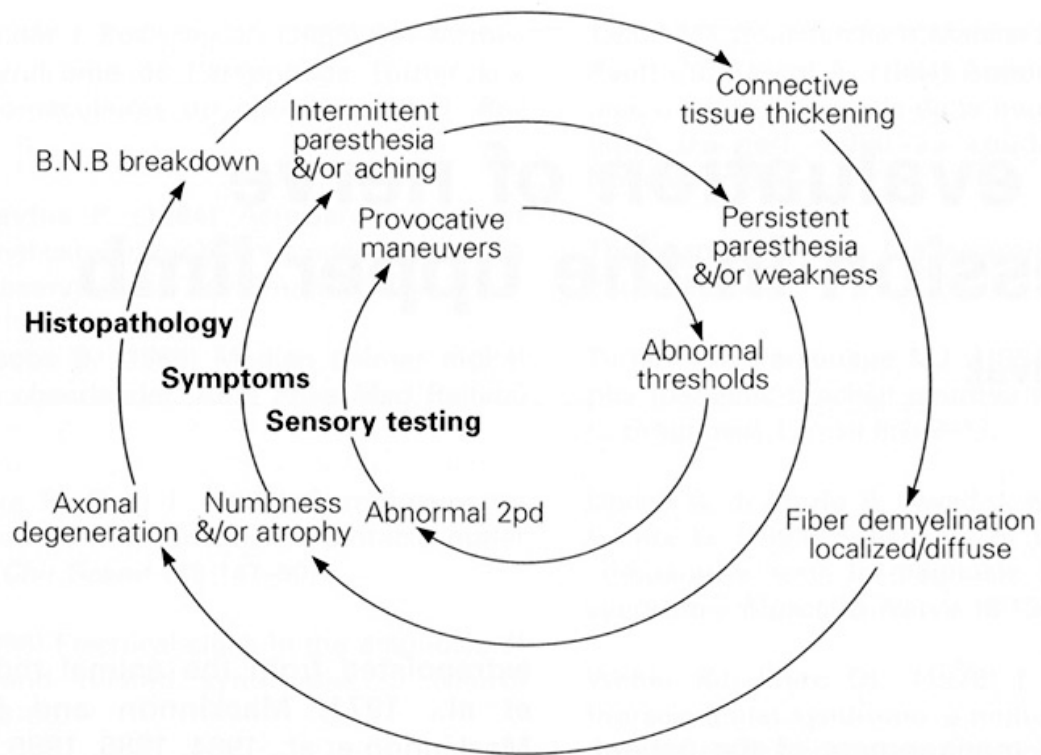


SYMPTOMS



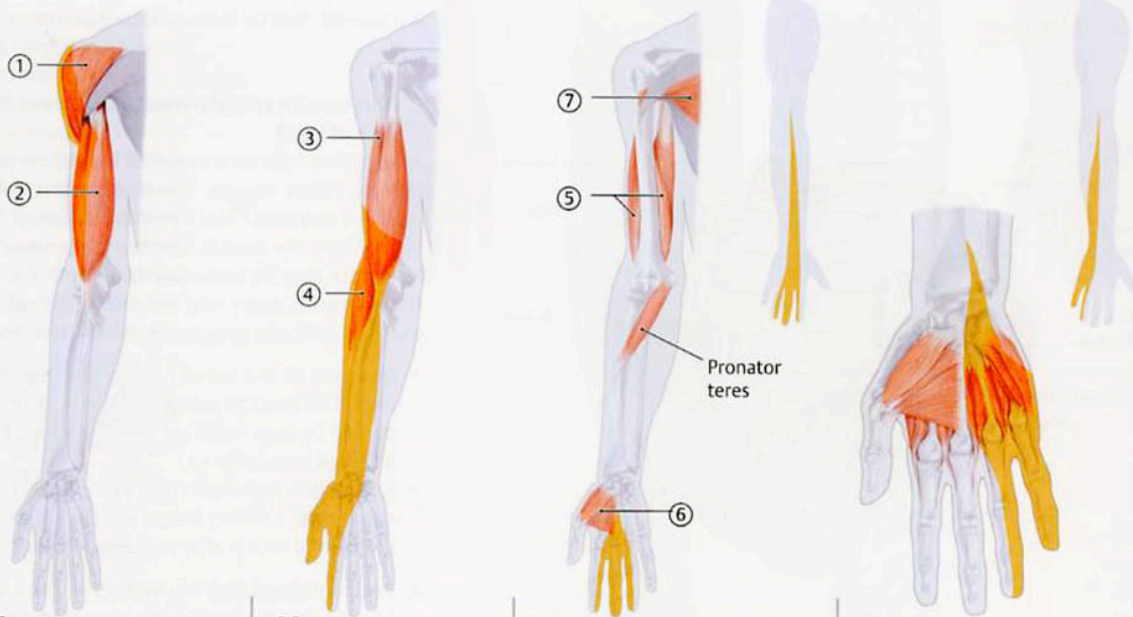
DIFFERENTES MANIFESTATIONS



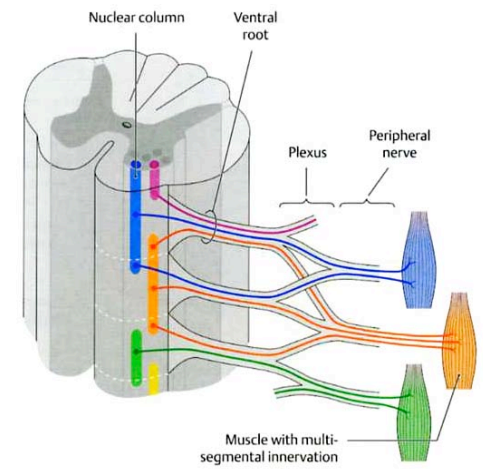
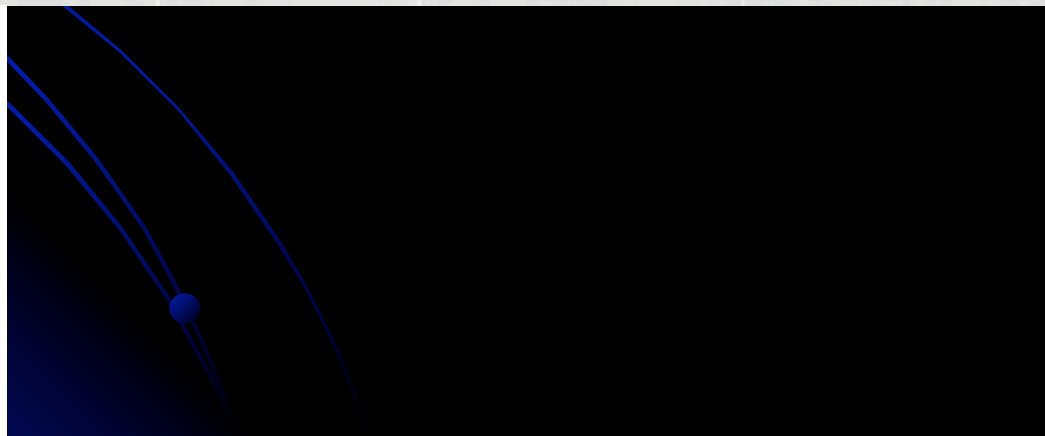
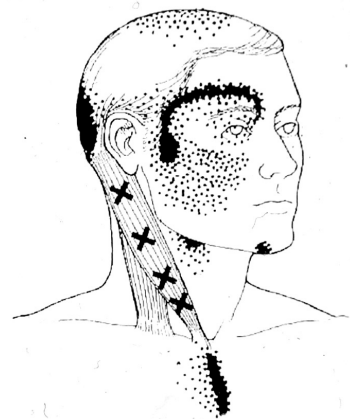


DIFFERENCES DE SYMPTOMES:

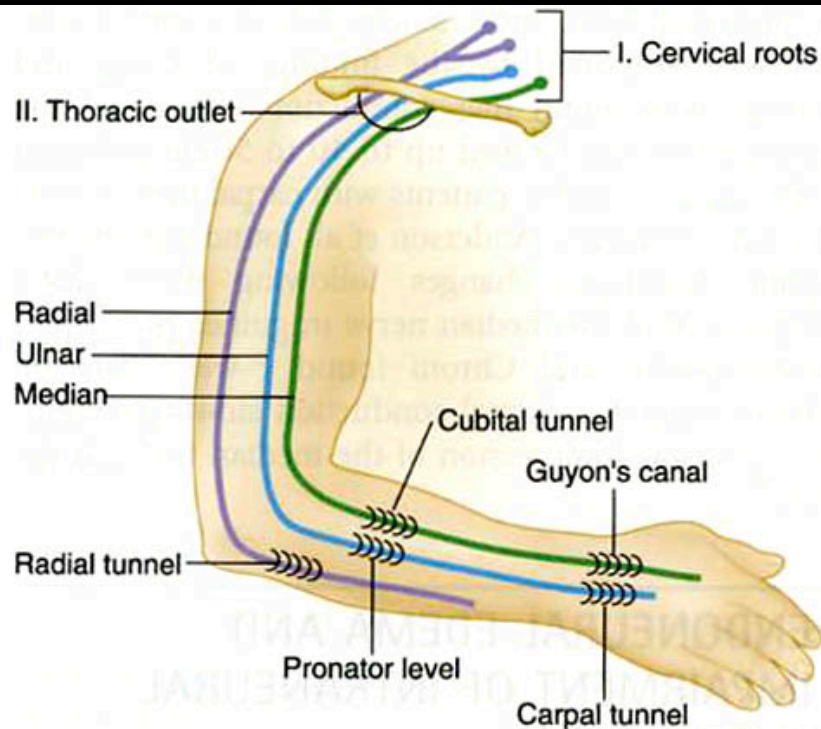
- RADICULAIRE
- PLEXUEL
- TRONCULAIRE



	C5	C6	C7	C8
Location of pain or sensory disturbance	Lateral and posterior side of shoulder, anterolateral side of proximal forearm	Dorsoradial upper arm, radial forearm → thumb	Posterior side of upper arm, extensor side of forearm → second/third (fourth) finger	Ulnar side of hand extending to small finger and ring finger
Indicator muscle (and other affected muscles)	① Deltoid ② (Biceps brachii)	③ Biceps brachii ④ (Brachioradialis)	⑤ Triceps brachii, hand and digital flexors and extensors ⑥ Thenar muscles ⑦ Pectoralis major (atrophy of sternocostal part)	Hypothenar, ulnar digital flexors (Triceps brachii, pectoralis major—abdominal part)
Reflexes abolished by a segmental lesion	Biceps reflex (Brachioradialis reflex)	Biceps reflex (Brachioradialis reflex)	Triceps reflex (Trömner reflex)	Triceps reflex (Trömner reflex)



« DOUBLE CRUSH SYNDROME » UPTON 1973



Common Double Crush Syndromes

Median

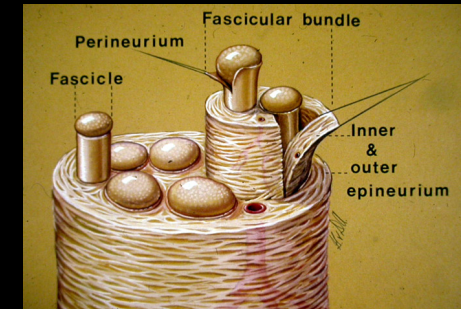
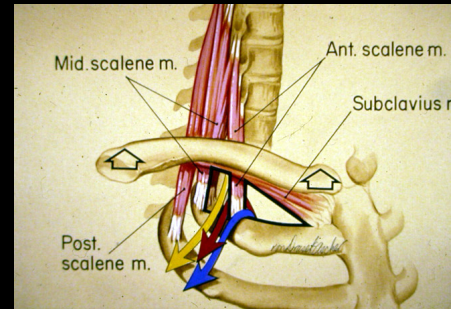
Cervical radiculopathy and carpal tunnel syndrome
 Thoracic outlet and carpal tunnel syndrome
 Pronator syndrome and carpal tunnel syndrome

Ulnar

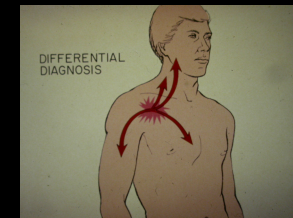
Cervical radiculopathy and carpal tunnel syndrome
 Thoracic outlet and carpal tunnel syndrome
 Cubital tunnel and Guyon's canal syndrome

Radial

Cervical radiculopathy and radial tunnel syndrome



SOUVENT CAUSE D'ERREUR DE DIAGNOSTIC OU DE MAUVAIS RESULTATS !

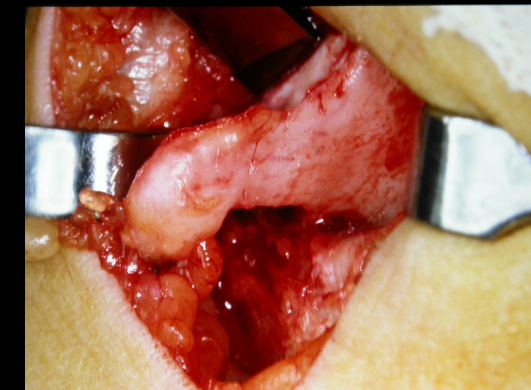
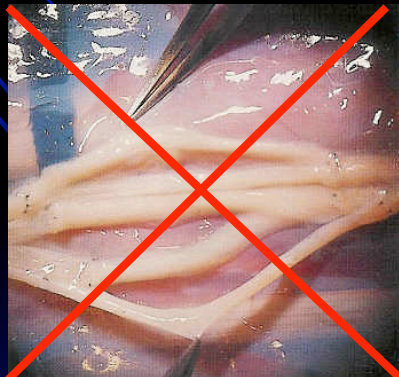
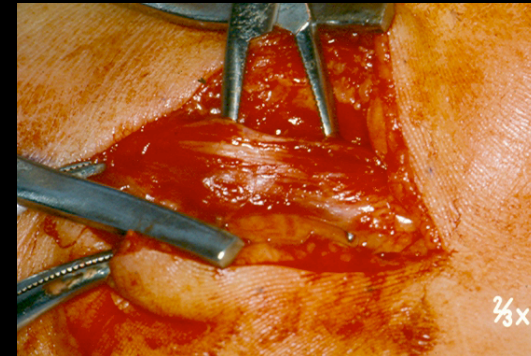


NB: LES NEUROPATHIES TOMACULAIRES: neuropathies héréditaires sensibles à la pression dues à une anomalies du chromosomes 17

LE TRAITEMENT DES ENTRAPPEMENTS

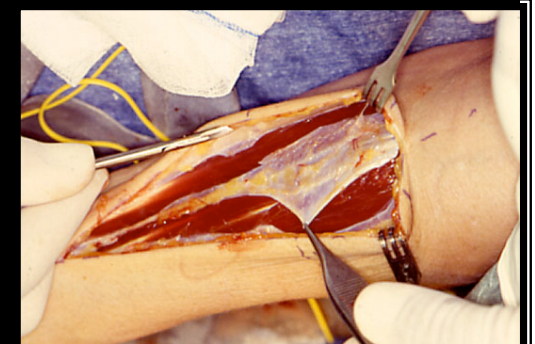
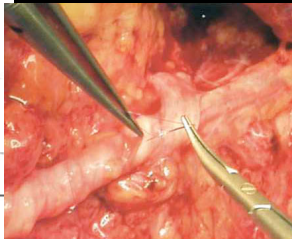
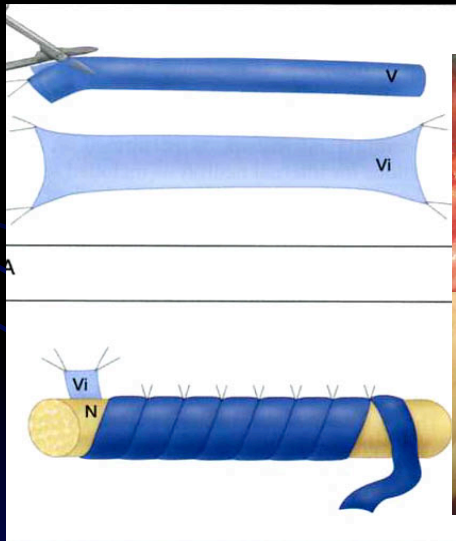
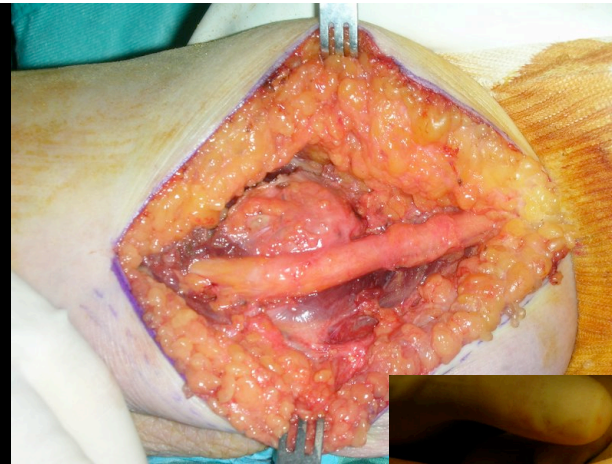
NEUROYLYSE mais en plus:

- **EXCISER LES STRUCTURES COMPRESSIVES**
- **EPINEUROTOMIE ?**
- **NE PAS DEVASCULARISER LE NERF**

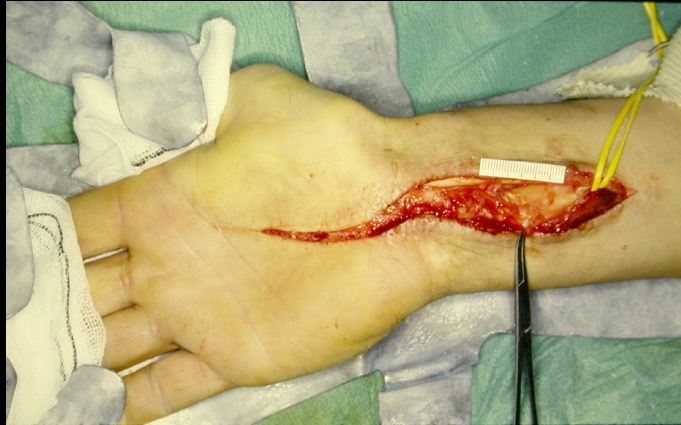


et aussi:

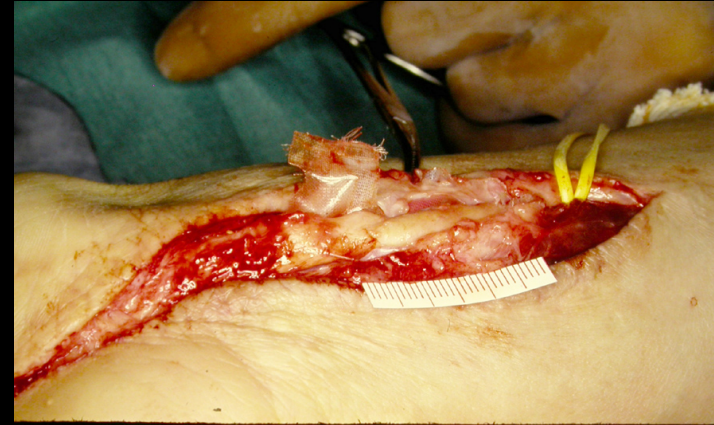
- la transposition,
- le « wrapping »...
- l'utilisation de moyens de glissement



Le silicone : NON



90.12.05 / S.A. SILASTIC N MED



90.12.05 / S.A. SILASTIC N MED



90.12.05 / S.A. SILASTIC N MED

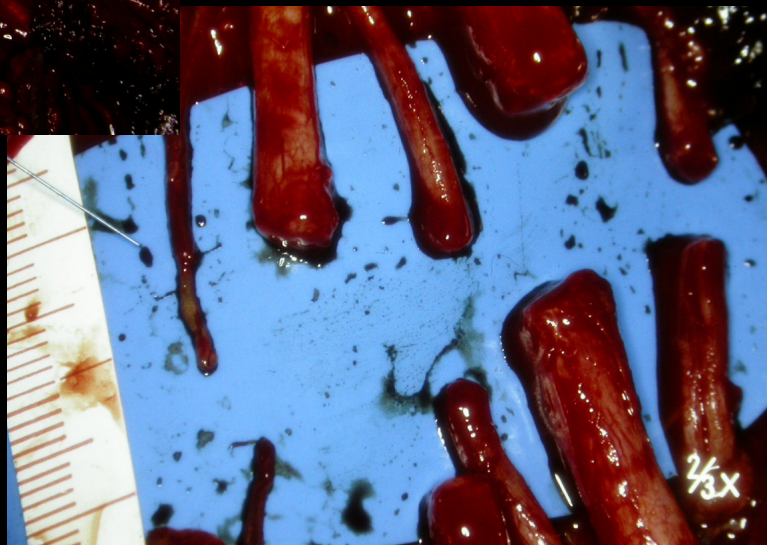
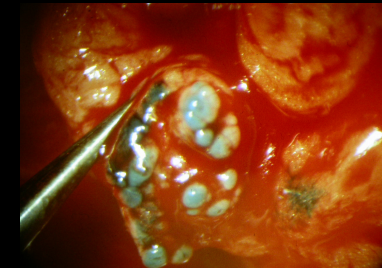


90.12.05 / S.A. - N. MED.

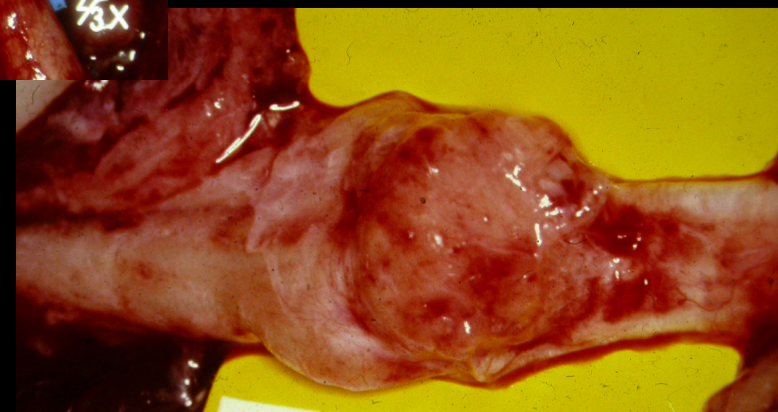
LES INTERRUPTIONS DE CONTINUITÉ



LES AVULSIONS



LES SECTIONS



LES NEVROMES EN CONTINUITÉ

Nerve response to injury :

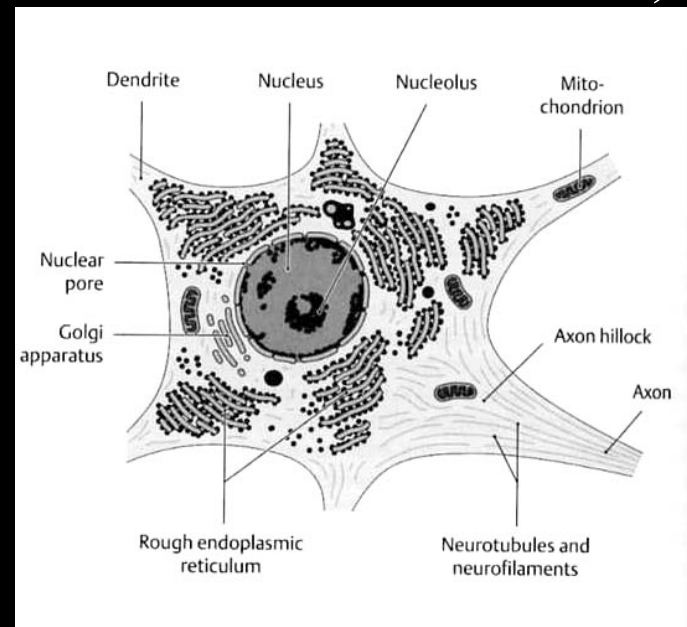
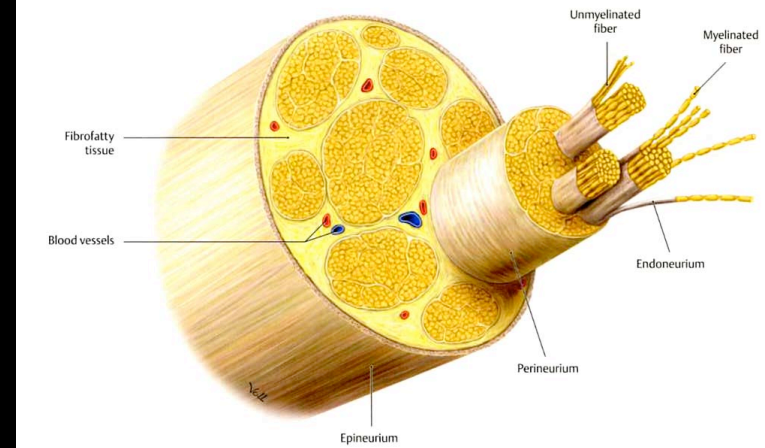
- neuroectodermic origin
 - no division
 - no proliferation of neurons



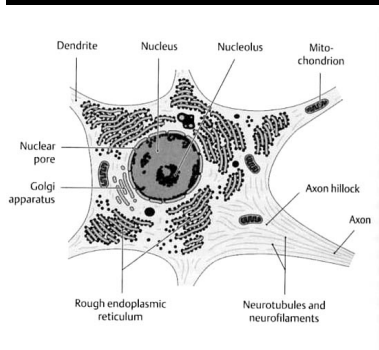
- mesenchymal tissues (scar with fibroblastic reaction)

- Cell body
- Distal nerve
- Proximal stump

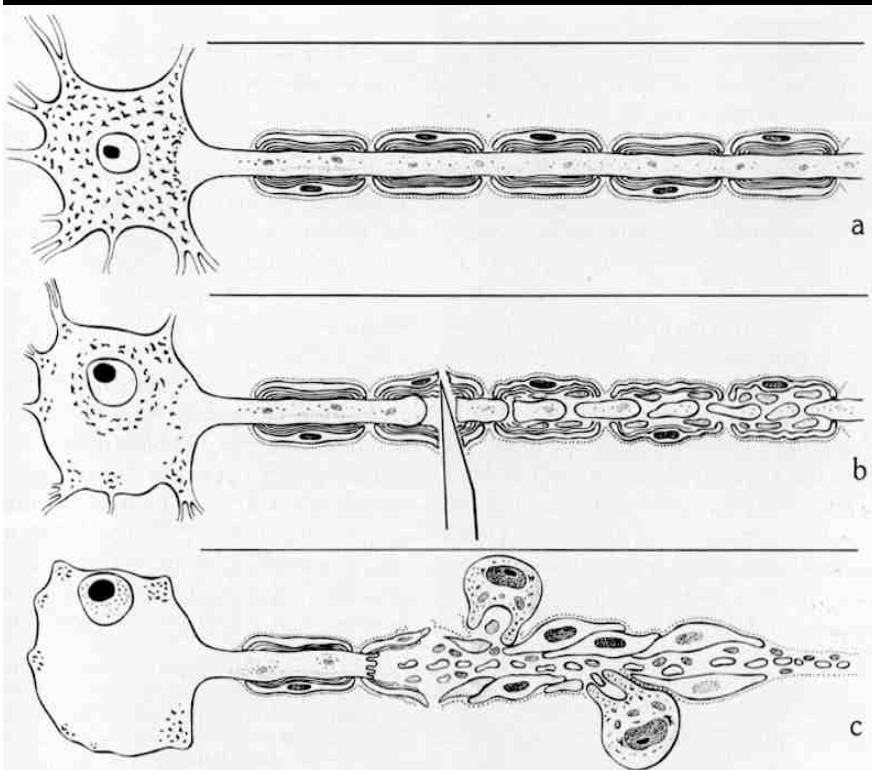
Cortical reorganization !



Cell body :



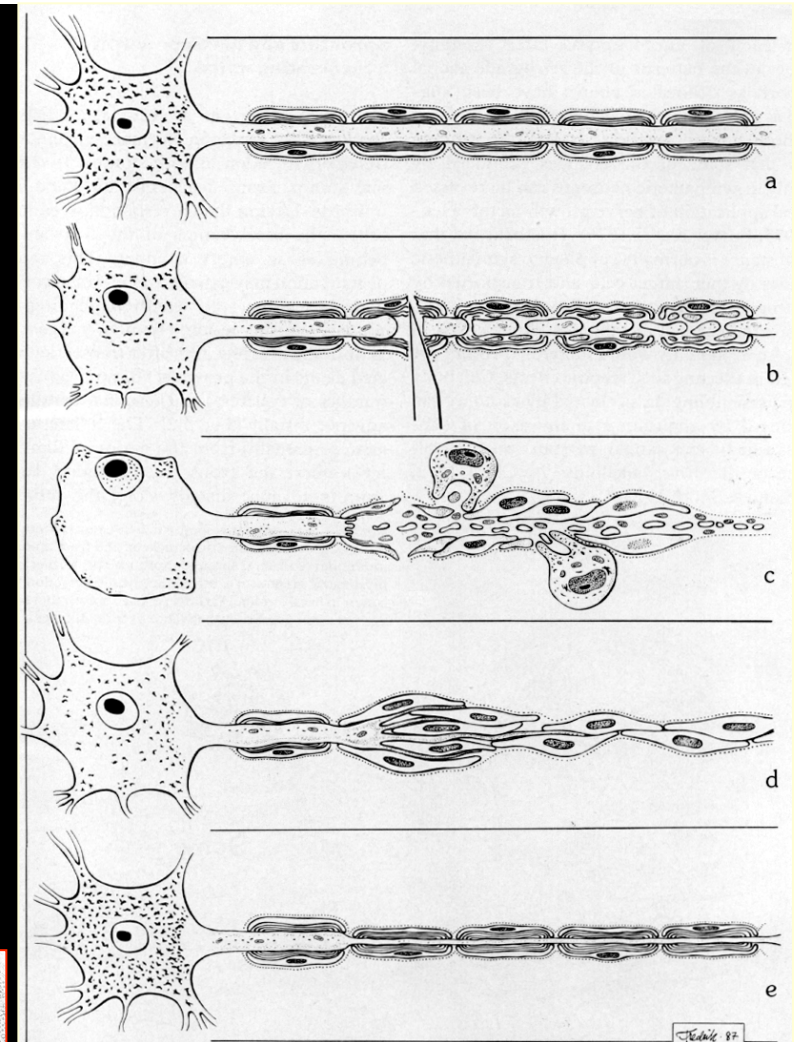
After already several hours,
chromatolysis :
increase of cell body,
breaking up of Nissl substance,
peripheral migration of nucleus,
increased protein metabolism....



Some cells die function of level of injury
(necrosis in case of proximal
lesion - necrosis 20 to 50%
i.e. BP lesions)

Distal nerve :

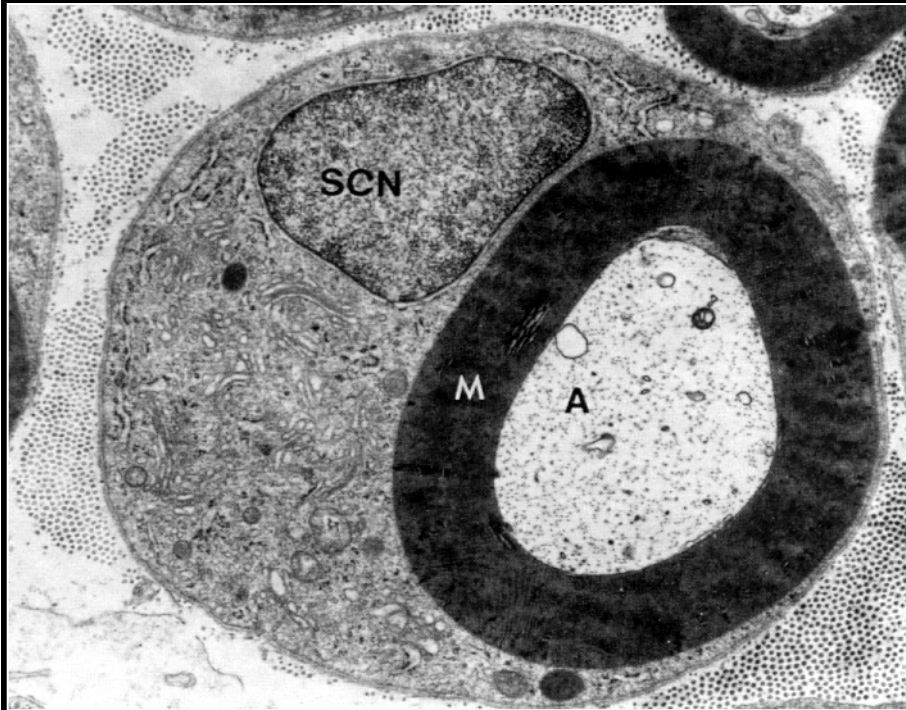
- break-down of myelin and axons (calcium-activated enzymes);
- proliferation of Schwann cells
- macrophagic phagocytosis of axonal debris (1 - 3 months)
- collapse (but persistence) of endoneurial tubes (basal lamina)



Wallerian degeneration

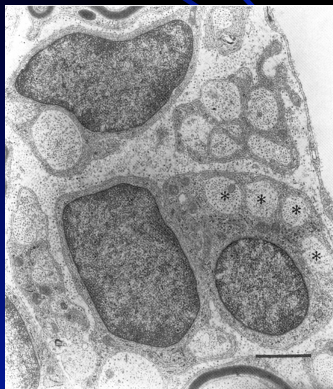
(Waller, 1850)

Wallerian degeneration : 1



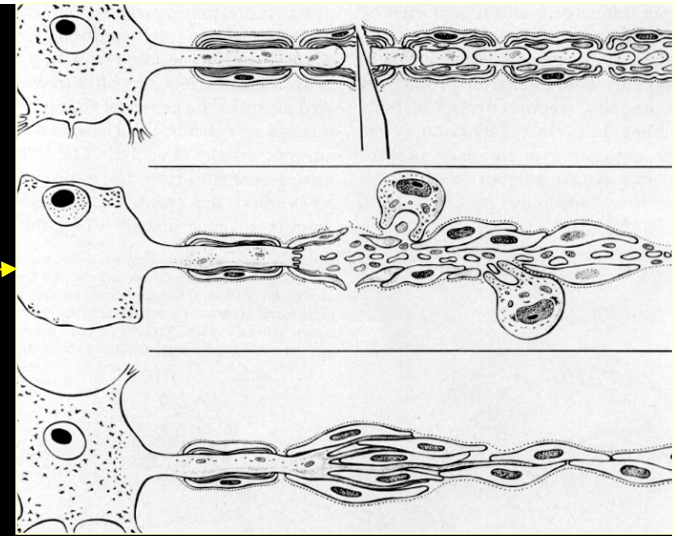
Normal myelinated axon + Schwann cell

**Wallerian degeneration:
myelin degeneration**
(M : myelin debris)



non myelinated axons

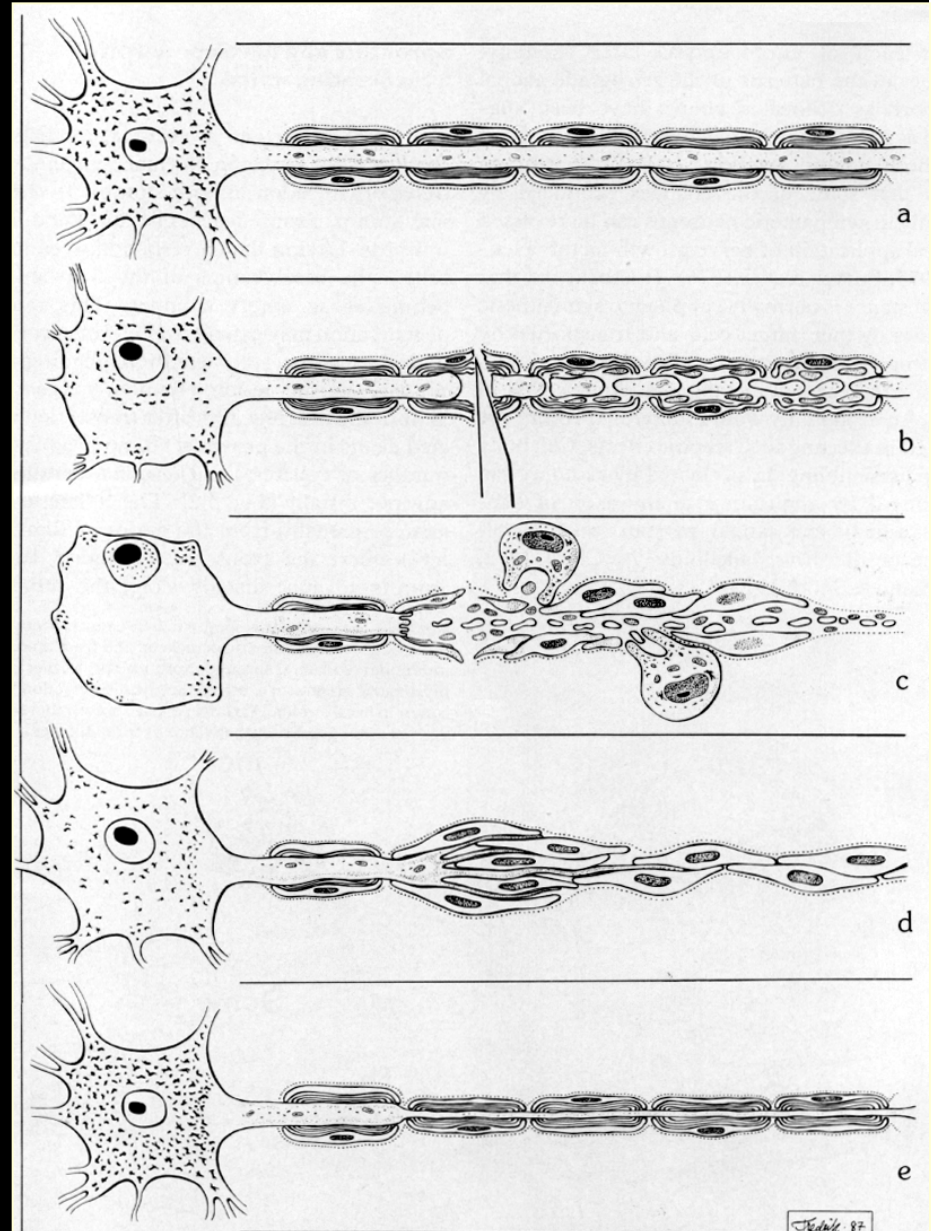
Wallerian degeneration : 2



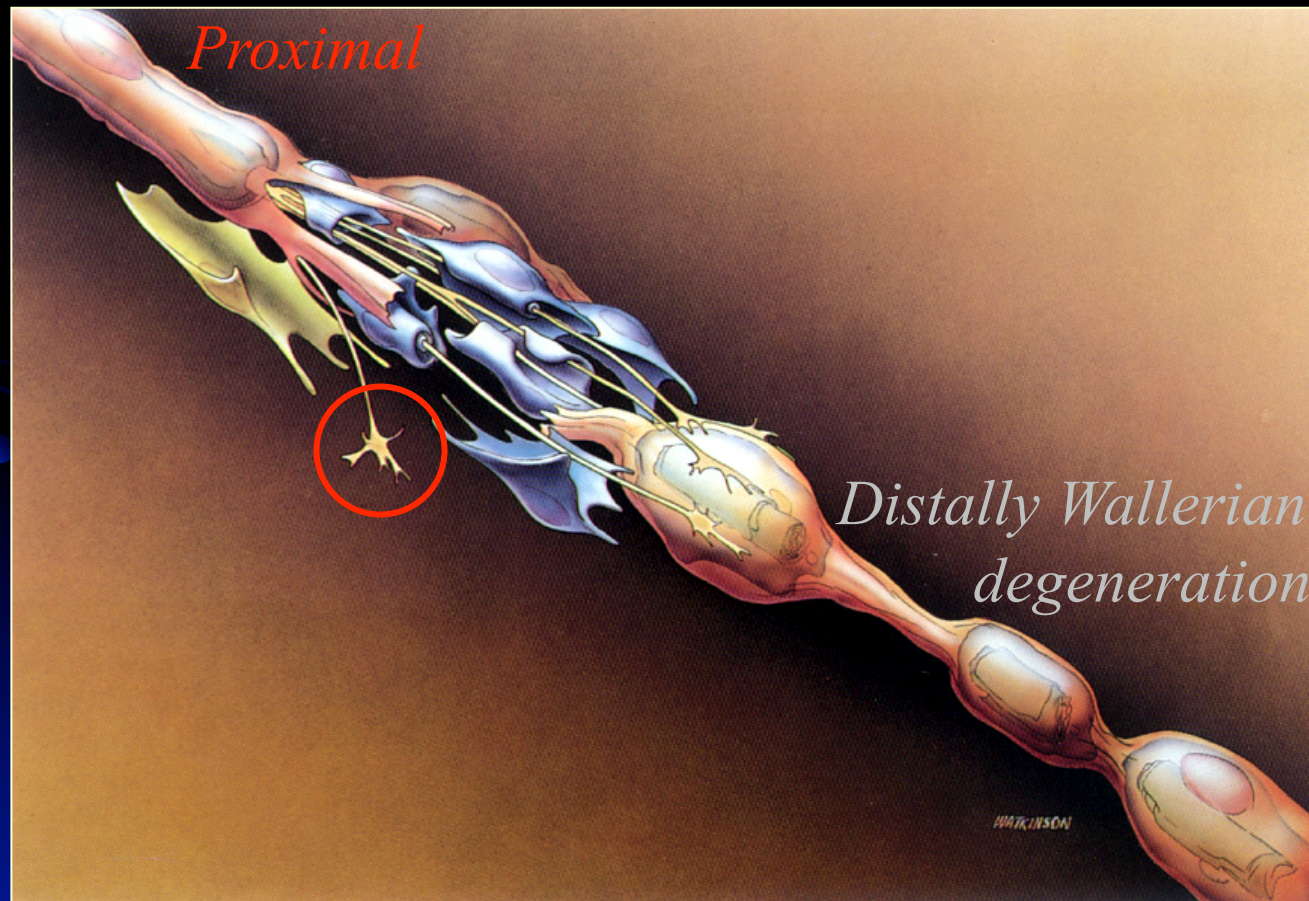
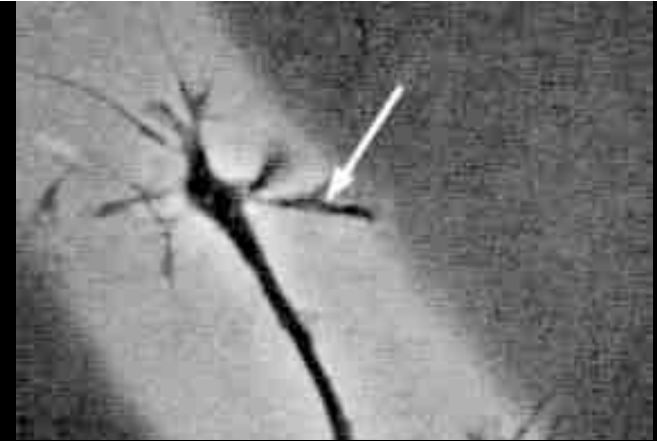
- **phagocytosis of myelin** by macrophages,
- **Schwann cells liberate** various neurotrophic factors
NGF...(survival of cell body and chromatolysis
phenomenons)
- but the **tubes, collapsed, stay** in position with
disorganized Schwann cells

Proximal stump :

- **short Wallerian degeneration**
(a few internodes)
- **sprout of axons :**
 - as early as 24 hours
 - unmyelinated fibers
 - many per axon
 - distally, each sprout has a growth cone (swelled area)

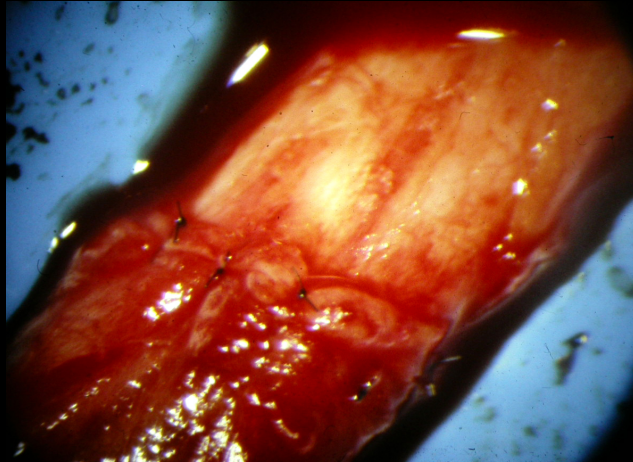


Growth cone :



Filopodia, rich in actin, at the tip of the growth cone, explore the distal environment

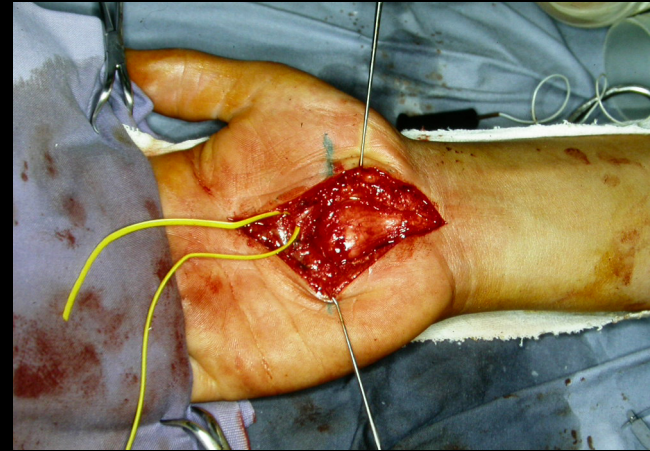
Evolution of growth cone :



encounter with endoneurial tube :

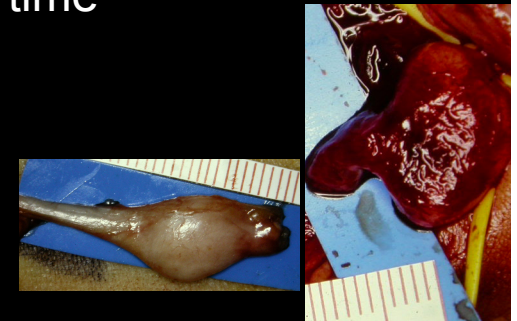
- nerve regeneration following basal lamina,
- up to sensory corpuscle or motor plate
- secondary myelination (neurotrophism, NGF)

Speed : " 1mm a day "



no encounter :

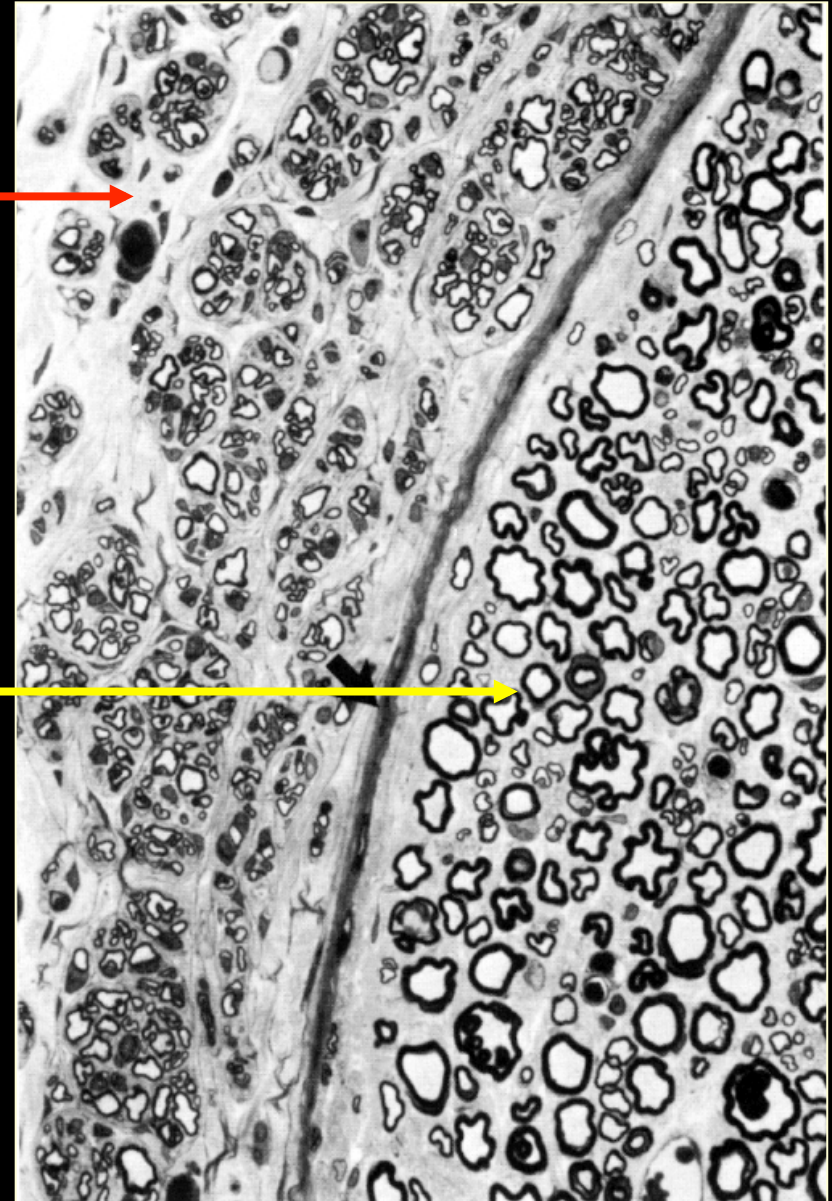
- some fibers disappear
- other form a painful neuroma increasing with time



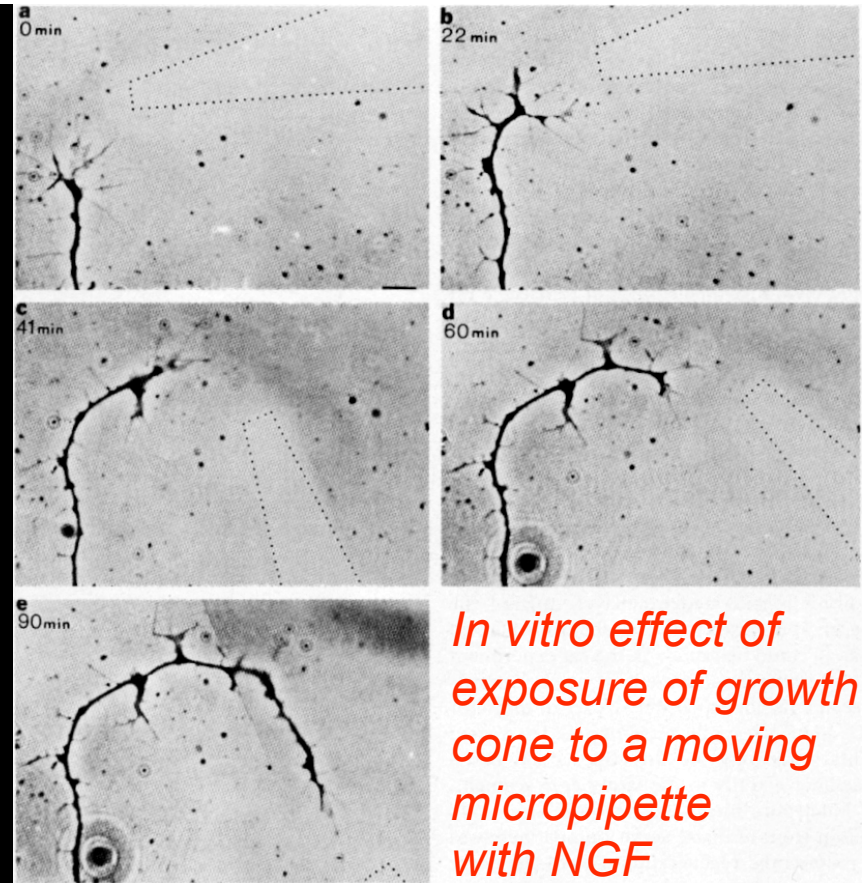
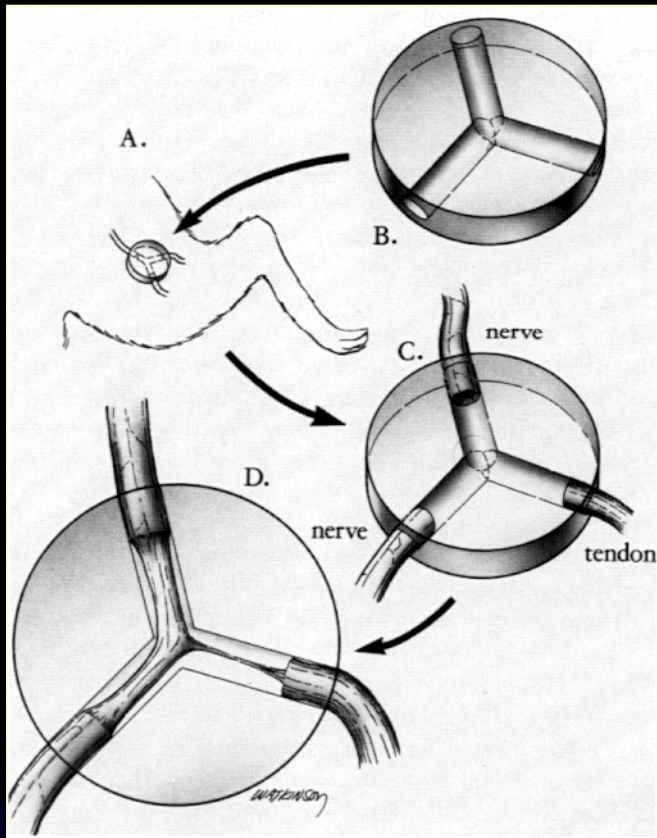
Evolution of growth cone :

No encounter : lost function,
neuroma formation
(extraperineurial space)

*Encounter with perineurial
tube* : nerve regeneration



2 main experiments



Y silicone tube : attraction of rat sciatic nerve towards nerve, and not tendon



**chemical factors
chemotaxis :
Neurotropism**



Neurotropism :

factors that would “attract” the nerve sprouts related to:

chemical factors:

NGF...

contact factors (adhesiveness) :

longitudinal fibrin clot,
segments of nerve graft,
collagen


laminin,

fibronectin (important molecules of endoneurial tubes basal lamina)

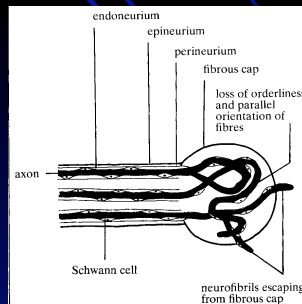
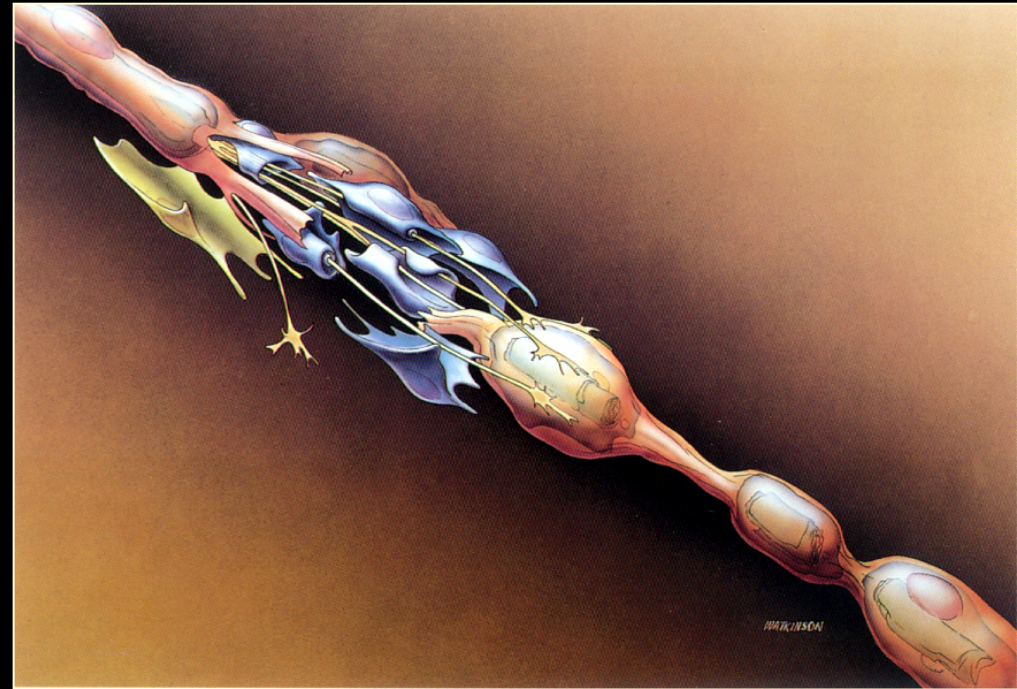
to be distinguished of **neurotrophism**

(factors responsible of maturation/maintain of nerve cell and axon + embryonic development)

but....

- **neurotropism of motor axons towards motor endoneurial tubes** : “preferential motor reinnervation” Brushart et al, 1987
 - ? even **“anatomical” neurotropism** (posterior tibial versus peroneal nerve) Seckel et al, 1986
controversial
 - **critical distance: 5 - 10 mm** (rat::< 2mm or > 15mm: no neurotropism)
 - **repulsive proteins** (various extracellular matrix molecules)
- 

Mais la réinnervation est
un **processus EVOLUTIF** :
aléatoire puis organisé



Implication pour la surveillance d'une suture

Implication pour la formation des névromes

Cortical loss of organization :

- very rapid !
- age-related
- reversible



+ IRM fonctionnelle

Enormous developments in neuroscience

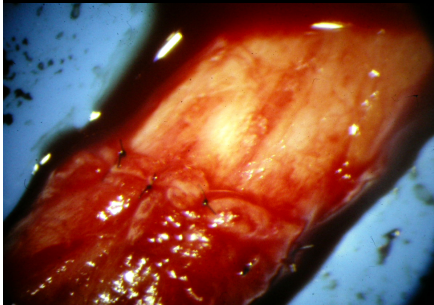
Progresses in surgery :

But no substantial improvement of clinical results from 25 years ago :
complete recovery in an adult remains exceptional

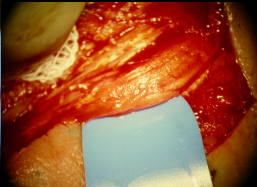
Lundborg, 2000



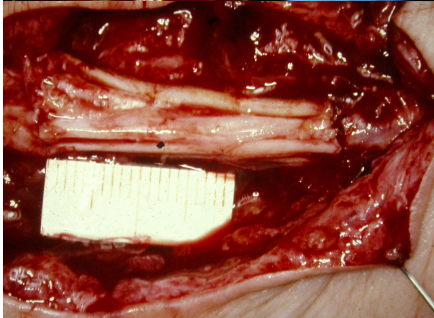
Les réparations



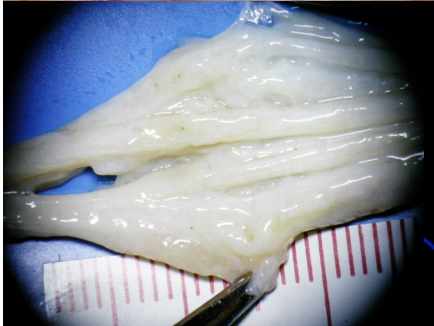
suture (totale ou partielle)



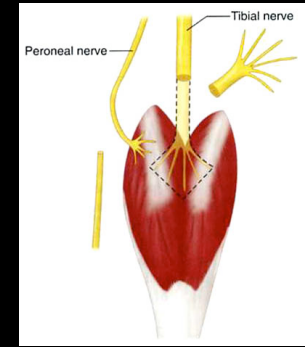
greffe



neurolyse

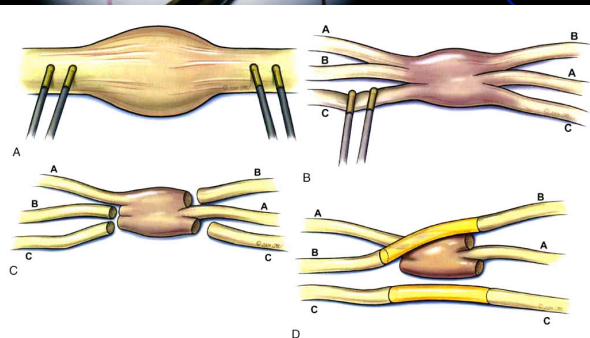
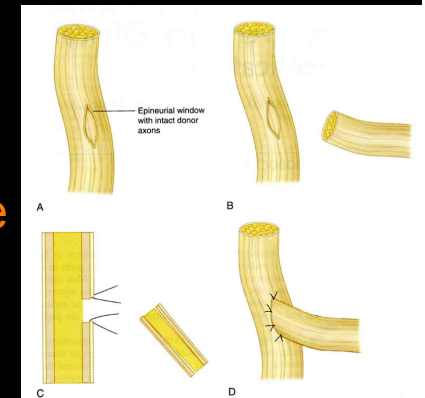


suture termino-latérale



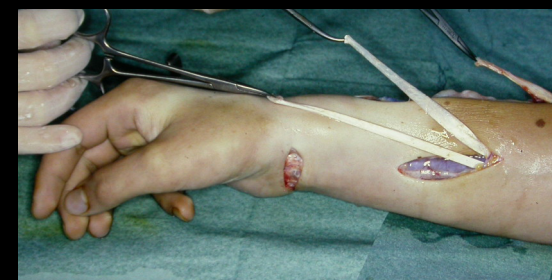
neurotisation

« ? »



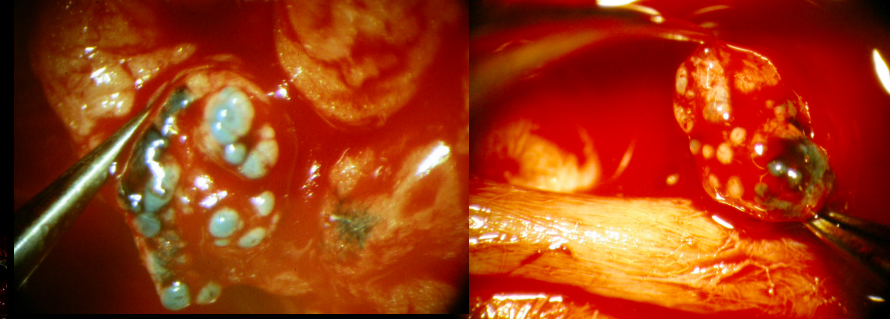
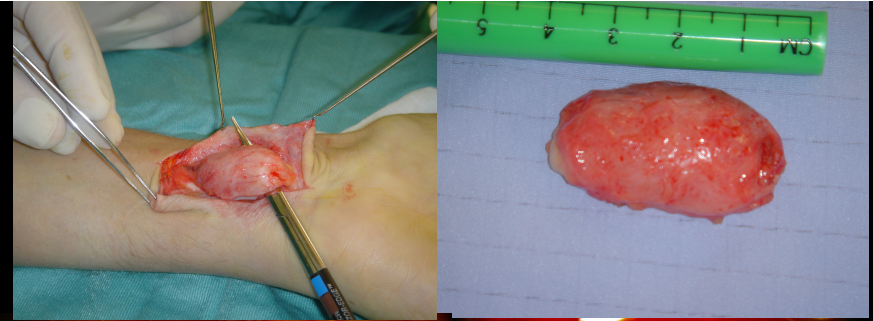
résection secondaire

transferts tendineux

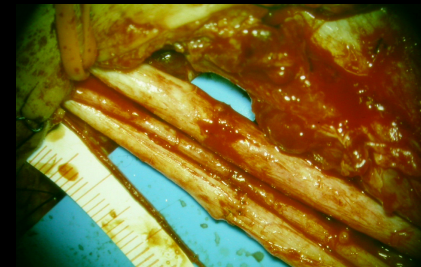
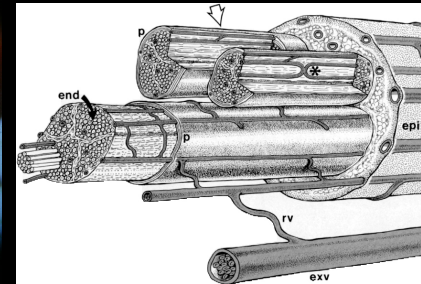
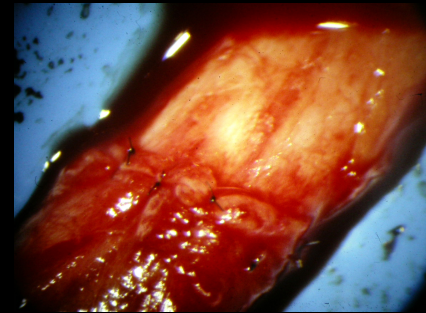


Les grands principes

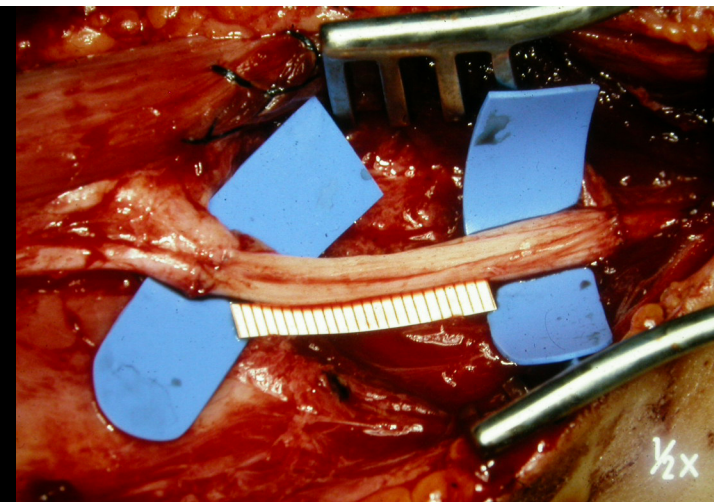
1) recoupe des extrémités



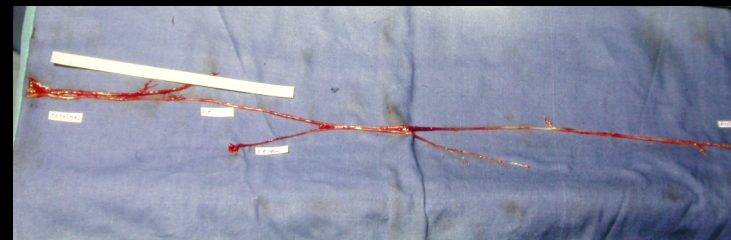
2) suture sans tension
ne pas dévasculariser le nerf



3) avec utilisation de greffe(s)
en cas de nécessité

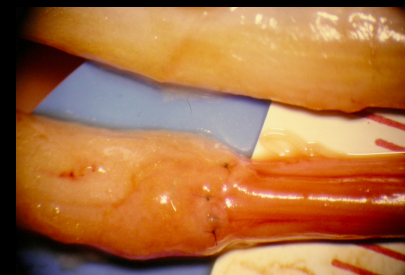


4) greffe prélevée « correctement »

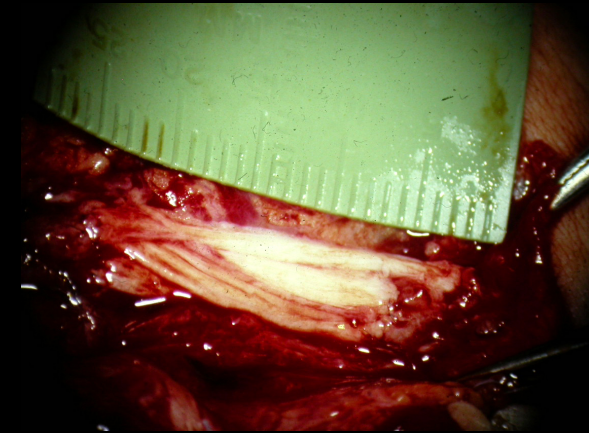


5) greffes « adéquatement placées:
en taille
en nombre

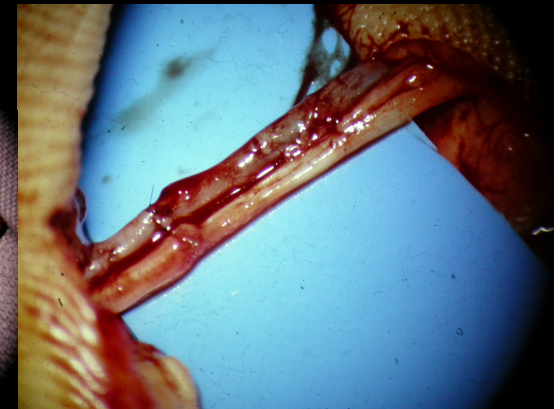
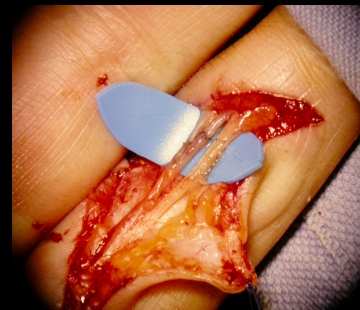
! Nombres d'axones



6) suture faite « sous microscope opératoire »



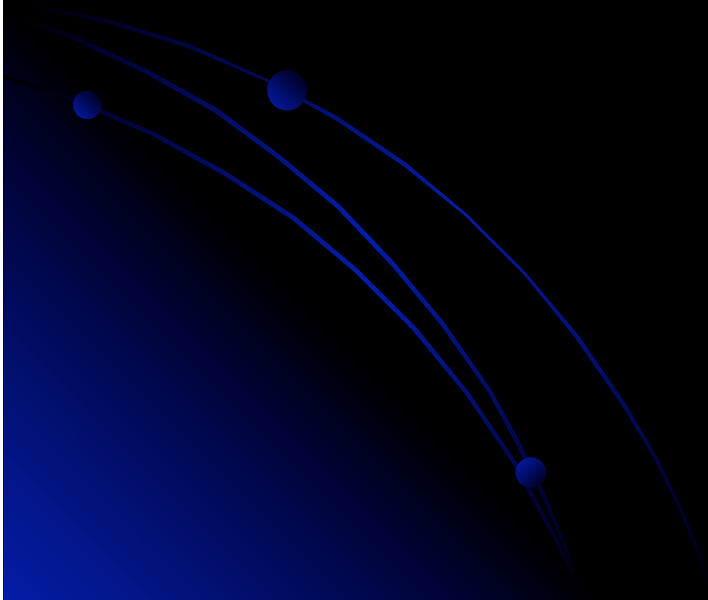
7) réparation artérielle associée



8) « suture en urgence » ?
« window repair = 24h »

9) suture dans une atmosphère adéquate

10) Suture et/ou colle chirurgicale ?



BUTS :

- EVITER LA FIBROSE
- FAVORISER LE PASSAGE AU NIVEAU DE LA SUTURE
- RETABLIR L'ATMOSPHERE INTRANEURALE
- Eviter la colonisation de la tranche de section

