CENTRE HOSPITALIER
UNIVERSITAIRE DE NANTES

Transferts de nerfs chez le Tétraplégique

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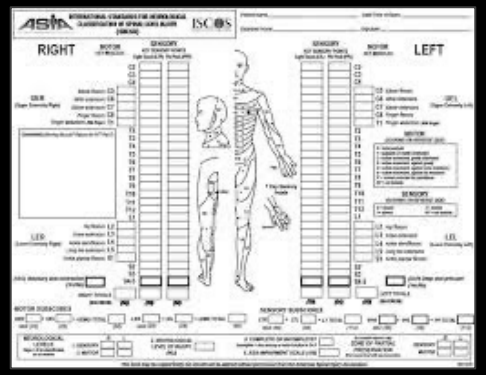
Premier Prérequis

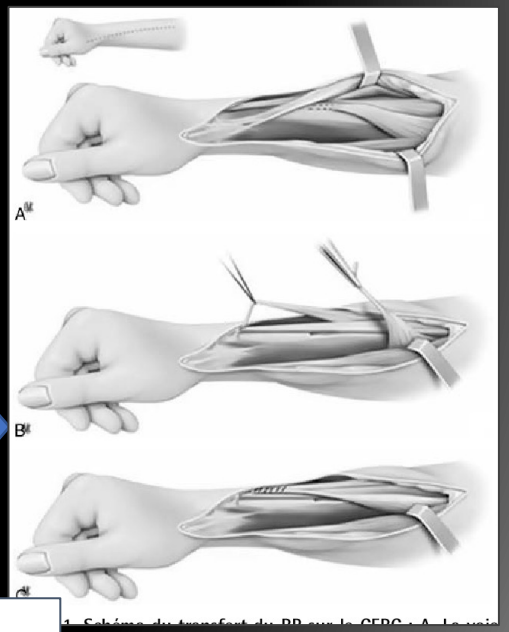
Spinal Cord injury

ASIA (American Society Injury. Association)



tétraplégie

'International Classification for Surgery of the Hand in Tetraplegia (ICSHT) Edimbourg 1978
Ou
Classification de GIENS 1984

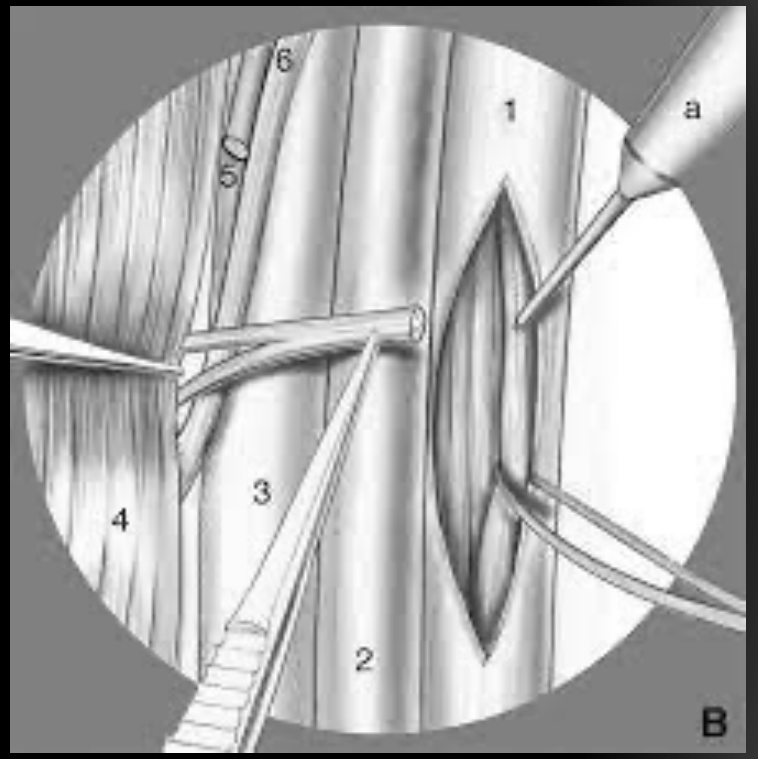


Six mois de stabilité neurologique :
avant d'envisager une chirurgie de réanimation fonctionnelle du membre supérieur

Deuxième Prérequis

Plexus Brachial

Chirurgie des transferts nerveux



Meilleurs résultats si opéré avant 6 mois post-traumatisme

Les neurotisations dans la chirurgie du plexus brachial sont réalisées dans les 6 mois post-traumatisme pour permettre la repousse nerveuse avant que ne disparaissent les plaques motrices du muscle à réinnerver.

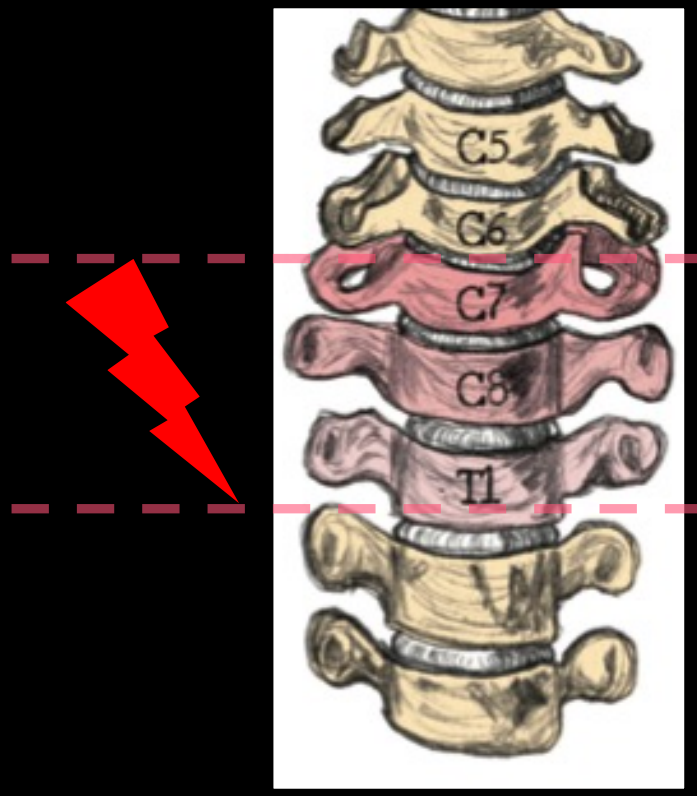
Transfert de Nerfs: Tétraplégique

6 mois de stabilité neurologique

Transfert de Nerfs: Plexus Brachial

6 mois Maxi Post-trauma

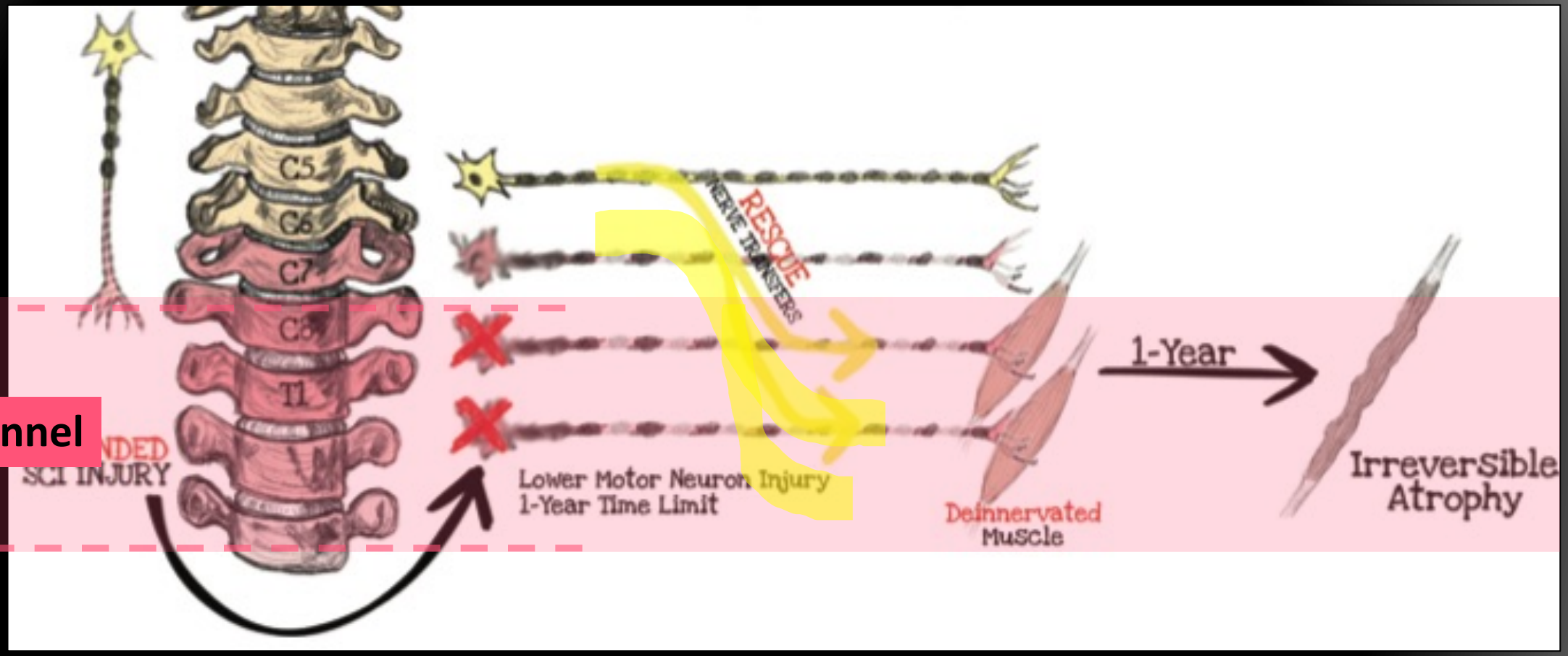
Niveau sus-lésionnel



Niveau Lésionnel

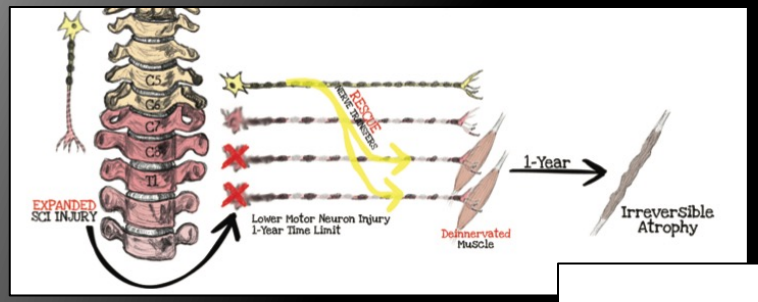
Niveau Sous Lésionnel

Niveau sus-lésionnel

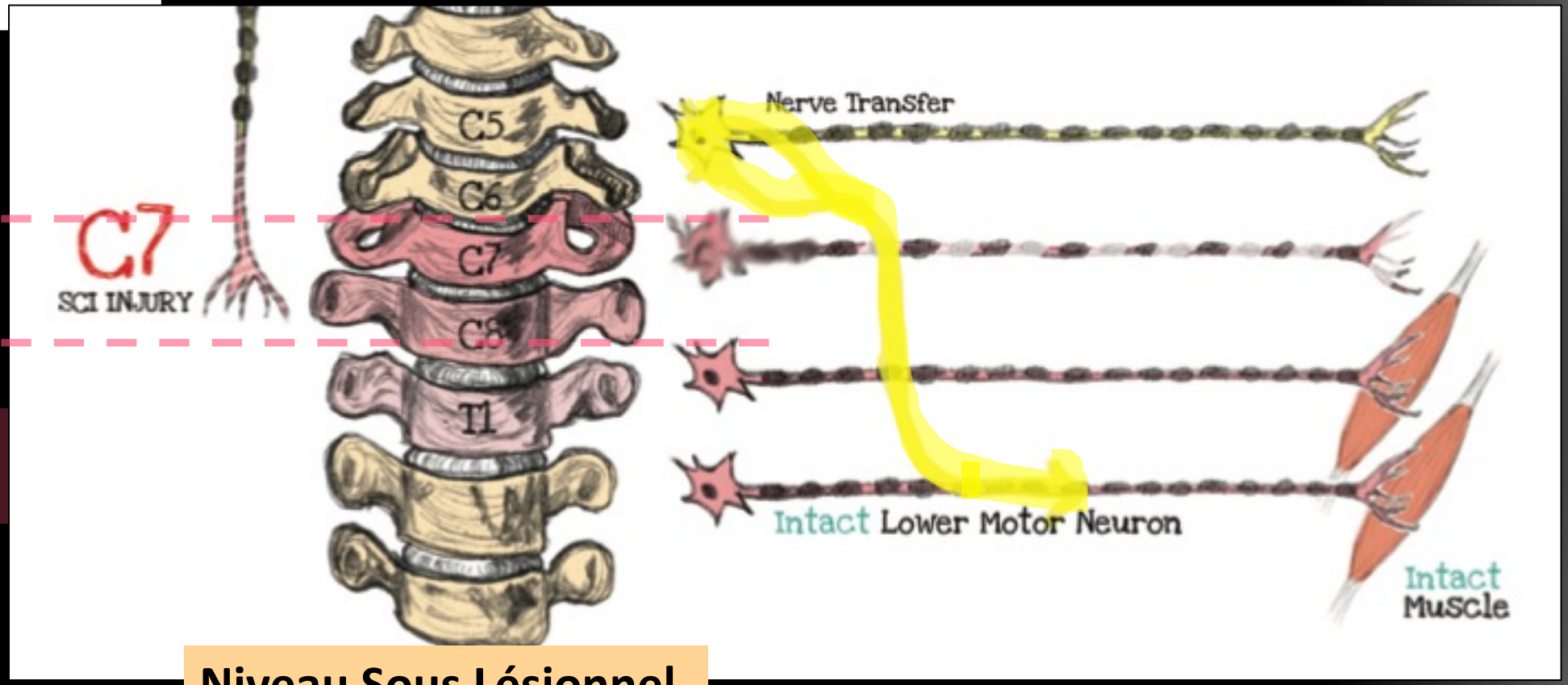


Niveau Lésionnel

Si un transfert de nerf de la zone sus-lésionnel à un nerf de la zone lésionnelle,
il devra être fait dans les 6 mois post-traumatisme, car les corps cellulaires des motoneurones sont abimés.



Niveau Lésionnel



Niveau Sous Lésionnel

Si un transfert de nerf de la zone sus-lésionnel à un nerf de la zone sous-lésionnelle, il n'y a pas de contrainte de temps, car les corps cellulaires des motoneurones sont intacts.

Spinal Cord injury

ICSHT GROUP	Muscle≥ MRC Grade 4
0	No muscle below elbow ; Brachialis
1	B-R ; Supinator
2	ECRL
3	ECRB
4	PT
5	FCR
6	Finger extensors
7	Thumb extensors
8	Partial digital flexors
9	Lack only intrinsics
X	Exceptions

Extension Coude

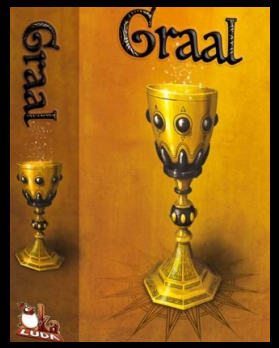
Extension Poignet

Key grip

Grasp

Extension/Ouverture des Doigts

Opposition du Pouce



Progression des objectifs de la réanimation fonctionnelle du membre supérieur Chez le tétraplégique , en fonction du nombre de muscles transférables

Listes des transferts de nerfs chez le tétraplégique

Donor nerve/branch	Recipient nerve/branch
Posterior/middle deltoid branch	Triceps
Posterior division of axillary branch	Radial
Posterior division of axillary branch	Triceps
Anterior division of axillary branch	Triceps
Supinator	Post. Interos. Nerve
Distal ECRB	LFP of Ant. Interos. Nerve
Brachialis	Ant. Interos. Nerve
Brachialis	ECRL
Musculocutan.	Median
Terres Minor	Triceps
Brachialis	Triceps

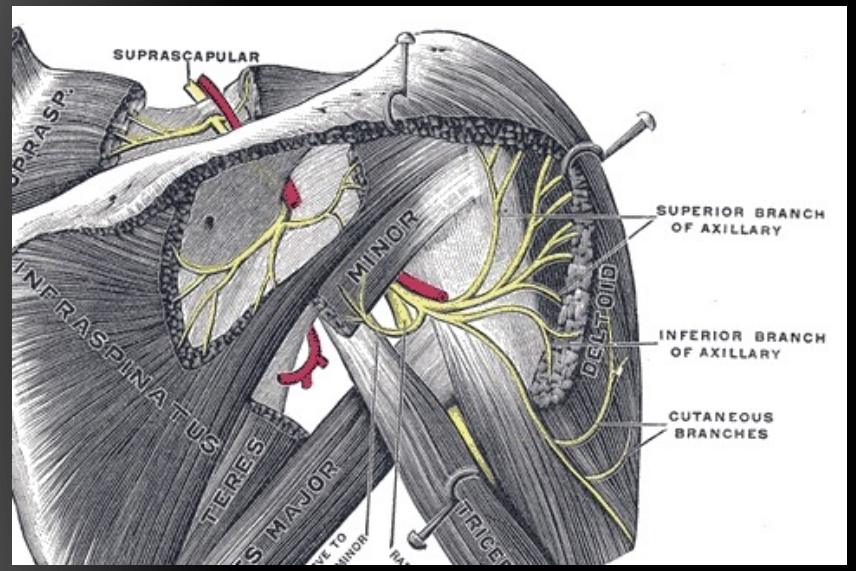
Cain 2015
J Brachial Plex Periph Nerve Inj; 10:e34-e42

Donor	Recipient
Elbow extension	
Teres minor	Triceps
Posterior deltoid	Triceps
Brachialis	Triceps
Thumb/finger extension	
Supinator	Posterior Interos. Nerve
Pinch Graps	
Distal ERCB	Flexor Pol. Longus
Brachialis	Anterior Interos. Nerve
Wrist Extension	
Brachialis	ECRL

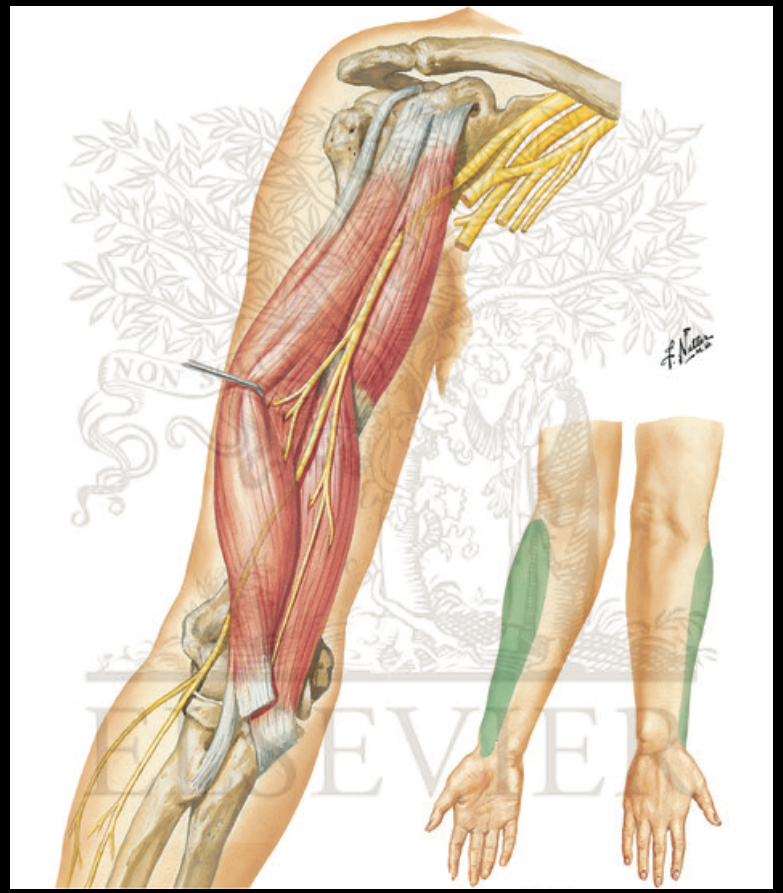
Comparaison entre le muscle transférable et le nerf innervant ce muscle transférable

Muscle	Donor Tendon	Nerve Tranfer
Deltoid C5	√	√
Triceps C6-7-8 : restored		
Biceps C5	√	
Brachialis C5		√
Supinator C5		√
Brachioradialis C5/6	√	
ECRL C6	√	
ECRB C6	√	√
Ponator Teres C5/6	√	
Flexor carpi radialis C7	√	
Extensor digitorum Comm.C7/8 : restored		
Extensor pollici longus C7/8 : restored		
Partial digital flexors C8-T1 : restored		
Lacks only intrinsic muscle function C8-TH1		

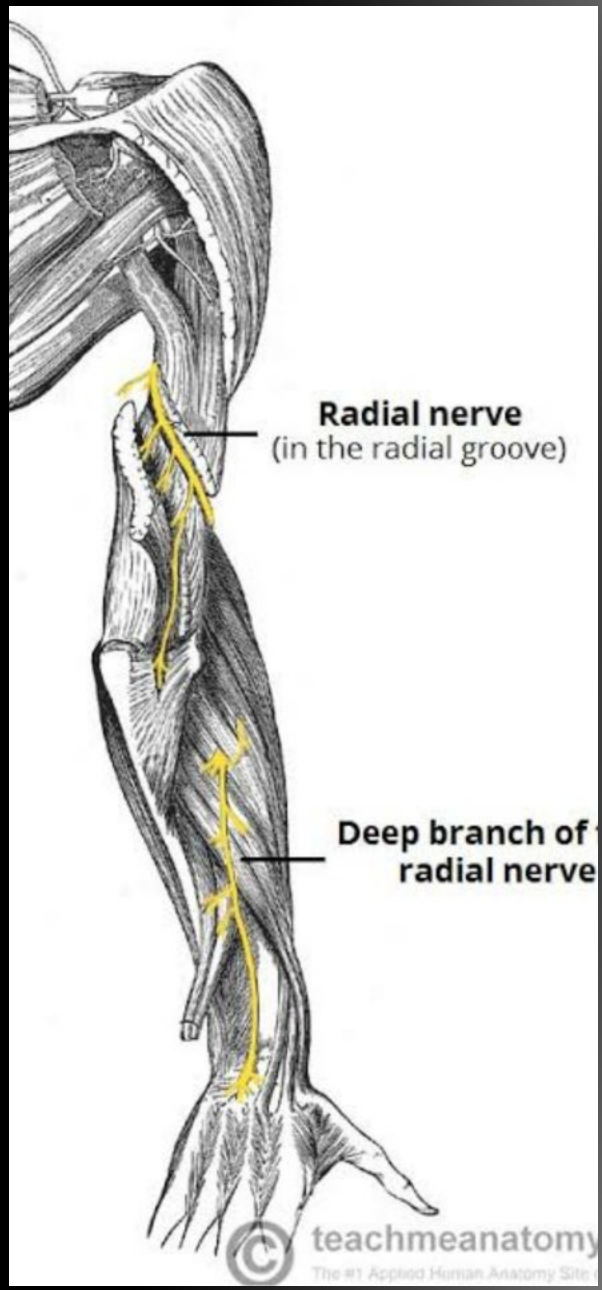
Nerf axillaire



Nerf musculocutané



Nerf radial



N.Teres minor à N. Longue portion du triceps

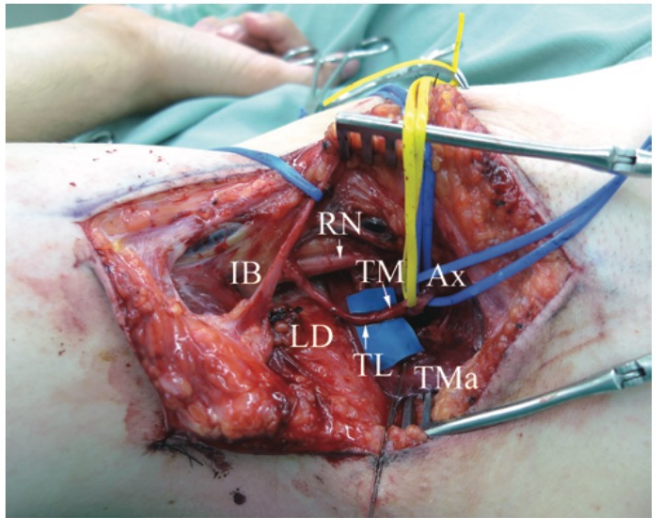
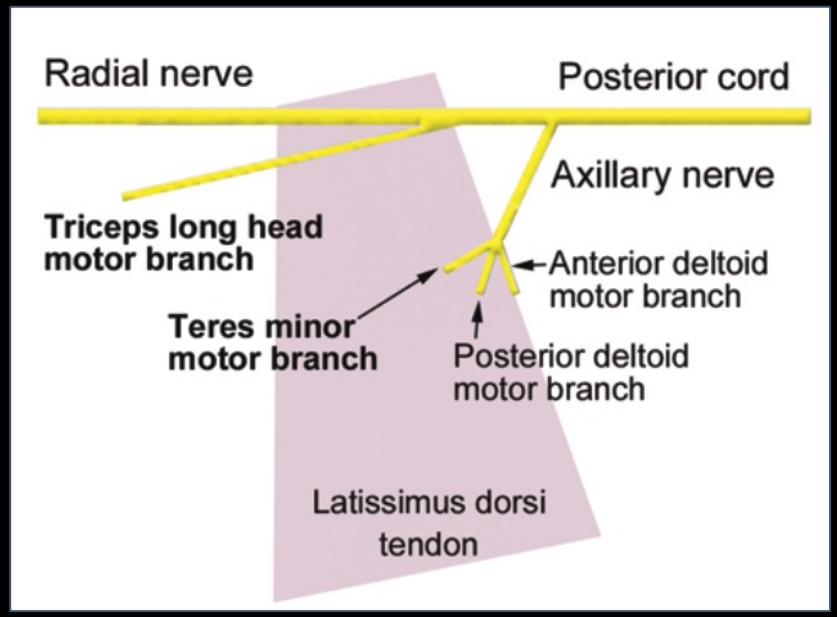
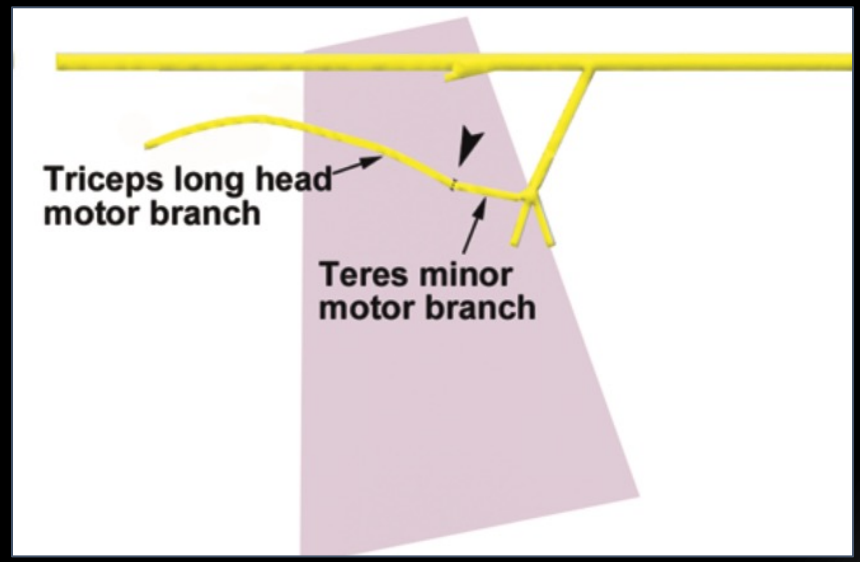


Fig. 2. Intraoperative view of the transfer of the teres minor (TM) motor branch to the triceps long (TL) head motor branch. Note the adequate diameter matching between the nerve stumps. Also, observe that coaptation is tension free. Ax = axillary nerve; IB = intercostobrachial nerve; LD = latissimus dorsi tendon; RN = radial nerve; TMa = teres major.





N.Supinator à N.Interosseux Postérieur

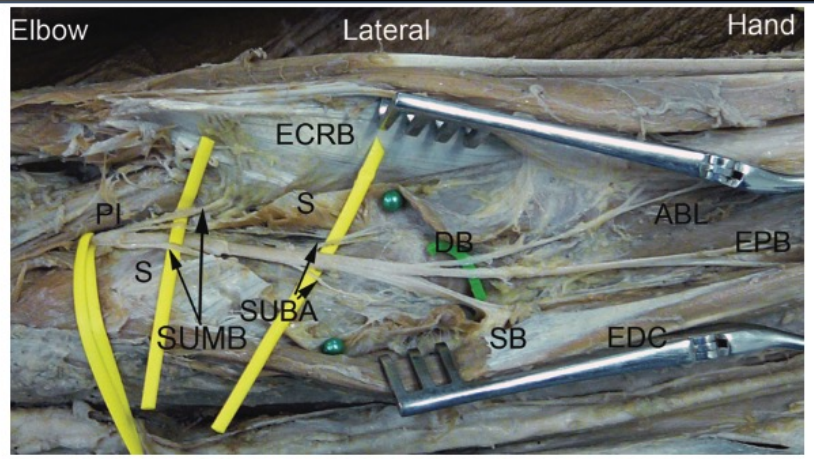
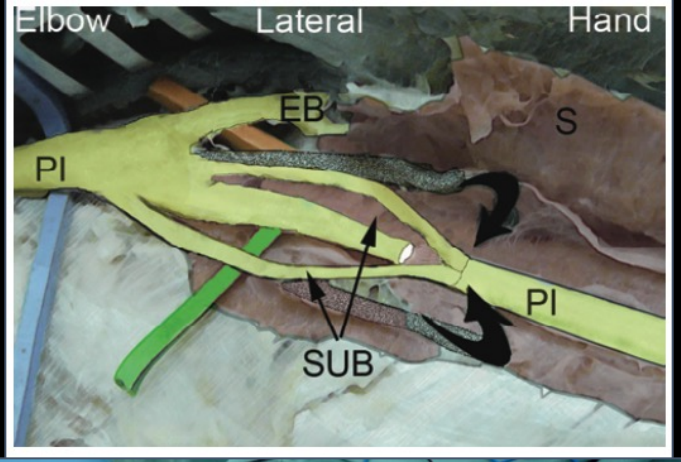
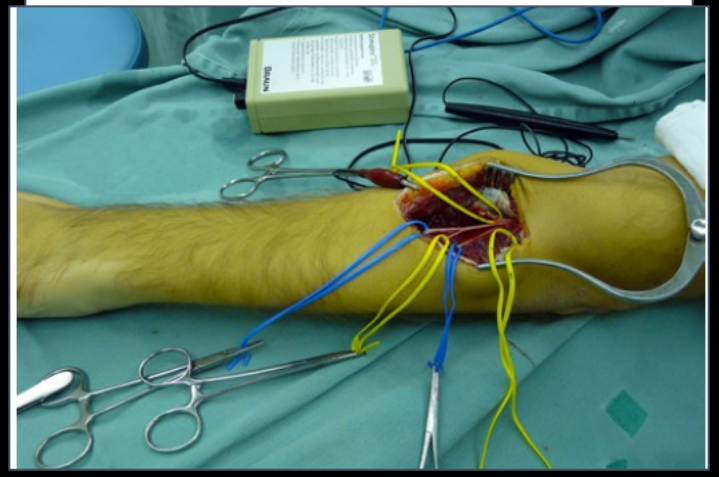


FIG. 1. Photograph of the dissection of the posterior interosseous (PI) nerve and its branches on the posterior aspect of the right forearm in the fully pronated position. Dissection of the posterior interosseous nerve is conducted via access between the extensor carpi radialis brevis (ECRB) and the extensor digitorum communis (EDC). Note the 2 main branches, which arise proximal to the supinator border (SUMB). The lateral branch supplies the superficial head, whereas the medial branch supplies the deep head of the supinator (S) muscle. At the distal limit of the supinator muscle, the posterior interosseous nerve divides into a superficial (SB) and a deep (DB) branch. The superficial branch innervates the extensor digitorum communis, the extensor carpi ulnaris, and the extensor digiti quinti. The deep branch innervates the abductor pollicis longus (ABL), the extensor pollicis brevis (EPB), the extensor pollicis longus, and the extensor index proprius. SUBA = accessory branches to the supinator muscle.





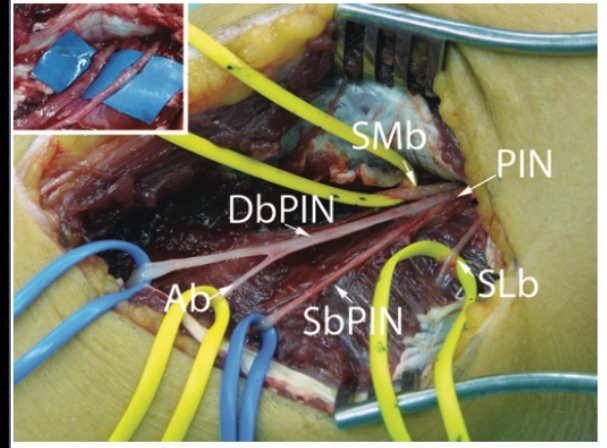


FIG. 2. Intraoperative view of the dissection of the supinator nerves; note the medial (SMb) and lateral (SLb) branches, and the posterior interosseous nerve (PIN). The particularity in this patient was a proximal division of the PIN into its superficial (SbPIN) and deep (DbPIN) branches. The superficial posterior interosseous innervates the extensor digitorum communis, the extensor digit quinti, and the extensor carpi ulnaris. The deep branch of the posterior interosseous nerve innervates the abductor pollicis longus (Ab), the extensor pollicis longus, and the extensor indicis proprius. *Inset:* The surgical connections of the medial branch of the supinator nerve to the deep branch of the posterior interosseous nerve, and of the lateral branch of the supinator nerve to the superficial branch of the posterior interosseous nerve are seen.

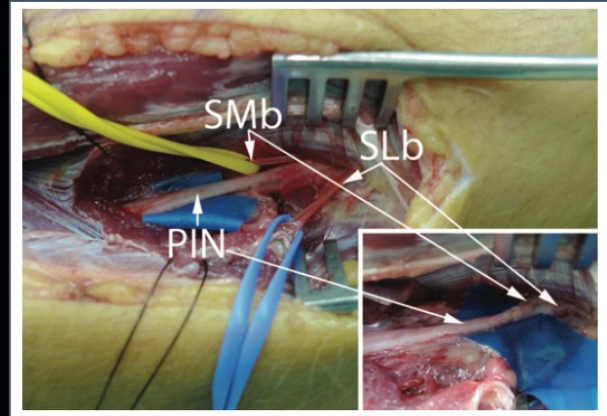


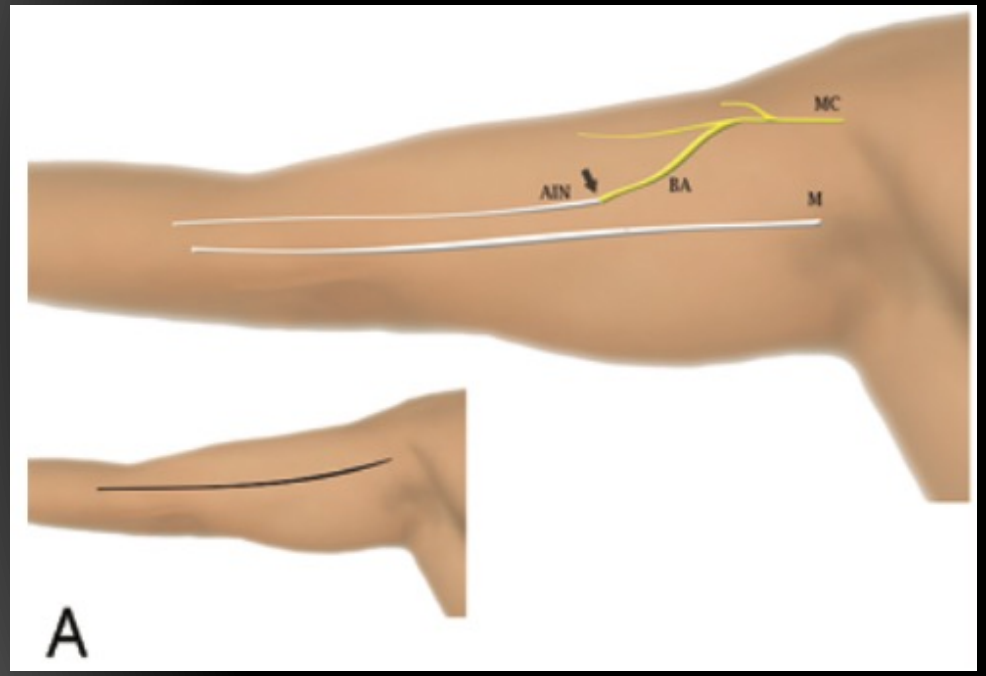
FIG. 3. Intraoperative view after dissection of the posterior interosseous nerve and the medial and lateral branches to the supinator muscle. Different from the patient shown in Fig. 2, in this patient the posterior interosseous nerve did not divide within the supinator muscle. *Inset:* The surgical coaptation of the posterior interosseouos nerve with the supinator branches is demonstrated.

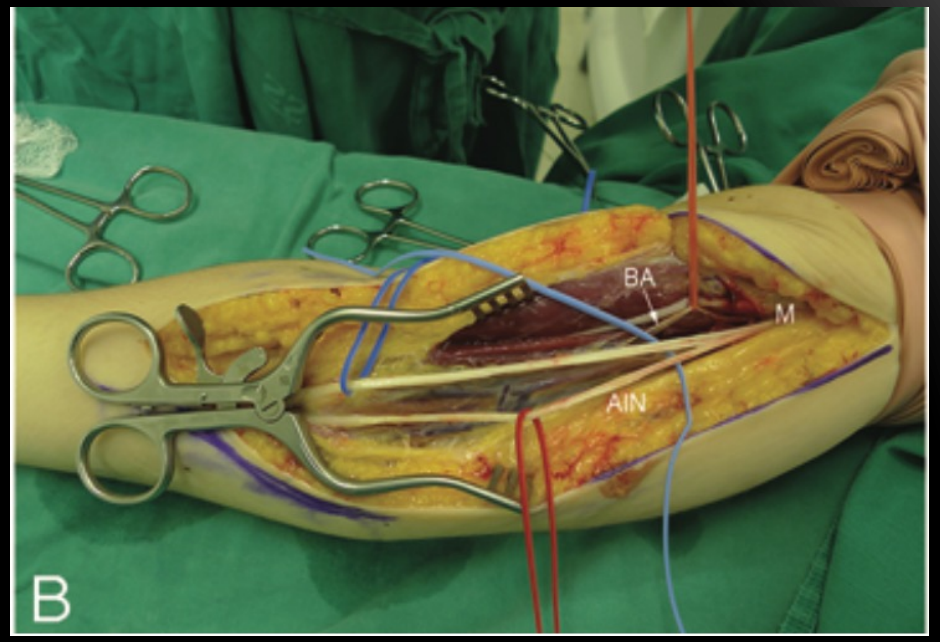
For hand opening nerve transfer: supinator nerve to PIN transfer

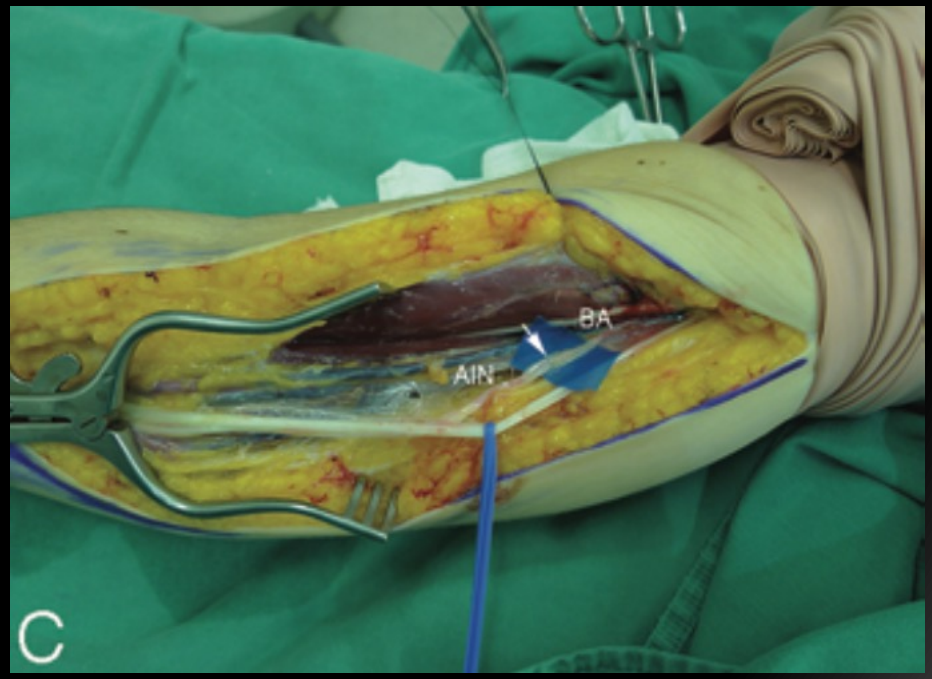
DONOR function	Examine for NORMAL supinator function (MRC 5)
Redundant function	Examine for NORMAL biceps (MRC 5) (will maintain forearm supination after nerve transfer is done)
DONOR EMG testing	For the supinator nerve donor, consider testing supinator and biceps muscles
RECIPIENT function	Examine for absent thumb, finger extension (MRC 0)
RECIPIENT CMAP	CMAP radial (recording done from the EIP) recipient in millivolts: CMAP > 2 – best outcome CMAP 1-2 – suboptimal (intraoperative stimulation required to make final decision) CMAP absent – unable to do transfer
RECIPIENT EMG testing	Consider testing EPL, EDC, EIP, EDQ, ECU muscles

N. Brachialis à N. Interosseux antérieur

Extensif rétrograde

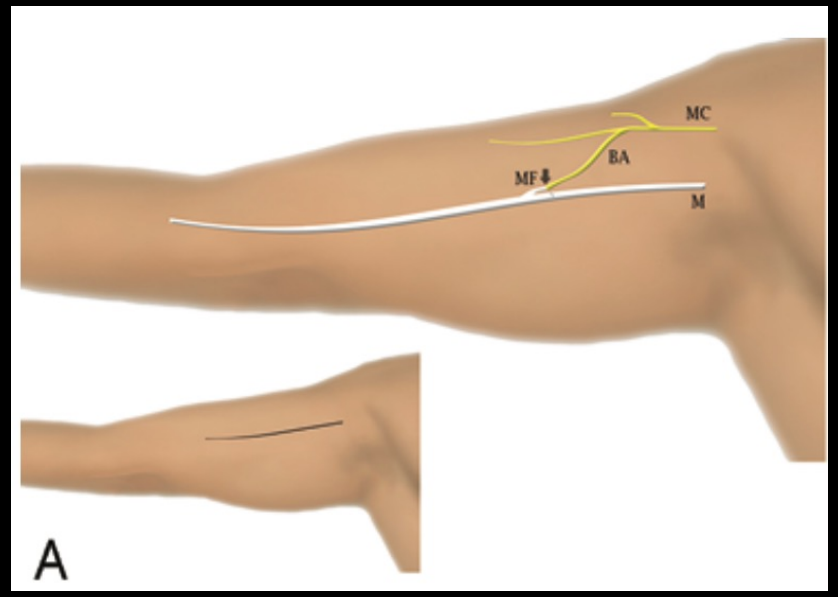


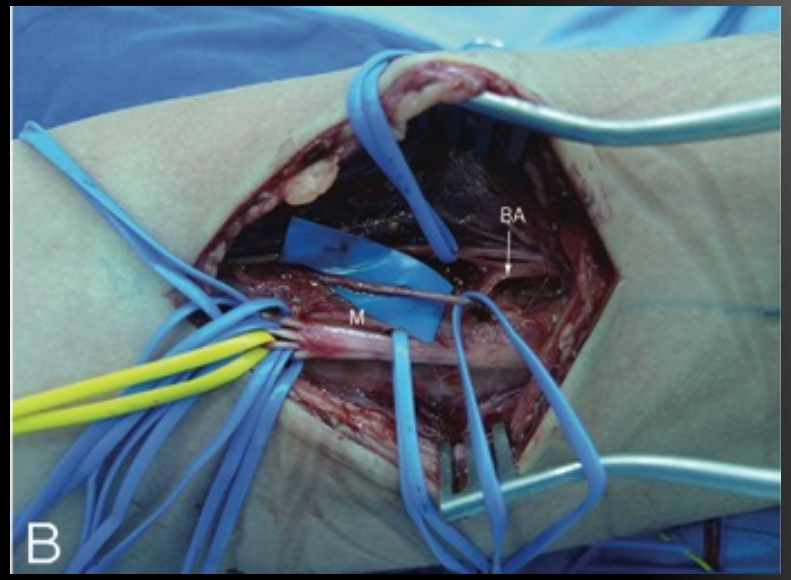


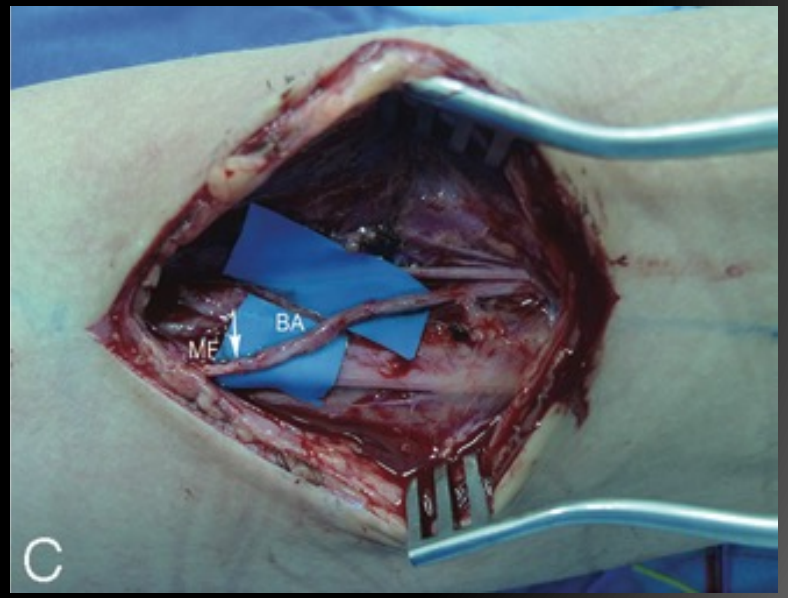


N. Brachialis à N. Interosseux antérieur

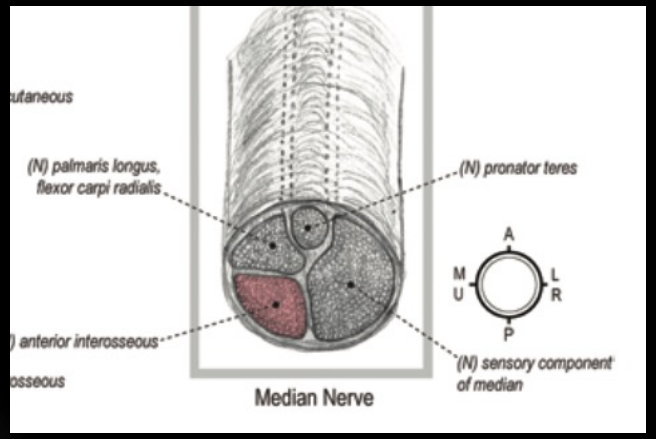
Abord Minimum



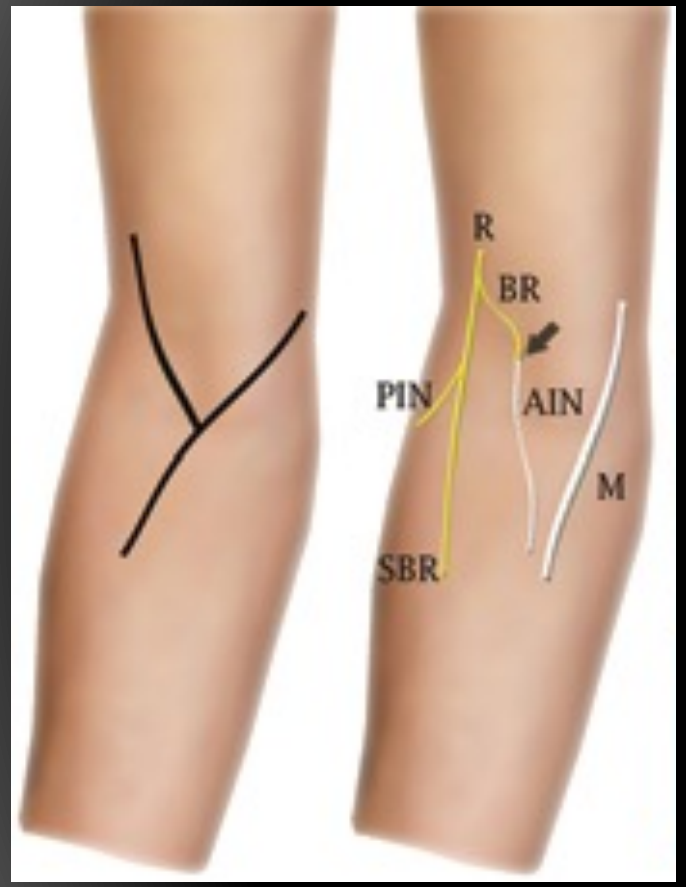




Postéro-Médial



N. Brachioradialis à N. Intereosseux antérieur



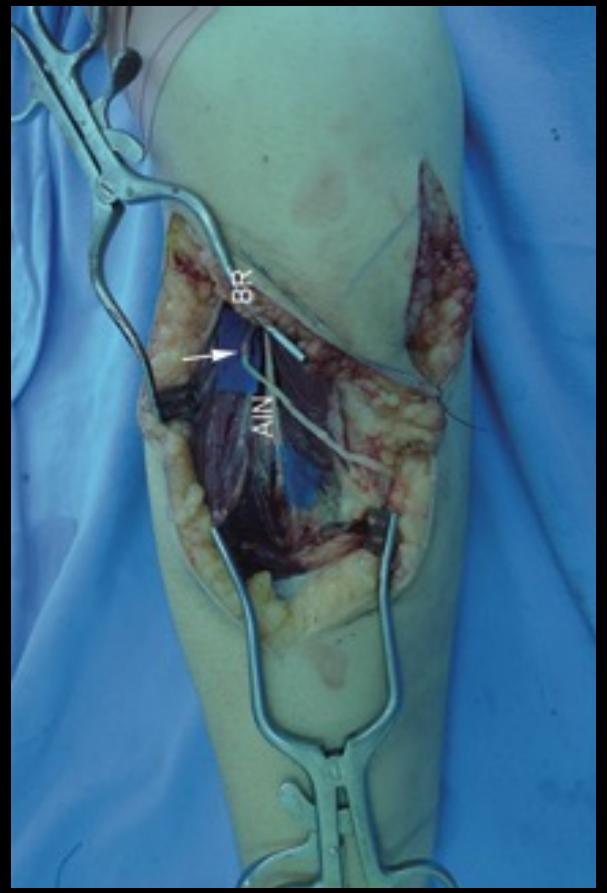
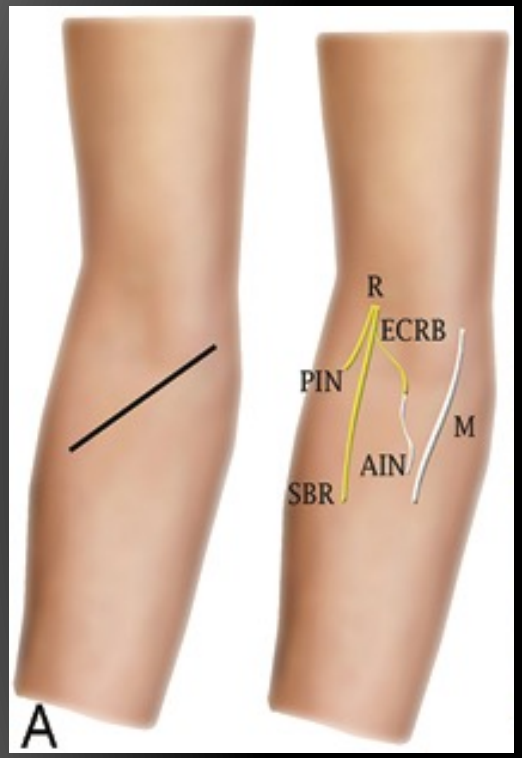
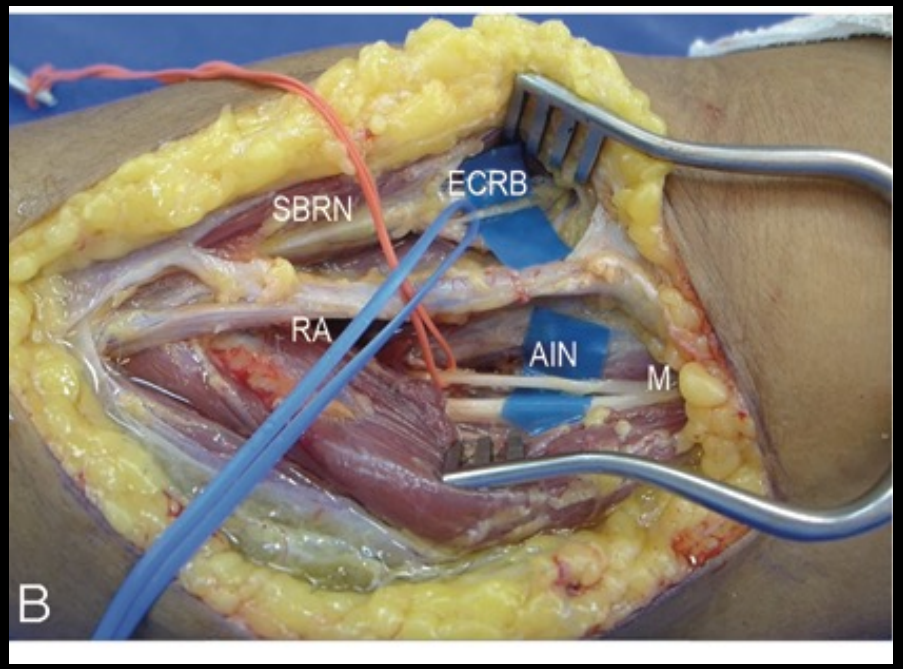
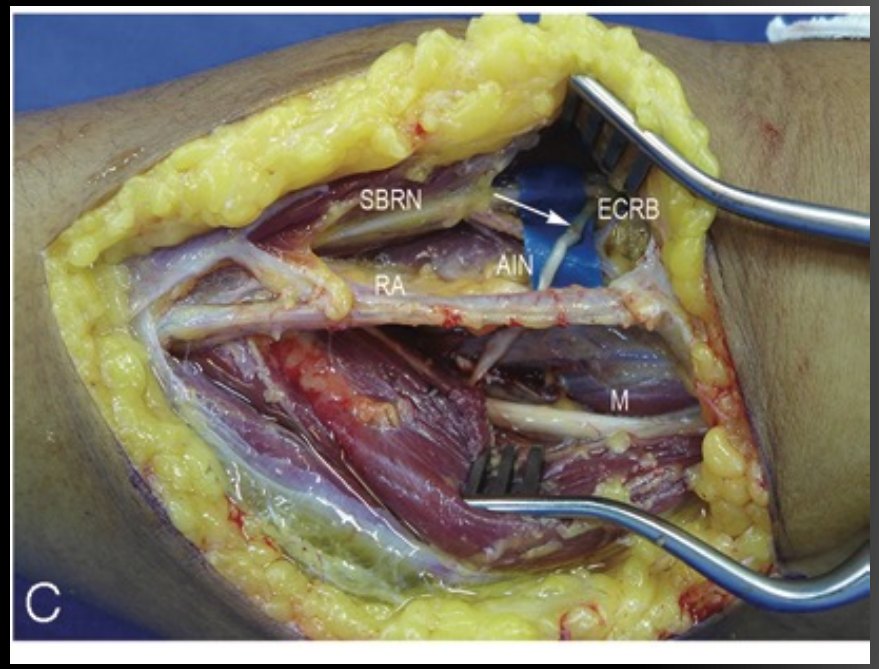


FIG. 3. Left: Schematic representation of the skin incision and transfer of the nerve to the brachioradialis (BR) to the AIN. M = median nerve; PIN = posterior interosseous nerve; R = radial nerve; SBR = superficial branch of the radial nerve. The *arrow* indicates the site of nerve coaptation. **Right:** Intraoperative view of the right antecubital fossa showing the connection of the AIN with the nerve to the brachioradialis (NBR) (Case 5). The *arrow* indicates the site of nerve coaptation. Figure is available in color online only.

N.ERCB à N. Interosseux antérieur



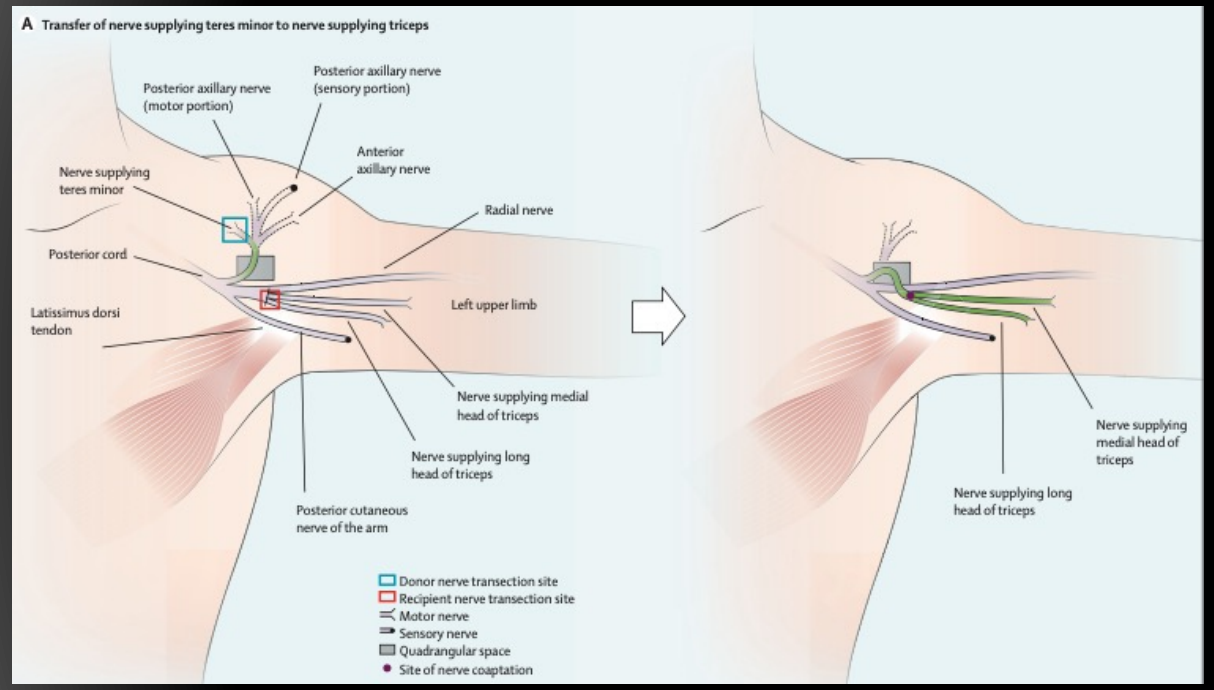




Génial,

Alors on arrête les transferts tendineux ?

Heu …
NON,
C’est complémentaire



VS : ?

Clinical Trial

Lancet
. 2019 Aug 17;394(10198):565-575.
doi: 10.1016/S0140-6736(19)31143-2. Epub 2019 Jul 4.

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Natasha van Zyl [1], Bridget Hill [2], Catherine Cooper [3], Jodie Hahn [3], Mary P Galea [4]
Affiliations

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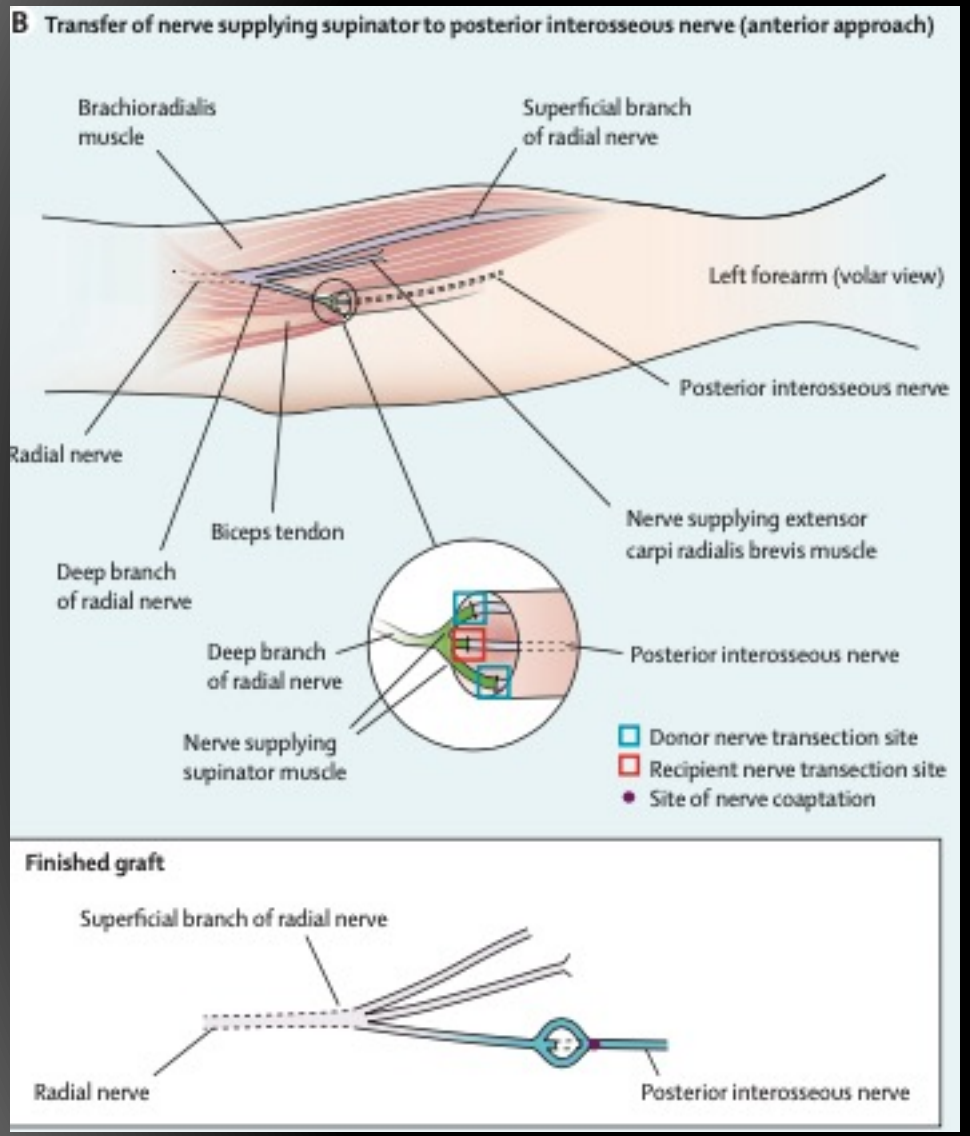

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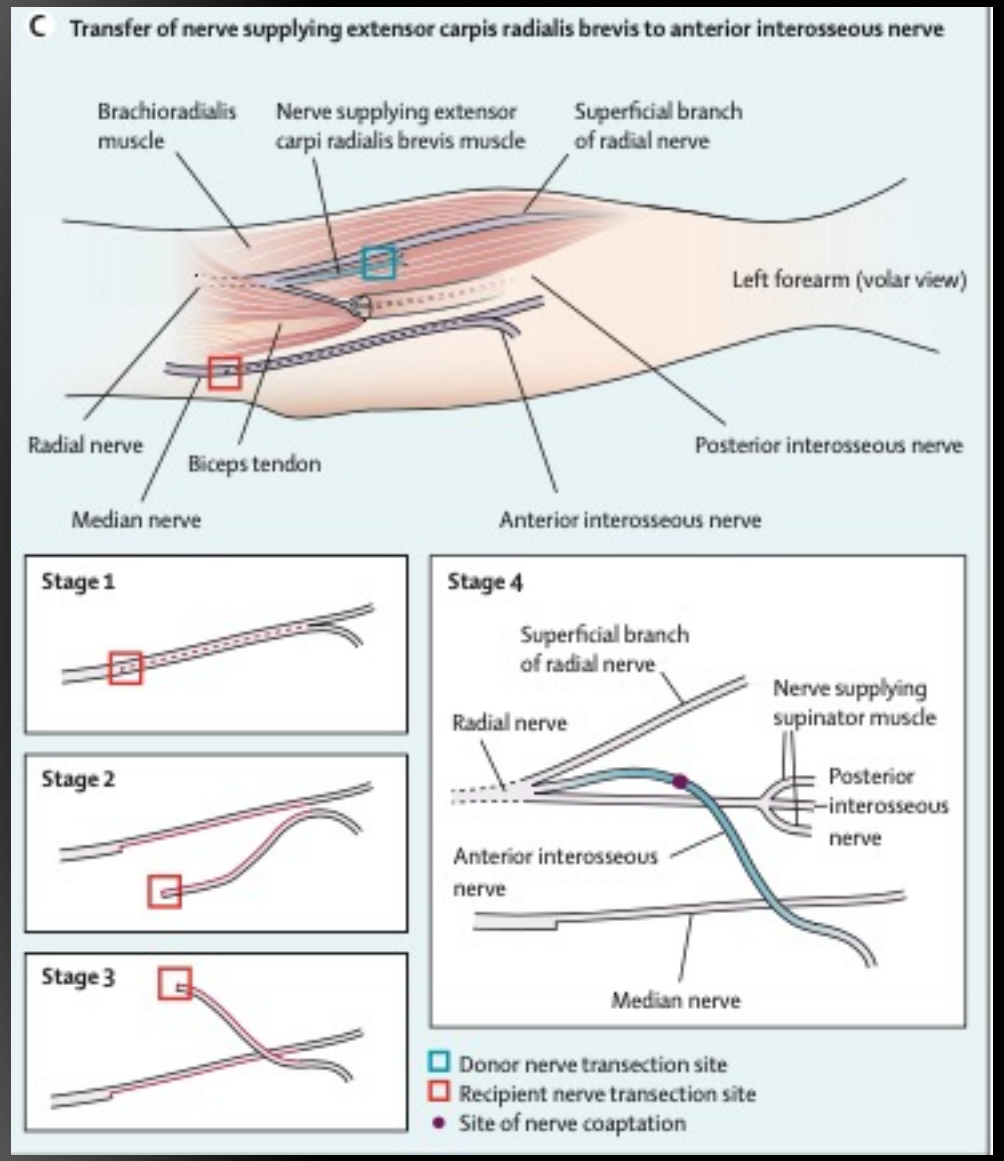

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Alors les résultats ?

	Number tested	Median MRC grade
Triceps	15	3 (2–3)
Extensor digitorum communis*	21	4 (4–4)
Extensor pollicis longus	21	4 (3–4)
Abductor pollicis longus	21	4 (3–4)
Extensor carpi ulnaris	21	3 (2–4)
Flexor digitorum profundus*		
Proximal nerve transfers†‡	9	4 (3–4)
Distal nerve transfers§	5	4 (4–4)
Tendon transfers	9	4 (4–4)
Flexor pollicis longus		
Proximal nerve transfers†	9	3 (1–4)
Distal nerve transfers§	5	4 (4–4)
Tendon transfers	8	4 (4–4)

Data are median (IQR). MRC=Medical Research Council. *MRC grade reported from the digit with the best power. †Results for transfers to the anterior interosseous nerve from the nerve supplying the brachialis muscle. ‡One patient in this group underwent a transfer to the flexor digitorum superficialis rather than the flexor digitorum profundus. §Results for transfers to the anterior interosseous nerve from the nerves supplying the extensor carpi radialis brevis muscle or the supinator muscle.

Table 3: **MRC grades for recipient muscles at 24-month follow-up**

	Number of limbs tested	12 months		24 months	
		Grasp score, kg	Key pinch score, kg	Grasp score, kg	Key pinch score, kg
All participants	22	2·2 (2·4)	0·8 (1·3)	3·3 (2·6)	1·3 (1·3)
Nerve transfers for grasp and pinch	14	1·1 (0·9)	0·5 (1·3)	2·9 (2·7)	1·0 (1·2)
Proximal nerve transfers*	9	0·6 (0·6)	0·6 (1·5)	2·8 (3·2)	0·7 (1·2)
Distal nerve transfers†	5	1·9 (1·0)	0·6 (1·1)	3·2 (1·5)	1·5 (1·0)
Tendon transfers for grasp and pinch	8	3·4 (3·2)	1·1 (1·4)	3·9 (2·4)	1·9 (1·4)

Data are n or mean (SD). *Transfers to the anterior interosseous nerve from the nerve supplying the brachialis muscle. †Transfers to the anterior interosseous nerve from the nerves supplying the extensor carpi radialis brevis muscle or the supinator muscle.

Table 4: **Grasp and pinch strength**

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Conclusion :

Techniques complémentaires

Résultats définitifs plus tardifs…

Nouvelle stratégie à définir

Bonus :
Tétra HAND 2023

Choosing the best combination of nerve and tendon transfers for upper limb reconstruction

Michael Weymouth (MBBS, FRACS)
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Optimal conditions for nerve transfers in SCI

Patient Selection

Co-operative, motivated, light limbs and supple joints

Lower level of injury C6, ICSHT group 4

Timing

Early post SCI - 6 m

Nerve transfer selection

Donor nerve close to target – double up if you can

Donor nerve health

Muscle of donor nerve always been MRC grade 5, no "recovered" nerves

EMG – no, 1+ or 2+ fibrillations, normal or reduced recruitment

Intra operative stimulation - low stimulation thresholds (0.5 mA), good movement on stimulation

No additional donor nerve injury (BP or compression injury)

Recipient nerve health

Low stimulation thresholds, good movement on stimulation

Predicting strength outcomes for upper limb nerve transfer surgery in tetraplegia.
Stanley, Edward A; Hill, Bridget; McKenzie, Dean P; Chapuis, Pierre; Galea, Mary P; et al. The Journal of hand surgery, European volume Vol. 47, Iss. 11, (December 2022): 1114-1120. DOI:10.1177/17531934221113739