Birth Brachial Plexus Palsy

History

- Birth-related upper limb paralysis was first mentioned in a midwifery text by Smellie in 1764.
- Upper limb paresis was later described by Erb, although not in infants. He localized the lesion to the point in the brachial plexus that now bears his name.
- He also credited Duchenne with describing the condition in infants, and the eponym Erb-Duchenne upper plexus palsy recognizes the contributions of the two men.
- Klumpke described lower plexus involvement

Incidence

- The incidence remains at 0.3 to 2.5 per 1000 live births.
- The trend toward larger birth weights as a result of better nutrition and general health of mothers and societal pressure to bring down cesarean section rates contribute to the number of cases still seen.
- However, the number of cases with severe involvement appears to have decreased

Etiology

- Risk factors
- large birth weight,
- breech position,
- prior delivery of a child with a brachial plexopathy,
- shoulder dystocia,
- and a prolonged second stage of labor.

Etiology

- A breech delivery focuses stretch at the lower plexus, with traction applied to the trunk with an abducted arm.
- A vertex delivery focuses stretch at the upper plexus, with lateral traction applied at the neck.
- The anatomic variation of the socalled prefixed plexus, with a greater contribution from the C_4 root, may predispose some infants to tolerate less stretch across the upper plexus

Classification

- *Neurapraxia* is paralysis in the absence of peripheral degeneration; the delay to recovery may be long, but recovery will be complete.
- *Axonotmesis* is damage to nerve fiber with complete peripheral degeneration but with intact external tissues to provide support for accurate spontaneous regeneration. Good recovery is anticipated, and no intervention can improve the outcome.
- In *neurotmesis* all essential structures, both neural and supporting tissues, have been disrupted. This category includes neuroma in continuity, division of nerve, and anatomic disruption.

Classification

- Sunderland classified nerve lesions as follows.
- A first-degree injury preserves all structure, but conduction is temporarily blocked.
- In second-degree injury, wallerian degeneration occurs, but endoneurial integrity is maintained and recovery is complete.
- A third-degree injury adds endoneurial destruction and internal fascicular disorganization; recovery is poorer, with possible cross-regeneration.
- In fourth-degree injury there is complete internal disorganization, but some continuity of external structure remains.
- A fifth-degree injury involves complete disruption of all nerve structures

Types

- Based on
- number of roots involved
  1) C5, C6
  2) C5,6 and 7
  3) Pan Plexus

- Severity of nerve injury
  1) Neuropraxia
  2) Axonotemesis
  3) Neurotemesis

Types

Table 1 Narakas Classification

Narakas Classification	Neurological Involvement	Functional Deficits
Group 1	C5–C6	Shoulder abduction, external rotation, elbow flexion, forearm supination
Group 2	C5–C7	As above, plus wrist and digital extension
Group 3	C5–T1	Flail extremity
Group 4	C5–T1	Flail extremity with Horner's syndrome

Clinical features

- decreased spontaneous movement and asymmetry of infantile reflexes such as Moro's reflex or asymmetric tonic neck reflex.
- the grasp reflex may be absent.
- An ipsilateral Horner syndrome consisting of ptosis, miosis, and enophthalmos, or a small pupil with a droopy eyelid, indicates injury to the T1 cervical sympathetic nerves.
- Phrenic nerve involvement is said to occur in up to 5% of upper plexus lesions.

Clinical features

- Cephalic hematoma, laryngeal nerve injury with vocal cord paralysis, and facial nerve paralysis in cases of forceps-assisted delivery may be found and are evidence of birth-related trauma.
- Cord-level trauma due to root avulsion should be suspected in cases of lower limb weakness or spasticity.
- Fractures of the clavicle, humerus, and other long bones may also be seen. Ipsilateral clavicle fracture is actually a favorable finding in birth-related plexopathy because the fracture allows the shoulder girdle to compress, thus decreasing the overall traction on the plexus.
- Cerebral palsy associated with brachial plexopathy is rare, and if it is encountered, it would be the type with global involvement associated with hypoxia.
- Spastic hemiparesis is not associated with brachial plexopathy.

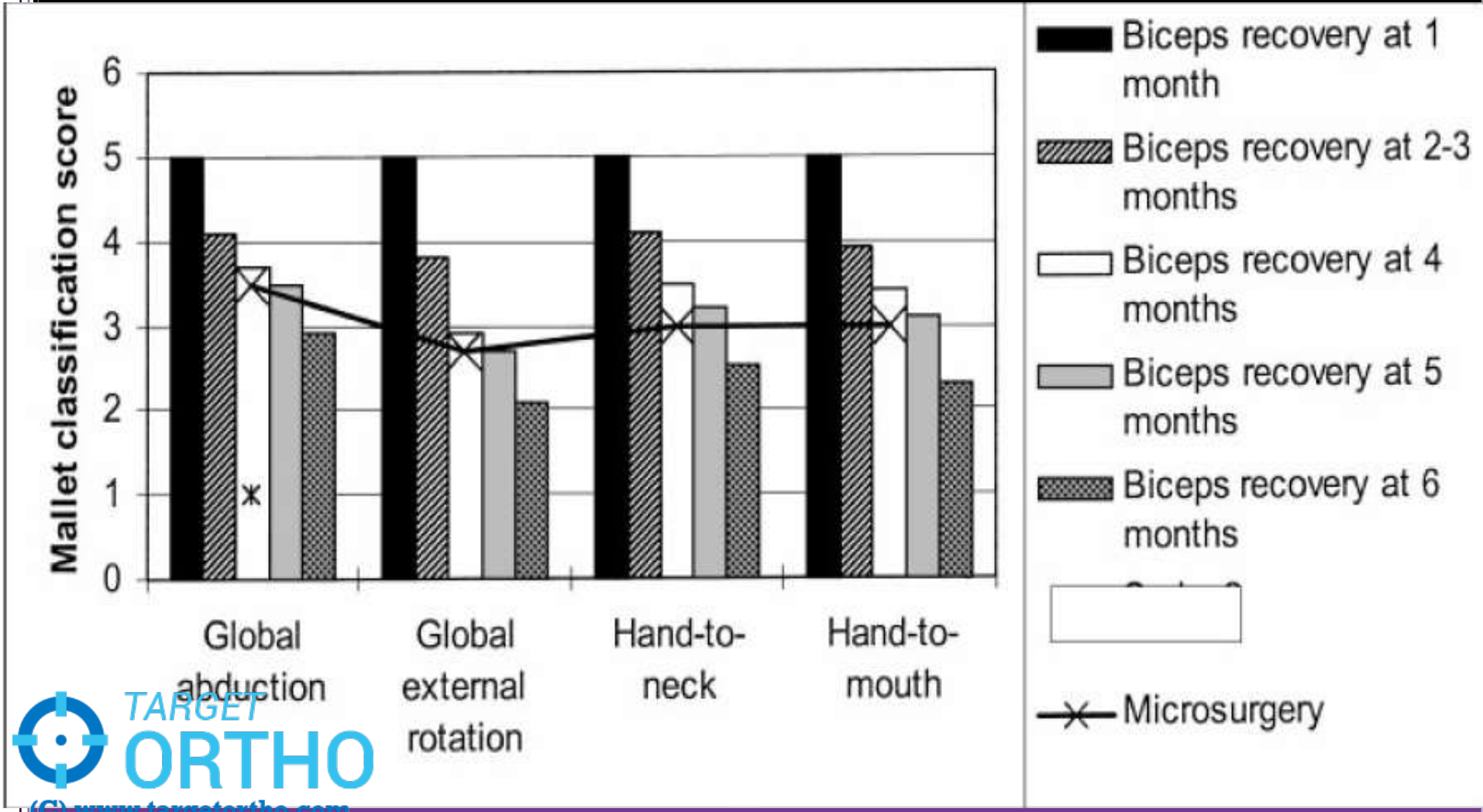
Clinical features

- Upper plexus or Erb-Duchenne-type lesions initially present with a shoulder abductor and external rotator weakness and absence of elbow flexors. The upper limb is positioned in adduction, internal rotation, and elbow extension. The wrist is often held in a flexed position. If C7 is also involved, the elbow extensors also are weak and the elbow held in mid-position

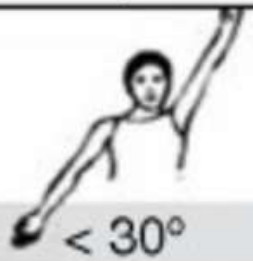
Prognosis & recovery

- Reported rates of complete recovery range from 7% to 95%
- Gilbert and colleagues reported in 1984 that infants who did not recover elbow flexion by age 3 months had a poor chance of full recovery.
- They based this conclusion on a study by Tassin in which 44 infants were followed from birth; 20 did not recover shoulder and elbow function by 3 months of age.

Prognosis: Natural History



Assessment

	1	2	3
Abduction			
	< 30°	30° a 90°	> 90°
External rotation			
	0°	< 20°	> 20°
Hand on back of neck			
	Impossible	Difficult	Easy
Hand on back			
	Impossible	S 1	T 12
Hand in mouth			
	Clarinet sign	Small clarinet	

Differential diagnosis

- Fractures of the clavicle and humeral shaft are relatively common; proximal physeal separation is rare.
- septic arthritis of the shoulder,

  acute osteomyelitis, or some other form of sepsis must be considered even in the absence of fever and generalized toxicity.
- Fracture or injury due to child abuse must also be ruled out.
- Loss of normal reflexes occurs in all of these conditions.
- Radiographs are indicated for further investigation

Treatment

- The involved upper limb should be protected initially by pinning the sleeve to the shirt or wrapping it around the body for the first several weeks.
- Muscle imbalance develops rapidly, and soft tissue contracture contributes to deformity and joint incongruence early in the neonatal period.
- Start Passive stretching as early as 1 wk After birth.
- Asses Elbow flexion every months

Assessment

- During the first several months after birth, careful, repeated observations are needed to establish a pattern of recovery.
- Attention to the shoulder ROM, especially maintaining passive external rotation, is critical.
- If there is a sudden loss of range of passive external rotation, the shoulder should be investigated with sonography or other imaging to determine whether it is subluxating or dislocating posteriorly.
- Closed or open reduction, contracture stretching or release, and casting are needed to treat posterior shoulder instability

Assessment

- If surgery on the plexus is considered, the window for most intervention is between 5 and 12 months.

- Restoration of elbow flexion using a peripheral transfer from the ulnar nerve to the musculocutaneous nerve offers an additional option for treatment

Treatment

- Biceps recovery in 2-3 months = Good prognosis almost normal upper limb function after 1 year

- Biceps recovery in 4 to 6 months

  none of these patients had return of normal upper extremity function.

Treatment

- If motor recovery is not adequate to maintain shoulder muscle balance, early contracture release and muscle transfer to the external rotators should be considered before established joint deformity occurs.
- If the shoulder joint is still congruously reduced and the humeral head has not flattened, muscle rebalancing procedures should be considered.
- If the shoulder has become "congruously incongruent," meaning that the potential to increase a smooth ROM is no longer present, extra-articular procedures to improve limb position are more effective.

Residual deformities: shoulder

Group	Subgroup[*]	Scapular Elevation Sign	Primary	Secondary	Initial Obstetric Lesion	Surgical Treatment
Group 1: Joint contracture (90.2%)	**1.** Internal rotation-adduction contracture without joint deformity or dislocation (26.5%)	Negative	Subscapularis	Pectoralis major Coracobrachialis		Anterior shoulder release plus external rotation transfer
	2. Internal rotation-adduction contracture with joint deformity and posterior subluxation or dislocation (67.4%)	Positive	Subscapularis	Short head of biceps Anterior deltoid	Upper brachial plexus and scapulohumeral joint	External rotation osteotomy
	3. External rotation-abduction contracture with anteroinferior subluxation or dislocation (4.8%)	Positive	Infraspinatus, teres minor	Posterior deltoid		Posterior shoulder release or internal rotation osteotomy
	4. Pure abduction contracture (1.2%)	Positive	Supraspinatus	—	Supraspinatus lengthening	
Group 2: Pure flaccid paralysis (9.8%)	Shoulder abduction and rotation paralysis and elbow flexion paralysis	Negative	—	—	Upper brachial plexus	Shoulder arthrodesis and elbow flexoplasty

From Zancolli EA: Classification and management of the shoulder in birth palsy. Orthop Clin North Am 1981;12:433

- Zancolli's second most common type is the externally rotated abducted type. Affected patients exhibit winging of the scapula on attempts at internal rotation—Putti's sign.

Elbow

- Flexion deformity
- Posterior sub-luxation or dislocation radial head
- Anterior sub-luxation or dislocation radial head

- Fairbank approached the shoulder anteriorly and released the tight subscapularis tendon, the upper portion of the pectoralis major, and the anterior capsule of the shoulder.
- Sever divided the entire subscapularis and pectoralis tendons but left the capsule intact to prevent anterior dislocation.
- L'Episcopo added a transfer of the teres major to an external rotator position, and Zachary added the latissimus dorsi to the external rotator transfer.
- Transfer of the origin of the anterior portion of the deltoid to a posterior position was thought by Green and Tachdjian

- Lengthening of the subscapularis and pectoralis major with transfer of the latissimus and teres major to the external rotator position was the procedure used by Green and Tachdjian.

- The anterior procedures that lengthen the subscapularis tendon at the insertion risk anterior instability and leave the anterior shoulder markedly scarred. Sectioning of the pectoralis major tendon destroys the contour of the anterior axillary fold and leaves a defect that is unsightly.

- Hoffer and colleagues used the teres major and latissimus dorsi to transfer into the rotator cuff at the insertion of the supraspinatus to add both external rotation and abduction.

- Carlioz and Brahimi combined release of the subscapularis with transfer of the latissimus dorsi and teres major to the rotator cuff

- Bony procedures that have been described in the older child include resection of the coracoid and acromioplasty-and rotational osteotomy of the humerus.
- The goal of these procedures is to relieve discomfort and reposition the limb for better function in front of the body.
- Osteotomy of the humerus at a proximal level rotates the insertion of the deltoid from an anterior to a lateral position and can augment lateral abduction as well as extension, which has the paradoxical effect of enhancing the reach to the back.

Microsurgery Recommendations

1. Patients with recovery of biceps function within the first 2 to 3 months of life can expect normal or near-normal upper extremity functional outcomes;

2. Patients with return of biceps function after 3 months of age do not obtain complete neurological recovery or normal upper extremity function;

3. Patients with more extensive brachial plexus involvement (e.g., greater involvement of the C8 and T1 cervical nerve roots) and a Horner's syndrome have poorer prognoses;

4. Patients without recovery of biceps function within the first 6 months of life benefit from microsurgical repair or reconstruction of the brachial plexus, although full return of upper extremity function is not expected.

Principles of nerve transfer

- Re-innervate the recipient nerve as close to the target muscle as possible
- Performing a direct repair, without intervening grafts.
- Use combinations of similarly behaving neuromuscular units.
- perform the transfer surgery as early as possible to maximize outcomes.

Spastic upper limb: Assessment and management

Spastic upper limb

- Hemiplegic
- Quadriplegic
- Diplegic (rarely)

Physical examination: Sensory

- Two-point discrimination (>15–20 mm) is the ideal to test.
- In younger children

  tactile sensitivity,

  stereognosis,

  and proprioception are easier and more accurate to test.
- The sensation is a good measure of the overall functional ability of the extremity.

Sensory Impairment

- Evaluation of sensory capacity is difficult,
- but sensory deficits are recognized to contribute more to the overall impairment in function.
- When SSEPs were included, impairment in at least one modality of sensory function was found in 88% of children with cerebral palsy.

Sensory Impairment

- Hemiplegic children who received intensive occupational therapy that concentrated on motor skills alone did not show improvement in their performance.

- A therapeutic focus on sensory rehabilitation is part of the nonoperative approach to a spastic upper limb.

Sensory Impairment

- Van Heest et al (1993)showed that 97% of the spastic limbs had a stereognosis deficit, 90% had a two-point discrimination deficit, and 46% had a proprioception deficit.

- Thus sensory deficits are the rule rather than the exception in children with spastic hemiplegia.

Sensory Impairment

- Significant b/l sensory deficits (88.8%) were ascertained in hemiplegic children when compared to the performance of the healthy controls.
- The extent of sensory loss did not mirror the severity of motor deficit.
- Conversely, findings on SSEP were closely related to motor function.

Cooper J, Majnemer A, Rosenblatt B, et al: The determination of sensory deficits in children with hemiplegic cerebral palsy. *J Child Neurol* 1995; 10:300

Effect on Growth

- A progressive, nonproportional, and unpredictable LLD is a common finding in SH.
- The overall rate of maturation of the limb is affected, as well as its length and girth.

- Roberts et al(1994) , delays in skeletal maturation on the affected side in comparison to the nonspastic side averaged 7.3 months.

Effect on growth

- Van Heest et al (1993) found a correlation between the severity of sensory impairment and the degree of growth impairment in the affected limb.

- Those children with severe stereognosis deficits had significantly smaller limbs than the children with mild or moderate stereognosis deficits.

Physical examination

- Passive and active range of motion of all joints from the shoulder distally.
- Evaluation of fixed muscle contractures vs dynamic muscle contractures.
- recognition of joint contractures and/or joint subluxations and dislocations

Physical examination

- Spasticity grading

- abduct and flex the shoulder,
- fully extend the elbow,
- supinate the forearm,
- and extend the wrist.

Physical examination

- If children can do active finger extension with the wrist extended 20° to 30°, finger motor function is good.
- If the fingers cannot be actively extended but can be passively extended, lack of extensor motor power is the problem.
- If the fingers cannot be passively extended, the primary problem is of contracture of the finger flexors.

Physical examination

- Typical thumb-in-palm deformity
- wrist in 20° to 30° of DF. The inability to passively abduct the thumb means there is a contracture of the thumb adductors.
- Passive abduction, which cannot even be done in part actively, demonstrates a lack of thumb abduction motor power.

Upper extremity functional patterns

- Type 0 No active function in the Entire UL
- Type 1 Proximal function, none to minimal distal function
- Type 2 Mass grasp, poor active control and strength, poor fine motor control
- Type 3 Fair active grasp/release (able to place object with fair accuracy), poor thumb opposition

Upper extremity functional patterns

- Type 4 Good active grasp/release, fair thumb opposition (key pinch only)
- Type 5 Normal to near-normal function, good thumb opposition, able to perform sophisticated fine motor tasks (e.g., buttoning clothes)
- A, no contractures;
- B, dynamic contractures only;
- and C, fixed contractures only.

Guidelines for setting Goals

- Goal setting for the treatment and expectations of upper extremity function has to consider

- the children's age,
- cognitive function,
- physical function,
- and cosmetic concerns.

Children 0-6 yrs

- Spasticity increases from 9 month to 2 yrs and then decreases as neurological maturation occurs.
- Occupational therapy
- Two hand toys
- Splinting minimal

Splints

- Minimal, night use only if there are contractures.
- Functional Day time splints i.e. soft opponens-type thumb splints.

Splints: What should be avoided

Middle Childhood: Ages 6 to 12 Years

- Children in this age group generally have maximized gross motor function but are continuing to develop fine motor skills.

Goals

- helping these children to develop skills in activities of daily living,
- such as getting dressed,
- self-toileting,
- and feeding.

Issues

- These children are going through a rapid growth spurt, muscle contractures are beginning to occur.

Management

- Dynamic contractures - BT injection
- Surgery for fixed contractures.
- Cosmetic concerns.

Adolescence: Ages 12 Years and Older

- Activities of daily living and skills such as
- recreational activities,
- Vocational and educational activities,
- the use of an aide to assist with handwriting and also learning to operate a laptop computer is very helpful.

Adolescence: Ages 12 Years and Older

- Trying to force children into a traditional predetermined mold of the way these children should use the involved extremity can be damaging to their self-esteem.

- Surgery.

Pre-operative evaluation

- Occupational therapist evaluation.
- Dynamic EMG.

Dynamic EMG

- Muscles found to be in phase with the recipient muscle have been found to perform better than those that are nonphasic

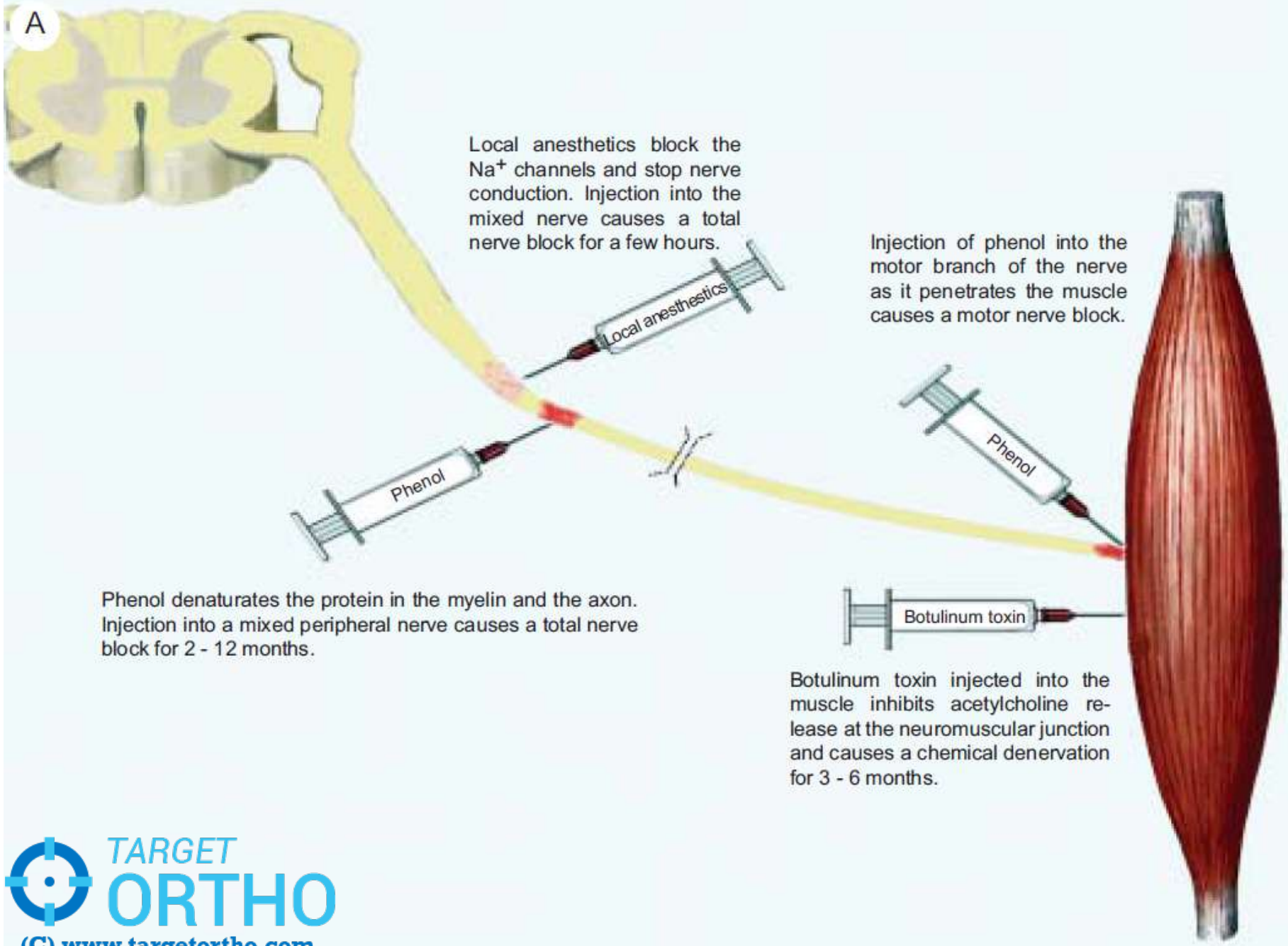
  (Hoffer et al 1979).

- Hoffer et al(1986) stated that flexor carpi ulnaris transfer to the wrist extensors causes excessive wrist extension if it is done out of phase.

Control of spasticity

- Neuromuscular blockade using
- Local anaesthetic
- botulinum toxin A
- Phenol
- Ethanol

- Intrathecal baclofen



Control of spasticity

- Corry and colleagues(1997) found Bt-a to be effective in improving ROM and GMF in the short term.
- Long-term benefits ?

Control of spasticity

- Aggressive therapy after injection helps strengthen antagonist muscles.
- Dosages of 20-50 units per muscle belly are utilized,
- limiting the total dosage to 10 to 15 units per kilogram.

Pre-requisits for surgery

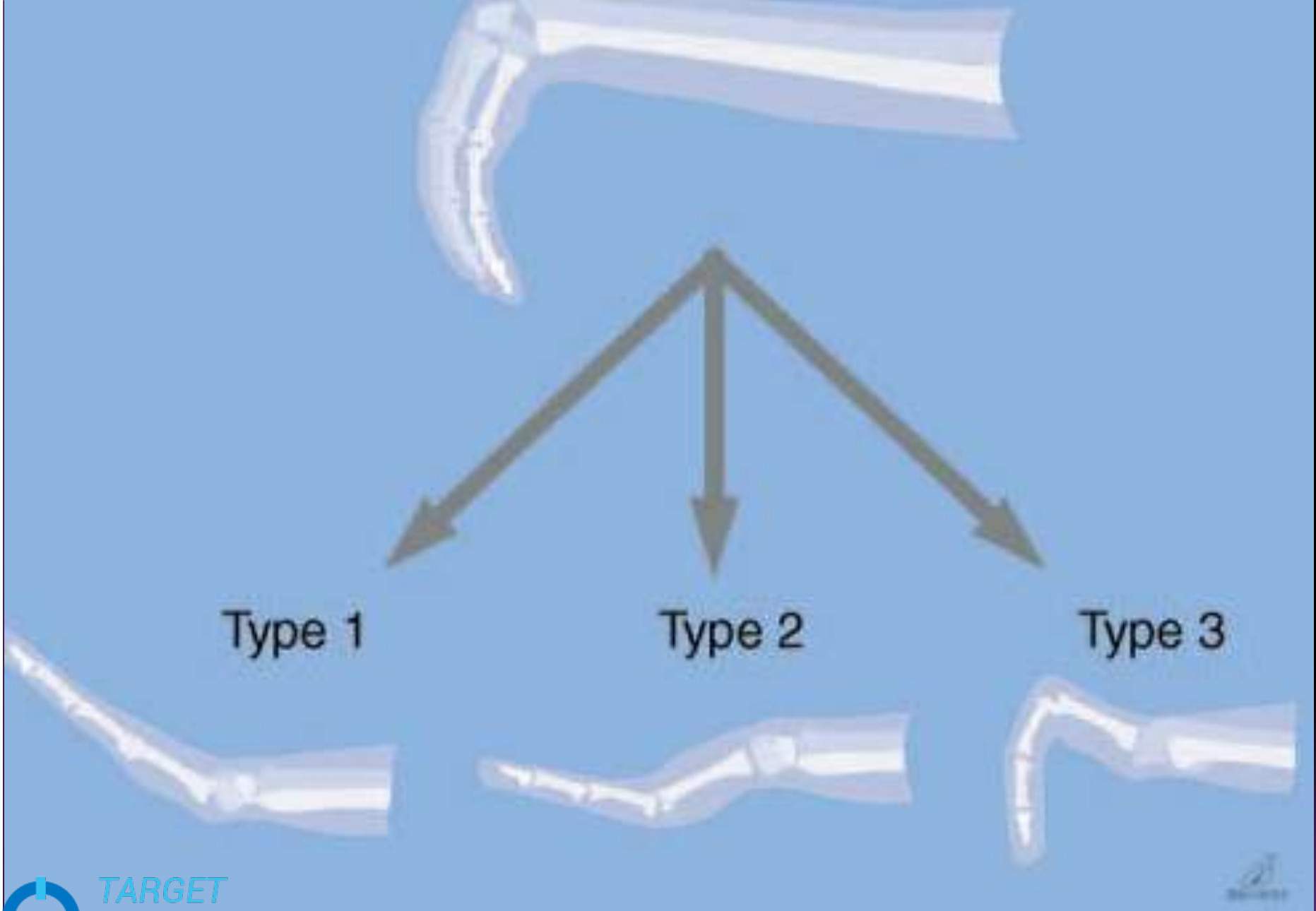
- voluntary control of grasp and release,
- sensibility,
- intelligence,
- age of the patient,
- and type of neurologic involvement.

Voluntary control of grasp and release: Zancolli and Zancolli

- In pattern 1: Active finger extension with <20 degrees of wrist flexion.
- In pattern 2: Active finger extension with >20 degrees of wrist flexion
- 2a Active wrist extension with fingers flexed
- 2b No active wrist extension with fingers flexed.

Voluntary control of grasp and release

- In pattern 3, Wrist and finger extension absent even with full wrist flexion



Voluntary control of grasp and release

- Patterns 1 and 2 have the most functional benefits after surgery.
- Pattern 3 cannot: Cosmesis

Sensibility

- Although important, sensibility should not in itself be a contraindication to surgery.
- Increased severity of sensory deficit is a reflection of an increasing severity of the neurologic impairment.
- Many children effectively use hand – eye coordination to compensate for defects in stereognosis and proprioception, particularly if they have good voluntary control.

Intelligence

- The ideal patient to consider for surgical reconstruction has an IQ > 70,
- adequate behavior,
- cooperation,
- and motivation

- Once again, minor abnormalities in mental status, should not contraindicate surgery if children have good voluntary control.

Patient Age

- 7 -12 years
- Enough maturity to cooperate with OT and enough skeletal growth where recurrence due to increasing muscle tightness secondary to growth is at less risk.

- These patients are also not too old for retraining of transferred muscles, and they have reached a plateau in their neurologic development.

Neuroloical type

- Patients with spasticity benefit most from surgery.
- In general, tendon surgery should be avoided in patients with movement disorders.
- An athetoid muscle should not be selected as a donor for tendon transfer because the result is unpredictable.

Shoulder

- Protraction and elevation of the shoulder through the scapulothoracic joint, with the clavicle becoming more vertical and anteriorly directed.
- Internal rotation contracture due to P. major
- Extension and Ext Rotation contracture - spastic long head of triceps and teres muscles.
- Problems related to hygiene and dressing.

Shoulder Instability

- Relatively common in individuals with quadriplegic involvement and children in middle childhood with athetosis.
- M.C. pattern is anterior subluxation as the shoulder becomes protracted and elevated.
- Complete acute dislocations
  - Anteroinferior
  - Posterosuperior

Treatment

- Primary: passive range of motion exercises.
- Splinting is of no use.
- Lengthening of adduction and internal rotators.
- Lengthening of long head of triceps.
- Derotation osteotomy
- Arthrodesis

Elbow and Forearm

Elbow Flexion Contracture

- Quadriplegic: severe contracture
- Difficulty in bathing and hygiene

- Hemiplegic
- Cosmetic concern

Elbow Flexion Contracture:treatment

- Extension splinting
- Botulinum toxin injection

Surgical: Severe contracture Quadriplegic

- Complete transection of biceps, brachialis and brachioradialis.
- Extension splinting
- Aim 60-90 flexion.

Surgical: mild-mod contracture

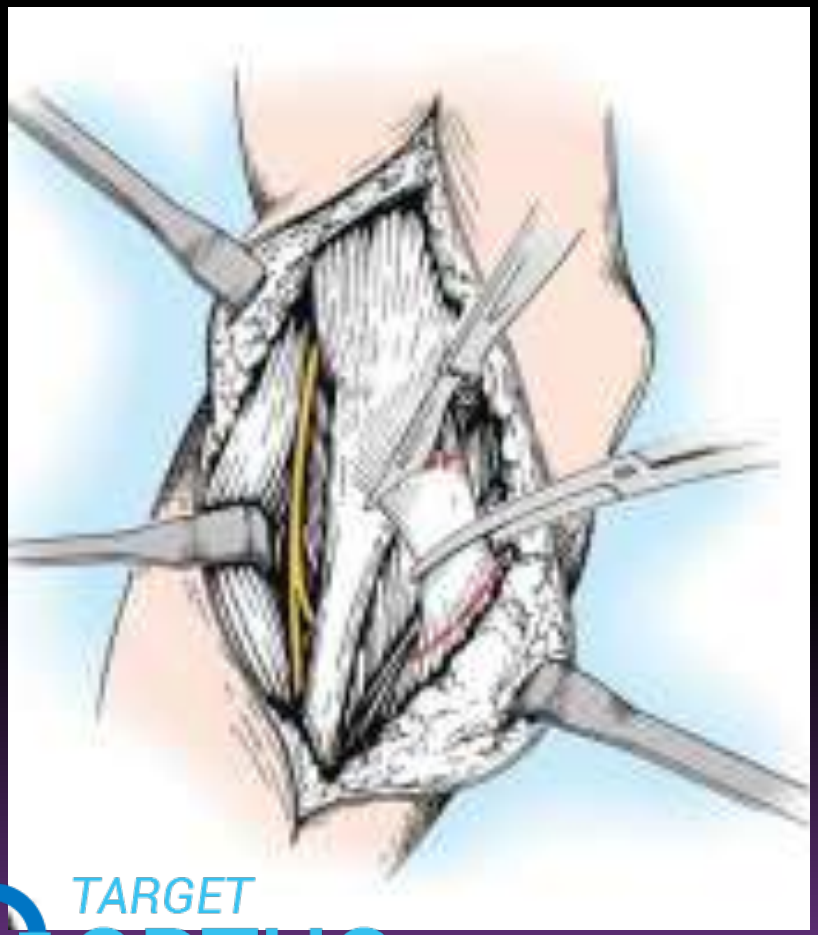
- Very Functional upper limb : z lengthening of biceps tendon.
- Less functioning upper limb: Complete release of biceps tendon.
- More severe positioning, especially if their arms are held to almost 90° during ambulation, a myofascial lengthening of the brachialis is added.

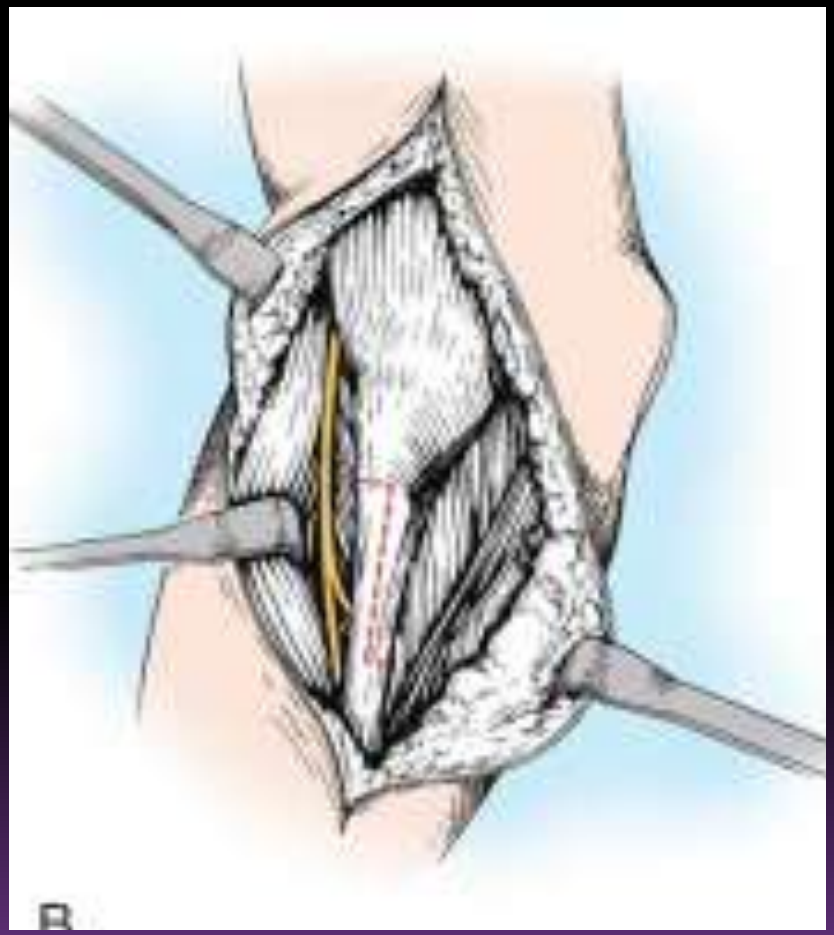
Surgical:Severe contracture Quadriplegic

- Extension osteotomy of the distal humerus.
- Elbow joint resection with a flexor release

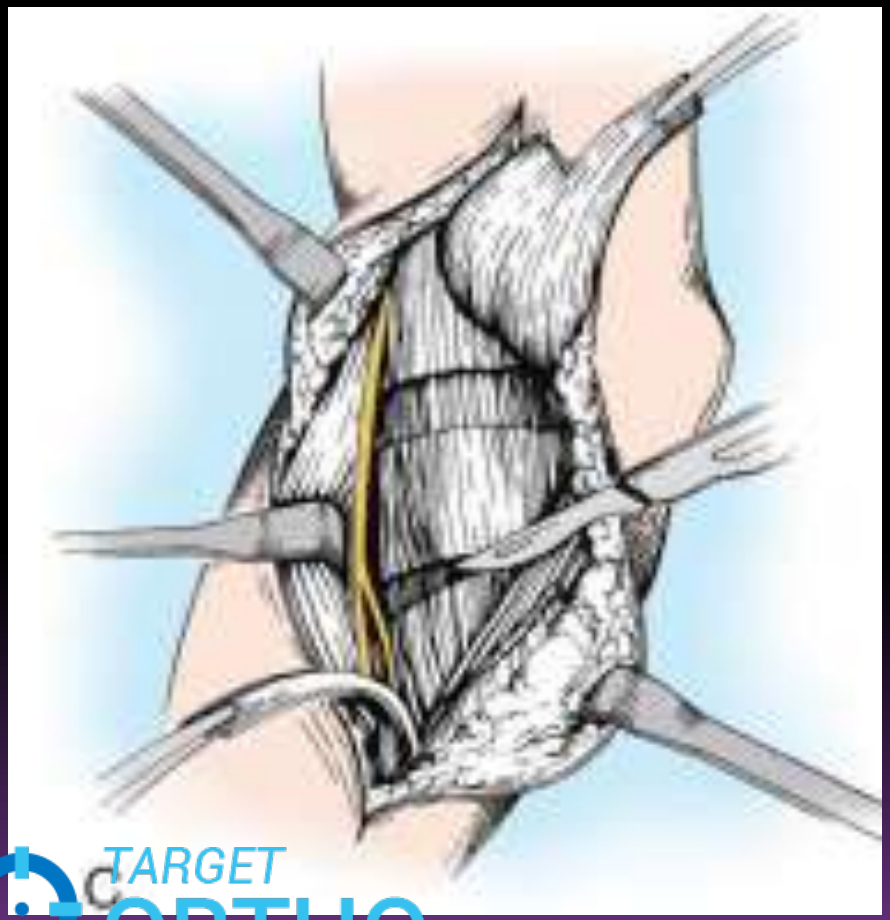
Sherk HH. Treatment of severe rigid contractures of cerebral palsied upper limbs. Clin Orthop 1977:151–5.

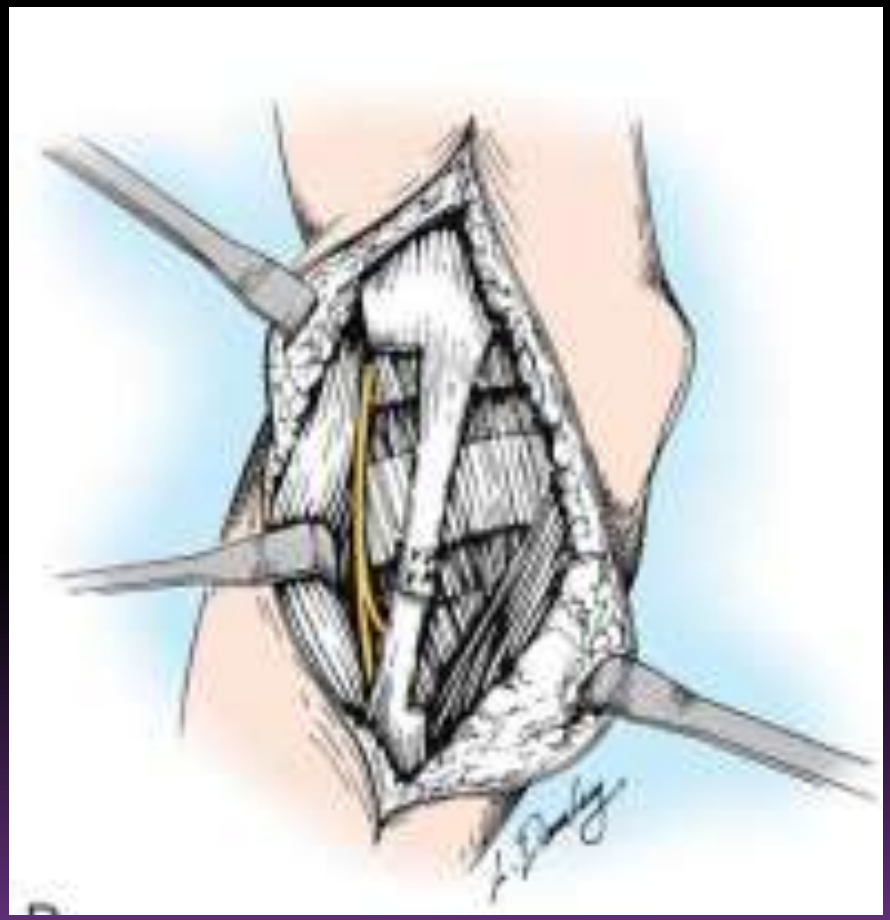
Technique:Mittal flexion crease release





Technique:Mittal flexion crease release





Radial Head dislocation

- Radial head dislocation reportedly occurs in 2% of all children with CP involving the upper extremity when elbow radiographs are carefully evaluated(1,2).

1. Nishioka E, Yoshida K, Yamanaka K, Inoue A. Radiographic studies of the wrist and elbow in cerebral palsy. J Orthop Sci 2000;5:268–74.
2. Pletcher DF, Hoffer MM, Koffman DM. Non-traumatic dislocation of the radial head in cerebral palsy. J Bone Joint Surg [Am] 1976;58:104–5.

Radial Head dislocation

- In those with severe elbow flexion and forearm pronation contractures, 27% have radial head dislocation(1).

- Most of these dislocations are posterior(2)

1. Mital MA. Lengthening of the elbow flexors in cerebral palsy. J Bone Joint Surg [Am] 1979;61:515–22.

2. Pletcher DF, Hoffer MM, Koffman DM. Non-traumatic dislocation of the radial head in cerebral palsy. J Bone Joint Surg [Am] 1976;58:104–5.

Prevention

- Splinting and early contracture release i.e. flexor and pronator

Treatment

- Painless no functional disability.
- release of the elbow flexors and pronation contracture,
- followed by stabilizing the radial humeral joint by reconstruction of the annular ligament, using the transected biceps tendon.

Treatment

- Excision, occasionally indicated

  for adolescents with very prominent radial heads that cause skin breakdown

Complications

- High Re-dislocation rate.

Forearm Pronation

- Aggravates wrist flexion deformity,
- Reverse grasp posture.
- Difficulty in holding Aid devices.
- Hand as a helper.

Gschwind Classification of Pronation Deformities as a Guide to Surgical Recommendations

Classification group	Pronation deformity	Surgical recommendation
1	Active supination beyond neutral	No specific surgery
2	Ac sup. ≤neutral	PQ release ± flx app release
3	No ac supination, free supination	PT rerouting
4	No act supination and only limited passive supination	PQ release and a flexor aponeurotic release

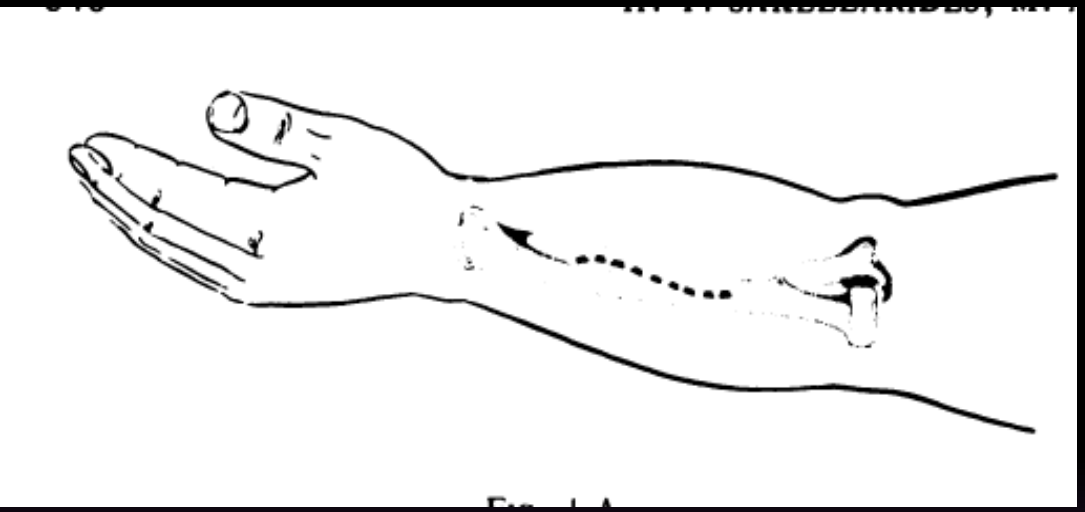
Treatment

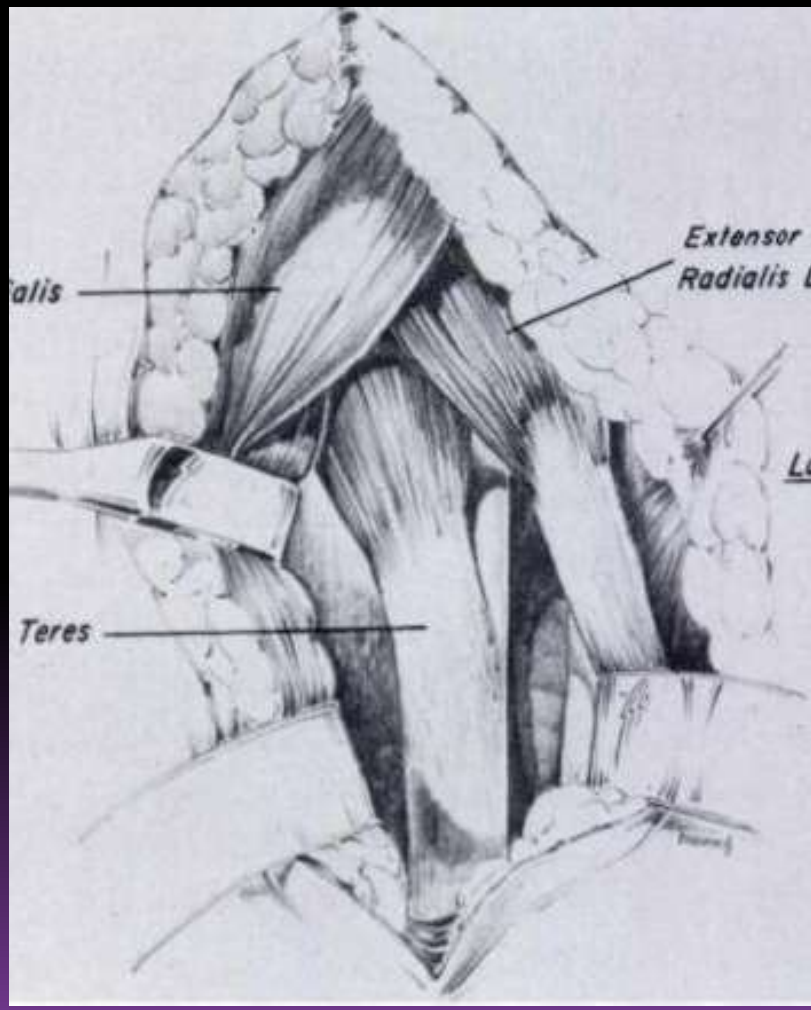
- Orthotics are seldom used
- The goal of treatment is to reduce the pronation deformity.
- Best position i.e neutral and 30° of pronation with active supination to 45°.
- Surgical treatment is indicated when individuals lack the ability to actively supinate atleast 20° to 30°.

Treatment

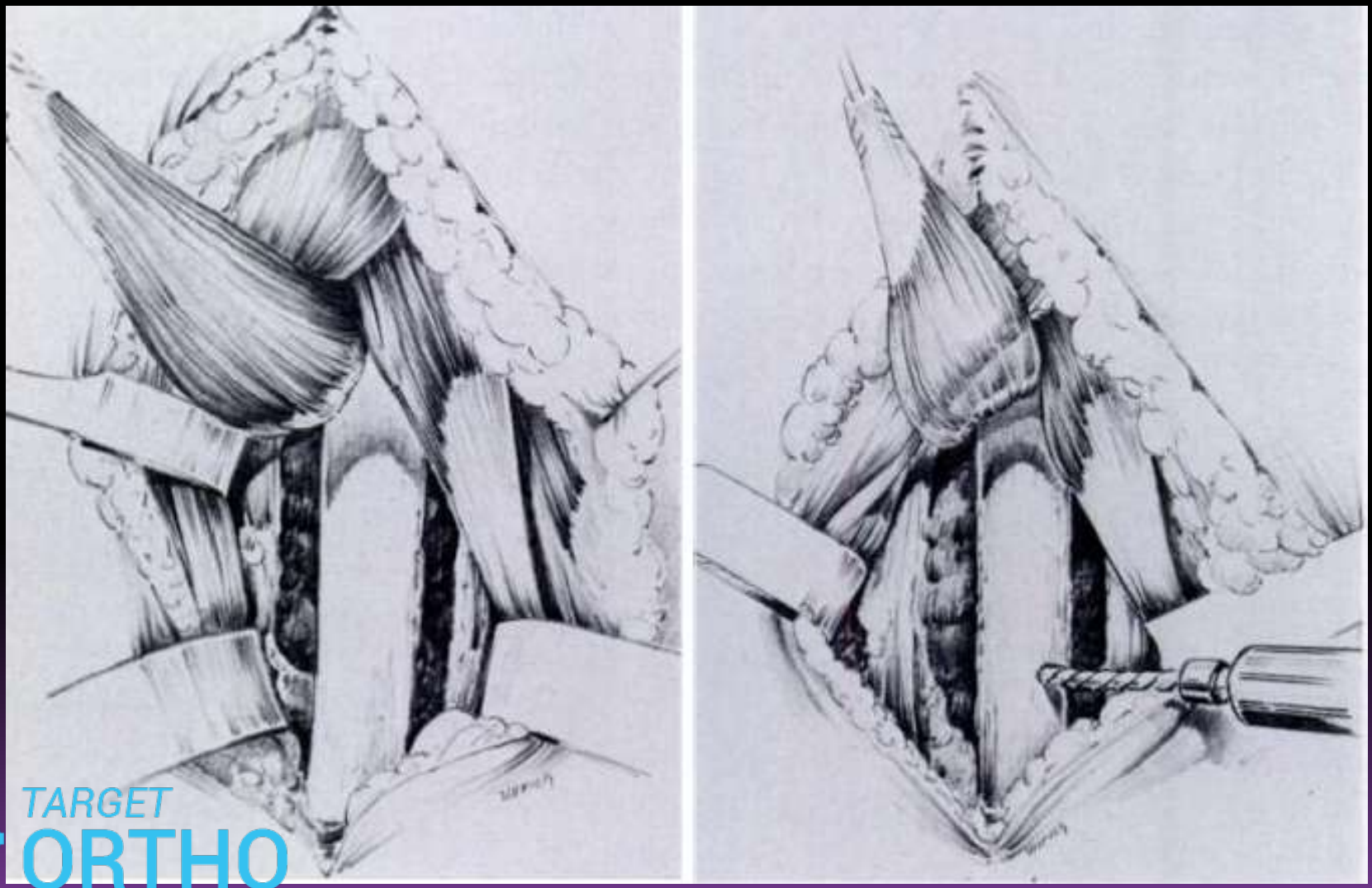
- Release of the pronator tendon from the insertion on the radius.
- Simple procedure, least complications
- Rerouting of pronator teres insertion.

Surgical technique





Surgical technique



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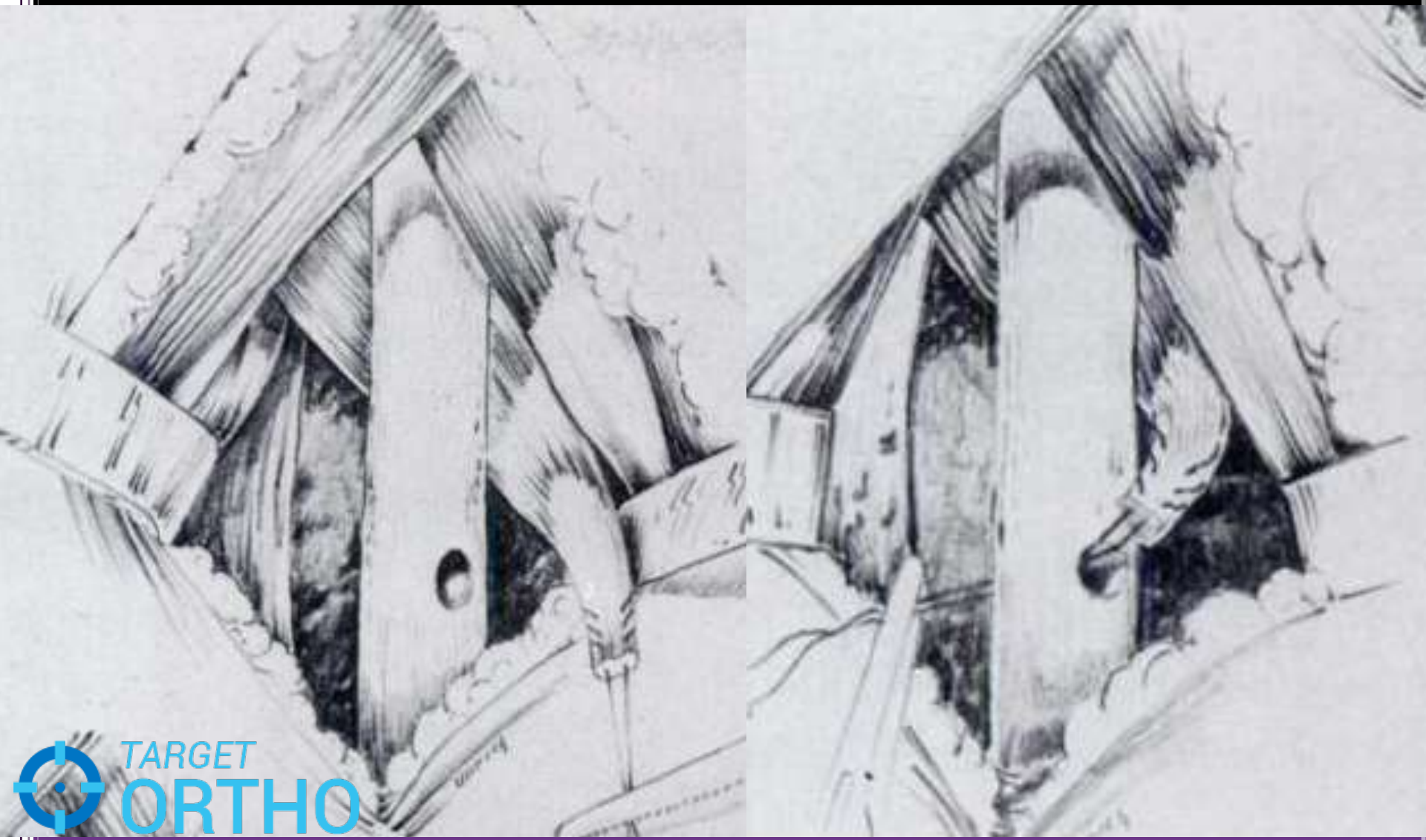

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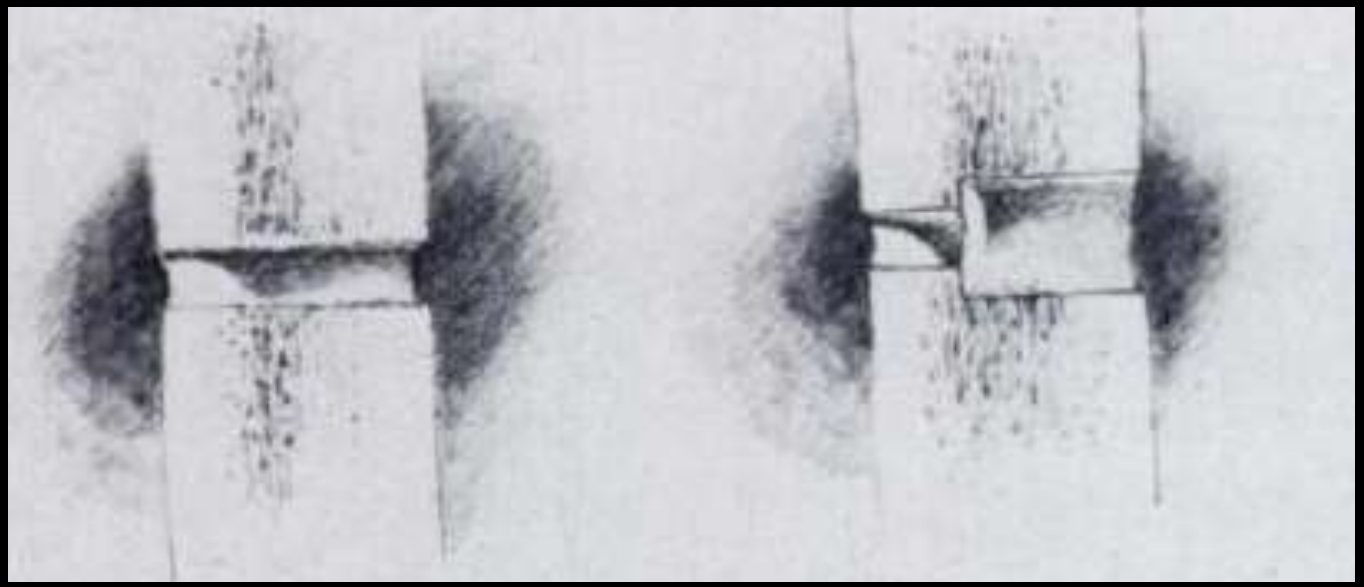
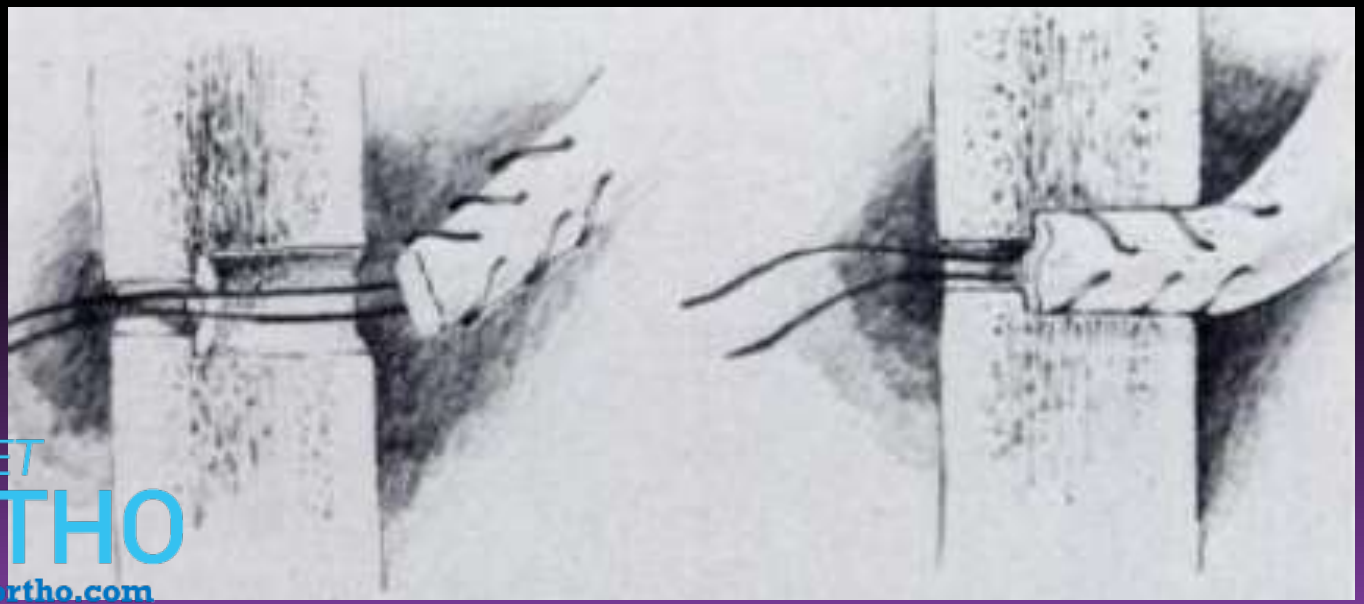




Surgical technique

Treatment

- Sakellarides and associates found 82% of their patients had good to excellent results with an average of 46° of active supination.
- They did have radius fractures as a complication.
- Strecker et al(1981). modified this technique.
- When comparing pronator release with rerouting, they found the latter group to have improved supination.

Treatment

- Transfer the distal end of the pronator into the ECR to provide wrist extension and decrease pronation.

- This procedure probably provides the least pronator weakening and has the advantage of assisting wrist extension.

Treatment

- Proximal pronator flexor slide at the muscle origin.
- Myotomy of the PQ may need to be added.
- contracture of the interosseous ligament as well, which may need to be stretched out by casting or even cross-fixated with a K-wire.

Complication

- Overcorrection, development of significant supination deformity.
- If overcorrection occurs and a pronator transfer has been performed, the transferred tendon has to be released.

Wrist flexion deformity

- In most wrists, the FCU is the primary and most contracted muscle, F/by FCR and then finger flexors

- As the wrist flexion deformity increases, the wrist joint tends to collapse and cause subluxation of the intercarpal joints.

- Severe spasticity : Poor Hygiene.

Classification

- Mild wrist flexion deformity: Class v

- Moderate Wrist Flexion Deformity: with some fixed flexion contracture of the wrist but good active finger extension with the wrist held passively extended. Class IV.

Classification

- Severe Wrist Flexion Deformity

- At the next level, types 2 and 3 are those individuals who cannot actively extend their fingers with the wrist passively extended to neutral to 20° of extension.
- Type 3 finger extensor deficiency.
- Type 2 fingers flexor contracture.

Classification

- Very Severe Wrist Flexion Deformity
- The last group is predominantly types 0 and 1, and they have severe fixed wrist flexion contractures getting a maximum of –20° of wrist extension.

- These individuals have minimal function in the hand.

Wrist Extension Contracture

- Although rare, wrist extension contractures may be seen in children with CP.
- These contractures are usually in individuals with very limited function of the hand.

- Often, the wrist extension contracture is a sign that this is a concomitant spinal cord injury and CP.

Treatment

- Dynamic deformities

- Splints
- Passive range of motion.
- Botulinum toxin.

Treatment: Surgical

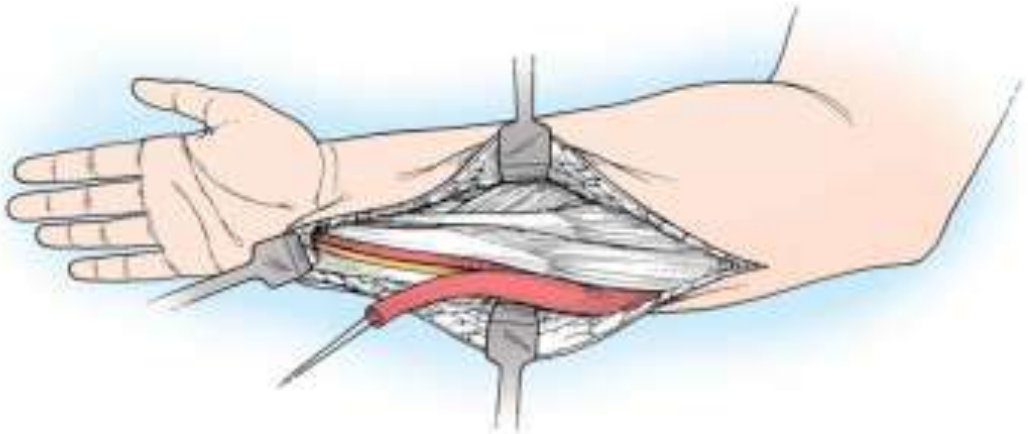
- Mild flexion deformity with no tendancy for ulnar deviation: Pronator teres transfer to ECRB.
- Tendancy for ulnar deviation: pronator teres transfer to ECRL.

Treatment: Surgical

- Moderate deformity
- Green's transfer : FCU to ECRB

- This transfer decreases the wrist flexor power, and augments wrist extensor power and forearm supination.
- This forearm transfer is usually combined with release or transfer of the pronator teres.

A



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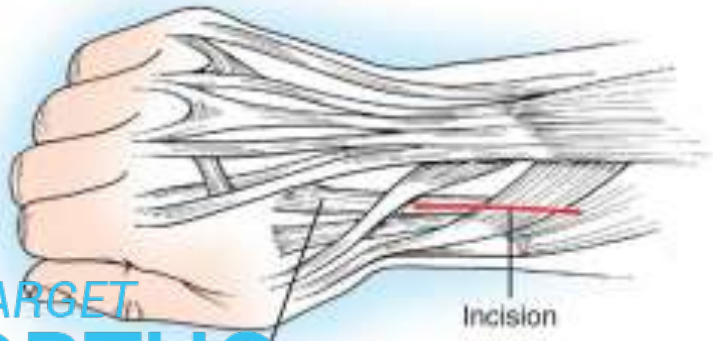

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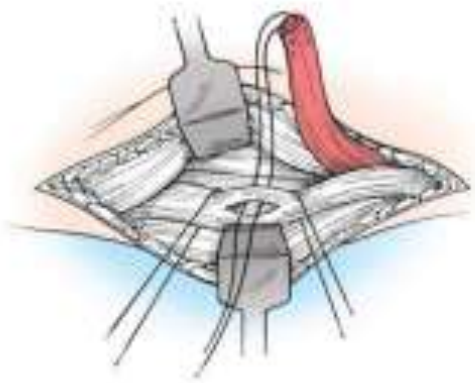


E

F

Transfer of FCU to Wrist extensor contraindicated, when????

- Inability to release with the wrist extended

Severe deformity

- Green transfer with additional lengthening of the finger flexors if finger flexor contractures are present.

- After the release of the flexor carpi ulnaris, the finger flexors are lengthened using group Z-lengthening or myofascial lengthening.

Severe deformity

- Severe wrist deformity with minimal finger flexor contractures but no active finger extension, transfer of the FCU should be into the EDC.

- Wrist extension is then augmented by plication
  of the radial wrist extensors or by adding a transfer of the pronator teres to
  the extensor carpi radialis brevis.

Other options

- Wrist arthrodesis.
- Flexor release at elbow
- Proximal carpectomy without an attempt at fusion has been recommended combined with muscle transfers and lengthenings.

White WF. Flexor muscle slide in the spastic hand: the Max Page operation. J Bone Joint Surg [Br] 1972;54:453–9.

Omer GE, Capen DA. Proximal row carpectomy with muscle transfers for spastic paralysis. J Hand Surg [Am] 1976;1:197–204.

Other options

- Transfer of the brachioradialis as an augmentation to flexor carpi ulnaris transfer.
- Neurectomy of the motor nerves to the forearm is possible

House JH, Gwathmey FW. Flexor carpi ulnaris and the brachioradialis as a wrist extension transfer in cerebral palsy. Minn Med 1978;61:481–4.

Msaddi AK, Mazroue AR, Shahwan S, et al. Microsurgical selective peripheral neurotomy in the treatment of spasticity in cerebral-palsy children. Stereotact Funct Neurosurg 1997;69:251–8.

Outcome

- The outcome of pronator transfer has been reported as good.

- Green type transfer. In general, excellent improvement in cosmesis in 88% to 100% in Hemiplegics.

Thumb in Palm deformity

- The thumb accounts for approximately 50% of hand function.
- most functionally hindering.
- The deformity consists of the thumb being adducted or flexed and adducted.

Thumb in Palm deformity: etiology

- spasticity of the adductor pollicis,
- the flexor pollicis brevis,
- first dorsal interosseous muscle,
- and the flexor pollicis longus

- which overpower the abductor pollicis longus and the extensor pollicis longus and brevis.

Classification of Thumb Deformity

Type of deformity	Deforming forces	Thumb position
Intrinsic	Add Pollicis 1st Dorsal Intess. FPB	MC adduction MCP Flexion IP Flexion
Extrinsic	FPL	MCP Flexion IP Flexion MC add Less markd
Combined	Add Pollicis 1st Dorsal Intess. FPB FPL	MC adduction MCP Flexion IP Flexion

Type 1.simple MC adduction contracture

Type1:Electromyography of the AP.

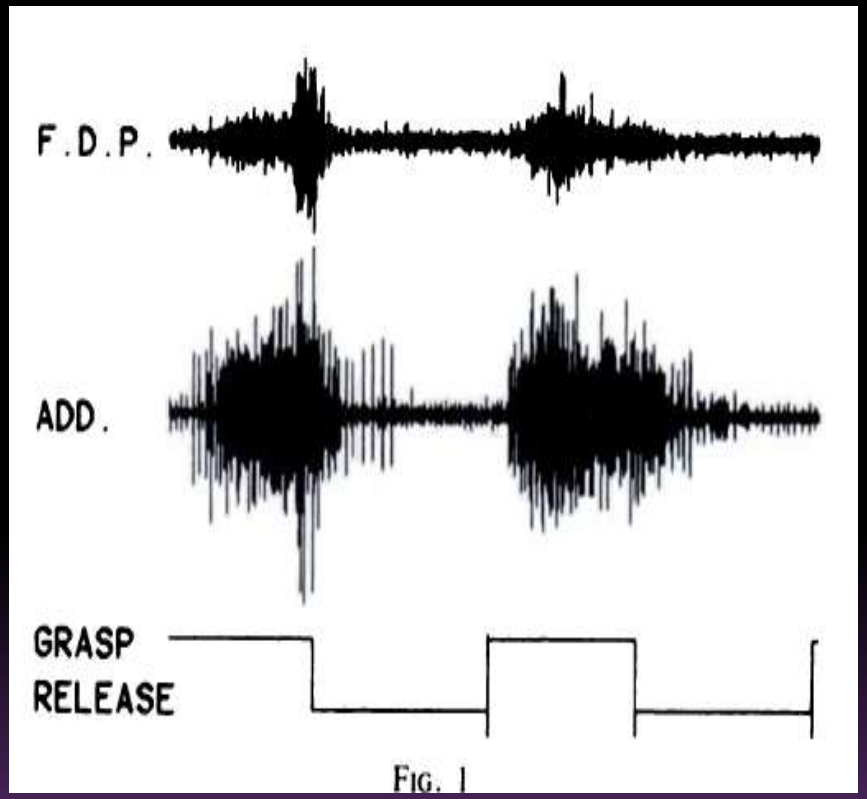
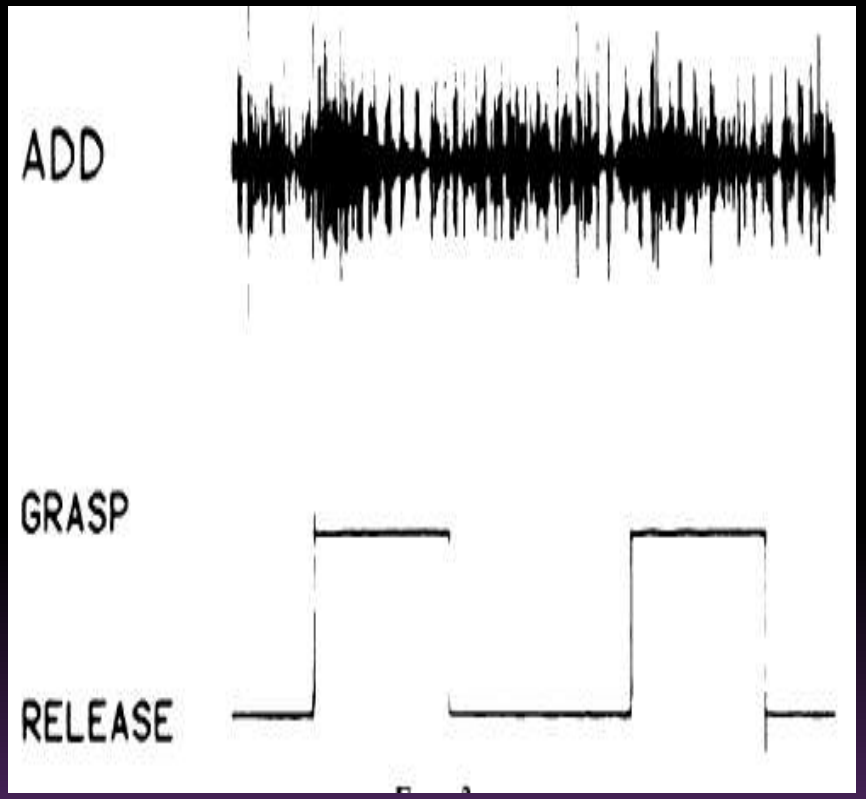
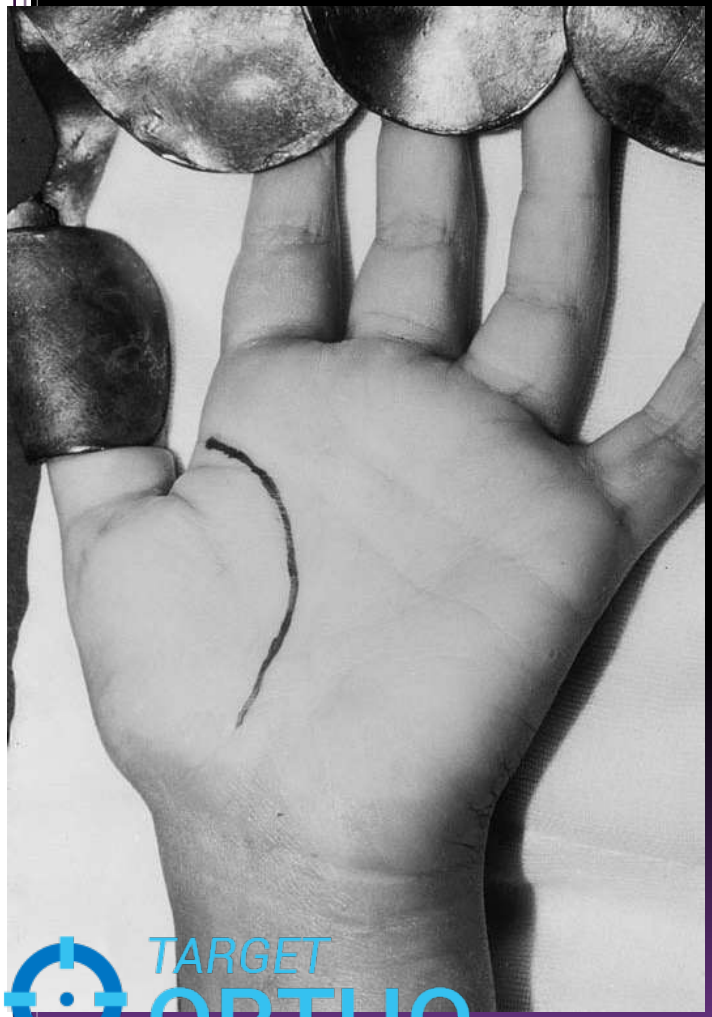


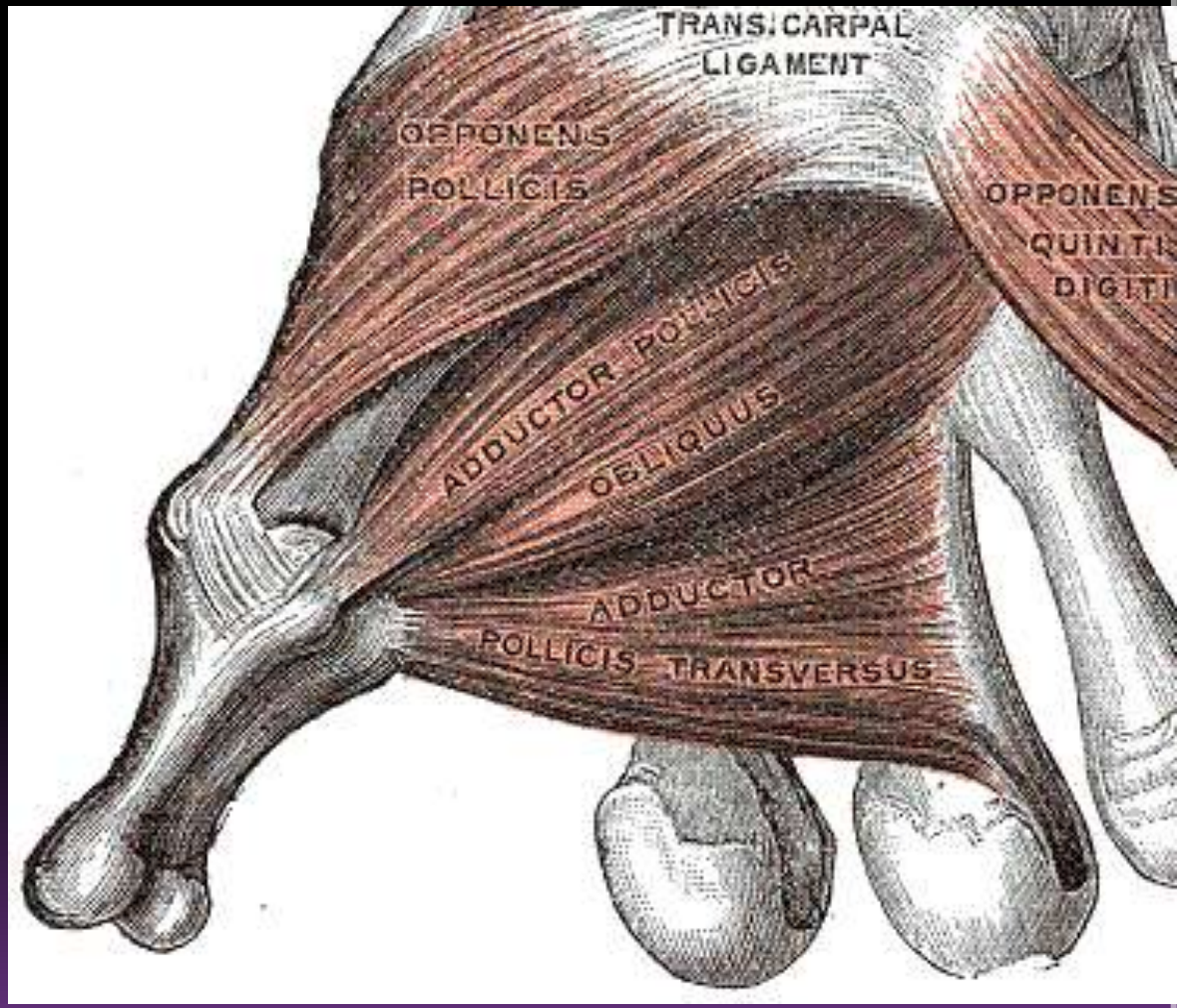
FIG. 1



Hoffer MM, Perry J, Garcia M, Bullock D.Adduction contracture of the thumb in cerebral palsy. J Bone Joint Surg [Am] 1983;65A(6): 755–9.

Surgical Technique: Hoffer's





Treatment – type 1

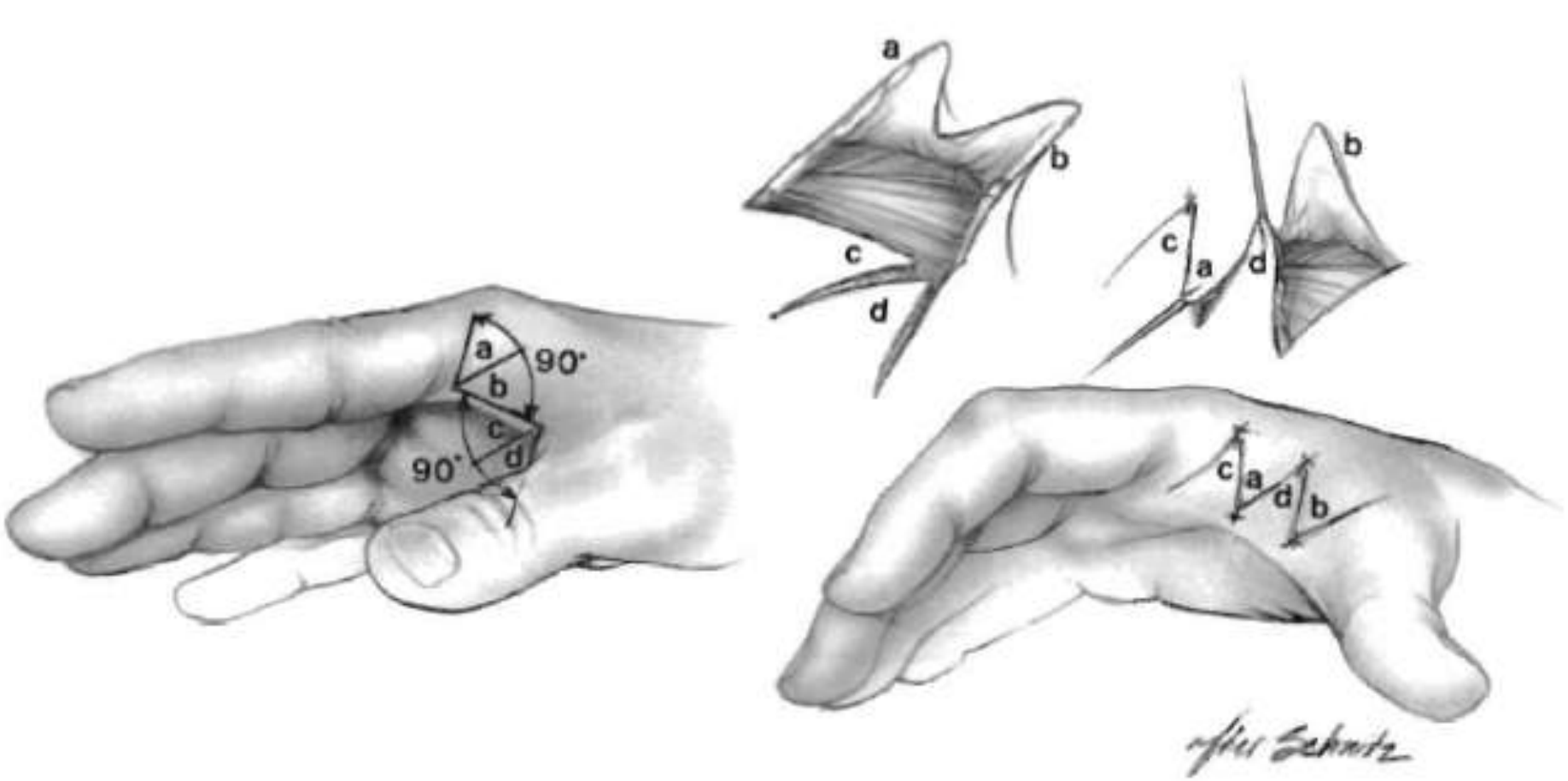
- Partial myotomy of the transverse fibers preserving the oblique fibers of the AP
- This technique preserves "key pinch," which many patients rely on for opposition.
- In patients without active adduction, traditional complete release of the AP & 1st dorsal interosseous from the MC

Treatment – type 1

- Complete release adductor pollicis.
- may result in loss of key pinch
- but give the ability to grasp a walker handle better.

Treatment – type 1

- If individuals want to use their hands to hold a glass, then web space deepening by Z-plasty is required
- a simple two-flap Z-plasty: increases web space 1 cm
- a four-flap Z-plasty will increase the web space by 50% more

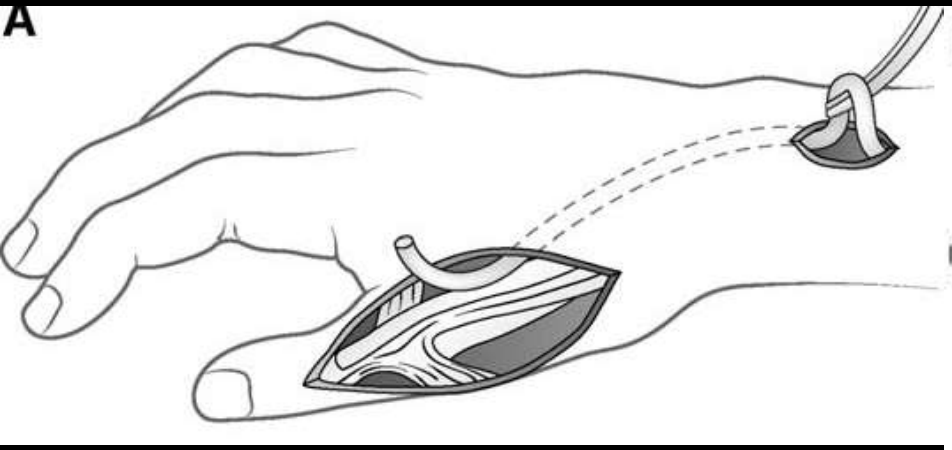


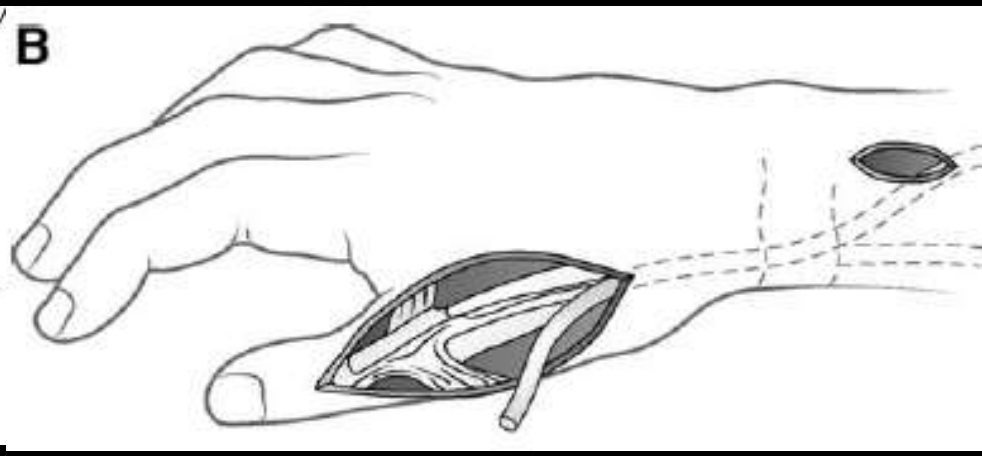
Type II. MC adduction contracture and MCP flexion deformity

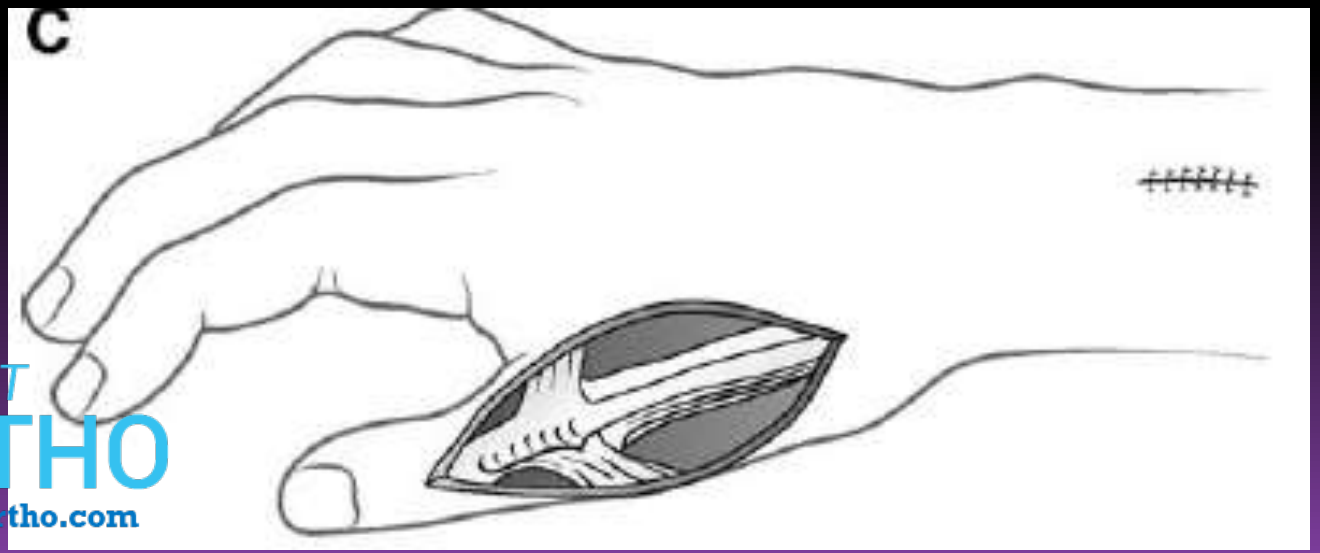
Treatment type 2

- Adductor release and augmentation of thumb abductor or extensor.
- The extensor indicis or palmaris longus is preferred.
- FPL Rerouting

Surgical technique: Manske







Type III MC add contracture combined with a MCP hyperextension deformity or instability

Treatment type 3

- These patients require treatment of the thumb adduction contracture as in type 1 plus stabilization of the thumb MCP joint.

- MCP joint stabilization is best done by doing a MCP joint fusion.

Type IV:MC add cont.combined with MCP and IP flexion deformities

Treatment - Type IV

- As these individuals have minimal function, the treatment usually is directed at improving hygiene.
- Release of the Adductor,
- Tenotomy of the FPL,
- and fusion of the MCP joint in full extension.
- In a few individuals with severe adduction, a Z-plasty of the web space may be required

Other treatment

- Radial and dorsal transfer of the flexor pollicis longus combined with fusion of the IP joint.

- Osteotomy of the first metacarpal or resection of the greater multangular.

Finger flexion

- FDS(Primary)
- FDP(secondary)

Finger flexion: Treatment

- Adequate finger extension is defined as a good release of grasp position.

- Indications:
- If extension of 30 at MP And IP with the wrist in 0° to 20° of extension, cannot be passively obtained.
- Severe contracture, problems of hygiene.

Finger flexion: Treatment

- Functional hand: lengthening of FDS.
- Lengthening of FDP along with FDS leads to weakening of grasp.
- In these severe contractures for hygiene both the flexor digitorum superficialis and flexor digitorum profundus have to be lengthened.

Finger flexion: Procedure

- Fractional Lengthening at musculo-tendinous junction of FDS.
- Z lengthening
- Usually lengthening the index and middle finger as a group and also the ring and little finger as a group.

Finger Swan Neck

- Tightening of the finger flexors secondary to the wrist flexion deformity
- Plus spasticity of the intrinsic muscles
- and the extensor digitorum longus

Finger Swan Neck

- The volar capsule of the PIP joint becomes stretched out secondarily.
- When the deformity is severe, the fingers may become locked into extension and cannot actively flex

Finger Swan Neck: Treatment

- Splints: Figure of 8 splints.
- Surgical
- For supple and moderate deformities:a volar capsulodesis and a flexor superficialis tenodesis.
- For severe deformities: proximal interphalangeal joint fusion in 30° to 40° of flexion.

Finger Swan Neck: Treatment

- lengthening or incising the central slip of the extensor digitorum longus proximal to the proximal interphalangeal joint.