Principles of tendon transfers

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Principles

Indications
Prerequisites
Technique
Strategy of repair
Alternatives

Indications

1 - Nerve lesion

Traumatic nerve injury
- Nerve trunk
- Brachial plexus
- Spinal cord (tetraplegia)

→ unrepaired, unrepairable
→ repaired but failed

Indications

2 - Muscle or tendon lesion

- Posttraumatic rupture
distal radial fracture (EPL)

Indications

2 - Muscle or tendon lesion

- Muscle defect
complex arm/forearm trauma

Indications

2 - Muscle or tendon lesion

- Posttraumatic ischemia
Volkman’s contracture
Indications

2 - Muscle or tendon lesion
- Rheumatologic disease
- Tendon rupture

3 - Central lesion
- Neurologic disease
- Cerebral palsy
- Head injury
- Stroke...

4 - Neuro-muscular disease
- Charcot-Marie-Tooth
- Myopathy...

5 - Congenital malformations
- Arthrogryposis
- Thumb hypoplasia...

Prerequisites

1. Local skin coverage
   ➔ skin flap
**Prerequisites**

1. **Local**
   - skin coverage
   - supple joints
   - stable joints
   - stabilization

2. **General**
   - Patient’s cooperation
   - IQ (relative)
   - behaviour problems
   - realistic expectations
   - motivation
   - Age
   - elderly
   - very young?

3. **Postoperative regimen**
   - Physiotherapy
     - daily basis
     - trained physiotherapist
   - Medical and familial environment
Timing of surgery

varies according to pathology

Posttraumatic nerve injury
no clinical / EMG progression

- Unrepairable:
  Brachial plexus: 6-9 months
  Tetraplegia: 9-12 months
- Repaired but failed:
  1 year post repair

Timing of surgery

varies according to pathology

Neurologic disease
Non progressive

Neurologic disease
Non progressive

Technical principles

Choice of motor
Direction of transfer
Tension of transfer
Distal insertion

Technical principles

Choice of motor

MRC scale
- Grade 0: no response
- Grade 1: palpable contraction
- Grade 2: active movement with gravity
- Grade 3: movement against gravity
- Grade 4: movement against resistance
- Grade 5: normal
### Technical principles

**Choice of motor**
- BMRC 4 and +
  - Full movement against resistance
  - No muscle fatigue
  - Some muscles are difficult to assess

*Testing of Brachioradialis*

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### Technique

**Choice of motor**
- BMRC 4 and +
  - Similar length
  - Avoid grafts

*ex: ECRL to fingers: graft*

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**Donor:** FCR

*MPj arthrodesis
-or distal re-attachment*

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**Donor:** FPB

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**Choice of motor**
- Similar excursion
  - Wrist tendons: 33mm
  - Finger extensors: 50mm
  - Finger flexors: 70mm

*ex: finger flexor to wrist extensor*

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**Example:** BR(25) to FDP(70) = no

*Smith, 1987*
**Technique**

*Choice of motor*
- Similar excursion
- Similar power

Power = muscle cross-sectional area

*Physiologic Cross Section (PCS)*
= muscle volume / mean fiber length

*Tension fraction*
= PCS / sum of PCS

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**Tension fraction**

<table>
<thead>
<tr>
<th>Name</th>
<th>Tension fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR</td>
<td>0.2</td>
</tr>
<tr>
<td>FPL</td>
<td>0.4</td>
</tr>
<tr>
<td>PL to wrist extensors</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Ex: BR to FPL
PL to wrist extensors

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**Direction of transfer**

- Direct route (straight line of pull)
  Proximal dissection of muscle body
  Wide subcutaneous tunnel
  Through interosseous membrane?

- Avoid pulleys
  But they are sometimes necessary...
Technique

Tension of transfer
One of the critical factors

Tension-length curve (Blix curve):
as one increases passive stretch,
contractile forces decrease

Technique

Posterior Deltoid-to-Triceps Tendon Transfer
Lieber & Friden 2003

Muscle Length (mm)

Posterior Deltoid-to-Triceps Tendon Transfer
Lieber & Friden 2003

Muscle Force

Strategy of repair

Distal insertion
- To tendon
  Resistant but non-adherent and non-ischemic
  → weaving Pulvertaft
  → fine nonabsorbable sutures
- To bone
  Bone anchor
**Strategy of repair**

1. One transfer for one function

**Example**

**radial palsy**

- One transfer for wrist extension
- One transfer for finger extension
- One transfer for thumb extension

**Example**

**thumb abduction**

**Strategy of repair**

2. Several options according to the patient’s needs

*ex: Radial palsy*

- Heavy manual worker: leave FCU in place
- Otherwise: use FCU for transfer

**Strategy of repair**

3. Depends on extent of paralysis

Normally 39 muscles to activate the hand and wrist

→ Simple paralyses (1 nerve trunk)

Repair all functions

**Strategy of repair**

*Ex: distal ulnar palsy*
Strategy of repair

3- Depends on extent of paralysis
Normally 39 muscles to activate the hand and wrist

- Complex paralyses
  Example tetraplegia: 1 muscle available
  Restore the most important function + additional procedures

Strategy of repair

4- The tenodesis effect
Automatic movement of one joint activated by another joint

Strategy of repair

Wrist flexion (through gravity)
  = automatic finger extension
Wrist extension
  = automatic pinch
  = potentialize finger flexion

Think twice before fusing the wrist

Strategy of repair

5- Additional procedures
Joint fusions (thumb)
Tenodeses

Alternatives

Tenodesis
Arthrodesis
Nerve transfer, neurotization
Free muscle transfer

Tenodesis

Passive (Zancolli)
Tenodesis

Active (Zancoli)

Alternatives

Arthrodesis

Nerve transfer, neurotization

Ex: transfer of AIN to motor branch of ulnar nerve (Wang & Zu 1997)

Alternatives

Free muscle transfer
Conclusion

1 - Tendon transfers are effective procedures provided one follows a few basic principles

2 - No standard procedure: each case is different

3 - Good knowledge of muscle anatomy and biomechanics

4 - Experience

5 - Imagination!