Tendon Transfers  
Principles and Practice  
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Genesis
- Birth palsy
- Cerebral palsy
- Polio
- World war

Goal
- Principles of tendon transfer
  - Focus on radial nerve transfers
- Specific transfers for:
  - Radial Nerve
  - Median Nerve
  - Ulnar nerve
- Not Included
  - Combined injuries
  - Excessive mental masturbation

Principles Simplified
- To rob from Peter and to give to Paul
- Peter remains none the wiser

Principles
- Straight line of pull
- Transfer Synergy
  - Finger flexion with Wrist extension
  - Finger extension with Wrist flexion
  - Independent cortical control may bail you out

Principles
- Expendable Donor
  - Exploiting redundancy
- One tendon – One function
- Timing -- “Tissue Equilibrium”
  - Scars soft
  - Wounds mature
  - Induration gone
  - Joints supple
**Principles**

- **Timing**
  - Early v. Late → *not that controversial*
  - Internal splint
  - Improves power following nerve regeneration
  - Minimizes period of dysfunction when nerve regeneration expected to be poor
    - Age
    - Gap > 4cm
    - Crush

- **Age**
  - Gap > 4cm
  - Crush

- **Match work capacity**
  - PT 1.2 → ECRB 0.9
  - FCR 0.8 → EDC 1.7
  - FCU 2.0 → EDC 1.7 *better match?*
  - PL 0.1 → EPL 0.1
  - FDS 4.8 → EPL 0.1

- **Match amplitude of tendon excursion**
  - Wrist flexion and Wrist extension require 33mm of excursion
  - Finger extension and Thumb extension require 30mm of excursion
  - Finger flexion requires 70mm of excursion
  - Increase amplitude by tenodesis effect
  - Increase amplitude by dissection of donor

**Evaluation**

- At least two meetings pre op
  - Answer questions
  - Chance to re-examine
  - Meet with therapy pre op
- Check sensation
- EMG not routinely useful
  - *What’s in – What’s out*

**Radial Nerve Transfer**

- My favorite
- Predictable outcomes
  - Easy to relearn
- High v. Low
  - More work v. less work
  - But not much
- Three main varieties
Radial Nerve Transfer

• “FCR transfer”
  – FCR → EDS
  – PT → ECRB
  – PL → rerouted EPL

• “FCU transfer”
  – FCU → EDC
  – PT → ECRB
  – PL → rerouted EPL
  – Straighter line of pull
  – More powerful, however...
    – Tenodesis more than makes up for it
    – Excessive radial deviation

Radial Nerve Transfer

• FCR and FCU transfers rely on intact PL
• If PL not there...
  – FDS IV to EPL

• “Superficialis transfer”
  – PT to ECRB
  – FDS III to EDC
  – FDS IV to EPL and EIP
  – FCR to APL and EPB
  – Violates “one tendon – one function”
  – Maybe too powerful
    – Work capacity FDS 4.8
    – Work capacity EPL 0.1

Technique

• OK to optimize incisions

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• Take PT with periosteum
Technique

- OK to optimize incisions
- Take PT with periosteum
- Set tension of EDC first

Technique

- OK to optimize incisions
- Take FCR with periosteum
- Set tension of EDC first
- Reroute EPL

Setting Tension

- By “feel”
  - Nothing beats experience
- Pulvertaft weave
- Too tight better than too loose

Median Nerve Transfers

- Not so much my favorite
  - Loss of sensation very disabling
  - Attempts to restore sensation illustrate triumph of technology over reason
- Must be clear why you are operating and what you hope to gain

Median Nerve Transfers

- Principles remain the same
  - Good soft tissue
  - Full passive ROM
  - Good sensation
Median Nerve Transfers

- Principles remain the same
  - Straight line of pull
  - Good synergy
  - Good amplitude match
    - Tension of APB + Opp = 3.0
    - FDS IV (3.0) PL (1.2)
    - ADM (4.0) EIP (5.5)
  - Must reach MCP

- Reconstruction determined by
  - Quality of sensation
  - Contralateral hand function
  - Patient motivation
  - Ability to adapt to sensory loss
    - Cortical plasticity

Low Median Nerve Transfers

- Low median nerve palsy
  - Distal to AIN takeoff
  - Loss of APB, opponens, and FPB
- HOWEVER
  - Many patients can retain thumb abduction and opposition from ulnar muscles
- THEREFORE
  - While the indication for opponensplasty is lack of opposition, the indication for SURGERY is loss of function due to the loss of opposition

Low Median Nerve Transfers

- Current indications
  - Traumatic injury to motor branch
  - Neuromuscular disorders
    - Charcot-Marie-Tooth
    - Spinal muscular atrophy
    - Syringomyelia

Low Median Nerve Transfers

- 4 Standard Opponensplasties
  - FDS
    - Excellent tension match
  - EIP
    - Excellent tension
    - Excellent line of pull
Low Median Nerve Transfers

• 4 Standard Opponensplasties
  – FDS
    • Excellent tension match
  – EIP
    • Excellent tension
    • Excellent line of pull
  – ADM
    • Excellent tension
    • Excellent line of pull
    • Cosmetic also

High Median Nerve Transfers

• Injury above AIN takeoff
  • Need to restore
    – Flexion of thumb
    – Flexion of index finger
  • Lack of sensibility tempers enthusiasm

Low Median Nerve Transfers

• 4 Standard Opponensplasties
  – FDS
    • Excellent tension match
  – EIP
    • Excellent tension
    • Excellent line of pull
  – ADM
    • Excellent tension
    • Excellent line of pull
    • Cosmetic also
  – PL
    • “Easy”

High Median Nerve Transfers

• BR to FPL
  • ECRL to FDP IF/MF

Ulnar Nerve Transfers

• Goals are straightforward
  – Stop clawing
  – Increase grip
  – Increase pinch

• Distinguish
  – High
  – Low
  – Very low

Neuromuscular disorders spare sensation
### Level of Injury

- **High**
  - Motor to extrinsics
  - Motor to intrinsics
  - Sensation dorsal and palmar
- **Low**
  - Motor to intrinsics
  - Sensation to hand
- **Very Low**
  - Spares hypothenar

### Ulnar Nerve Transfers

**Goals: FIX THE CLAW**

- **Static transfers**
  - Capsulodesis
  - No strength in transferable muscles
  - Easy
  - Poor durability

- **Dynamic transfers**
  - MANY kinds
  - Principle the same
    - Palmar motor
    - Flex MCF
    - Couple to PIP extension

#### Ulnar Nerve Transfers

- **Goals: FIX THE CLAW**
  - Static transfers
    - Capsulodesis
    - No strength in transferable muscles
    - Easy
    - Poor durability

- **Dynamic transfers**
  - FDS motor
Ulnar Nerve Transfers

• Goals: FIX THE CLAW
  – Dynamic transfers
    • FDS motor
    • Zancolli Lasso

Ulnar Nerve Transfers

• Goals: FIX THE CLAW
  – Dynamic transfers
    • FDS motor
    • Zancolli Lasso
    • ECRL transfer with graft

Ulnar Nerve Transfers

• Goals: INCREASE PINCH
  – Restore thumb adduction

Ulnar Nerve Transfers

• Goals: INCREASE GRIP
  – Side to side transfer
  – Easy

Summary

• Radial nerve transfers
  – Like magic
• Median nerve transfer
  – Little indication
  – Keep it simple - opposition
• Ulnar nerve transfers
  – Fix claw
  – Improve pinch

Summary

• Keep the principles in mind
• Your colleagues will make this shine
• Make sure to thank them daily!

THANKS!
• 0-4 Weeks Post-Op
  • Short arm splint
    – Personal preference
    – Wrist 45º extension
    – MP joints 10-15º flexion
    – IP joints Free
    – Thumb max Abd & Ext

• 4 Weeks Post-Op
  • Removable short arm extension splint
    – Remover for Finger/thumb ROM exercises
    – Synergistic movements
    – ? dynamic extension splint
    – Static protective splint for crowds/sleeping for 4-6 weeks