Ulnar Nerve: Injury and Repair

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OBJECTIVES

• Nerve Anatomy and Function
• Nerve Injury
• Nerve Repairs
• Tendon Transfers
• Nerve Transfers

FINANCIAL DISCLOSURE

Financial Disclosure
Douglas Cromack, MD has no relevant financial relationship with commercial interests to disclose.

Brachial Plexus

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Ulnar nerve innervation

Flexor digitorum profundus

Flexor carpi ulnaris

Hypothenar Group

Abductor digiti minimi
Flexor digiti minimi
Opponens digiti minimi
Intrinsics Group

- 3rd & 4th lumbricals
- 2nd palmar interossous
- 1st dorsal interossous

Sensory Exam

Thenar Group

- Flexor pollicis brevis
- Adductor pollicis

Functional loss

- Low ulnar nerve injury – Distal to FDP
  - Loss of lateral pinch
  - Loss of normal hand contour
  - Small finger hyperabduction

- High ulnar nerve injury – Proximal to FCU
  - Less clawing due to partial extrinsic flexor denervation
Functional loss

Froment's sign

Ulnar clawing

Primary repair

TABLE 2-1
The Ideal Nerve Repair
1. Performed primarily, either immediate or delayed.
2. Well-vascularized bed with little or no straining.
3. Viable nerve ends.
4. No hematoma.
5. Accurate fascicular alignment.
6. Fewest number of stitches, placed in epineurium.
7. Minimal tension.
8. Minimal or moderate joint flexion.

Repair of injuries

- Primary repair
- Nerve grafts
- Tendon transfers
- Functional free muscle transfers
- Nerve transfers

Epineurial and grouped fascicular repair
Nerve grafts

- Autografts
- Allografts
- Nerve conduits

Basic nerve grafting

Autografts

- Gold standard
- Schwann cells, neurotrophic factors for guidance.
- Donor morbidity
- Sural, LABC, MABC, PIN
- Motor donor best for motor repairs

Ulnar nerve repair results

<table>
<thead>
<tr>
<th>Primary Repair</th>
<th>Delayed Repair</th>
<th>Grade</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extensor</td>
<td>6</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Cross</td>
<td>34</td>
<td>35</td>
<td>69</td>
</tr>
<tr>
<td>Four or More</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>79</td>
<td>119</td>
</tr>
</tbody>
</table>

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Suture repair results

<table>
<thead>
<tr>
<th>Ulnar nerve level</th>
<th>Motor Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper arm &amp; elbow</td>
<td>M0: No contraction</td>
</tr>
<tr>
<td>Wrist</td>
<td>M1: Return of perceptible contraction in the proximal muscles</td>
</tr>
</tbody>
</table>

Kim, DH et al, Nerve Injuries, 2nd Ed

Allografts

- Acellular but retains scaffolding and protein components for regrowth.
- Animal studies-similar to autograft, superior to collagen tube. Evenly spaced axonal regeneration.
- Industry sponsored multicenter study
- 12 sites/25 surgeons
  - 132 nerve injuries
  - 76 repairs used in outcomes group
  - 48 digital, 11 median, 6 ulnar, 2 radial
  - Healthy, mean 41 yrs age

Sensory Recovery

<table>
<thead>
<tr>
<th>Sensory Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>S0: Absence of sensibility in the autonomous area</td>
</tr>
<tr>
<td>S1: Recovery of deep cutaneous pain sensibility within the autonomous area of the nerve</td>
</tr>
<tr>
<td>S2: Return of some degree of cutaneous pain and tactile sensibility within the autonomous area</td>
</tr>
<tr>
<td>S3: Return of some degree of superficial cutaneous pain and tactile sensibility within the autonomous area with disappearance of any previous overreaction</td>
</tr>
<tr>
<td>S3+: Return of sensibility as in stage 3 with the addition that there is some recovery of two-point discrimination within the autonomous area</td>
</tr>
<tr>
<td>S4: Complete recovery</td>
</tr>
</tbody>
</table>

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Allografts

- 87% Meaningful recovery (S3-4, M3-5)
  - 89% sensory
  - 86% motor
  - 77% mixture
  - 100% of <15mm gap
  - 75-91% up to 50mm gap

Nerve conduits

- Mechanically guide axonal cone preventing extrusion.
- Locally concentrated growth factors-from distal nerve to help guide axons.
- Limited infiltration of local tissue.
- May improve surgical debridement-no risk of tension repair.

Peripheral Nerve Surgery, Slutsky & Hentz

Nerve conduits

Peripheral Nerve Surgery, Slutsky & Hentz

Tendon Transfers

Peripheral Nerve Surgery, Slutsky & Hentz

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Principles of tendon transfers

- Correction of contracture
- Adequate strength
- Amplitude of motion
- Straight line of pull
- One tendon – one function
- Synergism
- Expendable donor
- Tissue equilibrium

Tendon transfers

Thump adduction

Tendon transfers for UN

- Lateral pinch
- Thumb adductorplasty
- Index finger abductorplasty

Nerve transfers
Rational for nerve transfers for motor nerve lesions

- Motor endplate degrade at 1%/week.
- Nerve growth is 1in/month or 1mm/day.
- In one year, nerve regrowth of 12 inches and 50% of endplate will be lost.
- Maximum length for restoration of motor-function is 13-18 inches.

Distal Median to Ulnar Nerve

- AIN to ulnar motor
- 3rd web CDN to sensory fascicle of ulnar nerve
- Ulnar dorsal cutaneous nerve, end-to-side to median nerve sensory component
- Sacrificed 3rd WS of median nerve transfer end-to-side to remaining intact median nerve sensory
- Flexor tenodesis of ulnar FDP to median FDP to restore extrinsic function

Nerve Transfers

Distal Median to Ulnar Nerve

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**Motor Recovery**

<table>
<thead>
<tr>
<th>THE MEDICAL RESEARCH COUNCIL SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>M0</strong></td>
</tr>
<tr>
<td><strong>M1</strong></td>
</tr>
<tr>
<td><strong>M2</strong></td>
</tr>
<tr>
<td><strong>M3</strong></td>
</tr>
<tr>
<td><strong>M4</strong></td>
</tr>
<tr>
<td><strong>M5</strong></td>
</tr>
</tbody>
</table>

**High ulnar injuries**

- Retrospective review of 15 pts
- Nerve grafting vs. nerve transfers
  - Recovery of M3/M4 22% vs. 80%
  - Mean grip strength 14 kg vs. 31 kg
  - No difference sensory recovery

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**Sensory Recovery**

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<tbody>
<tr>
<td><strong>S0</strong></td>
</tr>
<tr>
<td><strong>S1</strong></td>
</tr>
<tr>
<td><strong>S2</strong></td>
</tr>
<tr>
<td><strong>S3</strong></td>
</tr>
<tr>
<td><strong>S3+</strong></td>
</tr>
<tr>
<td><strong>S4</strong></td>
</tr>
</tbody>
</table>

**High ulnar injuries**

- Retrospective review of 52 pts, > 2 yr f/u
- Nerve grafting (24) vs. nerve transfers (28)
- Isolated high UN injury > 6 months
  - Recovery of M3/M4 57 % vs. 83 %
  - Mean grip strength 52 lbs vs. 73 lbs
  - No difference sensory recovery

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Post op therapy
• Motor
• Early ROM for uninvolved joints on day 3
• Orthotics for involved joints through 3 wks
• Daily E stim at 6 weeks, increasing resistance
• After reinnervation, 6 mon, cortical remapping and relearning
• Sensory
  • Early – protection from injury
  • Later – sensory reeducation

References
• Crucial Elements in Hand Surgery 2, ASSH
• Green’s Operative Hand Surgery, 5th Ed
• Peripheral Nerve Surgery, Slutsky & Hentz
• Nerve Injuries, 2nd Ed, Kline & Hudson
• Tendon Transfer Surgery of the Upper Extremity, ASSH, Van Heest & Goldfarb

Thank you