Peripheral Nerve Injury and Associated Reconstructive Options

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Founders Circle
Course Outline

9:15  Review of the anatomy and pathology of peripheral nerve injuries
9:30  Repair versus grafting of the acute peripheral nerve injury
9:45  Delayed presentation of injury
10:00 General principles in therapy for the acute peripheral nerve injury
10:15 Break
10:30  Repair and reconstruction of the radial nerve
11:00  Therapy for radial nerve palsy and subsequent rehab after treatment
11:30  Repair and reconstruction of the ulnar nerve
12:00  Therapy for ulnar nerve palsy and subsequent rehab after treatment
Peripheral Nerve Injury

Wide ranges of severity and loss of function in injury

Sensory Changes ➔ Loss of coordination and strength ➔ Loss of active motion
Nerve Anatomy
Axonal Anatomy

- Dendrite
- Cell body
- Axon
- Axon terminal
- Node of Ranvier
- Schwann cell
- Myelin
- Nucleus
Internal Topography

- Deep motor branch
- Ring finger, ulnar side
- Little finger, radial side
- Little finger, ulnar side
- Flexor dig. profund.
- Flexor carpi ulnaris
- Dorsal cutaneous
Evaluation

• Sensory
  – 2-point discrimination (5-7 mm static)

• Motor
  – Specific muscle testing

• NCS/EMG
Nerve Specific Sensory Exam

• Median Nerve
  – Pulp of the thumb

• Ulnar Nerve
  – Pulp of the small finger

• Radial Nerve
  – Dorsum of 1st web space
Specific Muscle Testing

- **Median Nerve**
  - All sublimis, FPL, Index FDP

- **Ulnar Nerve**
  - First Dorsal I0, Abductor Digiti Minimi

- **Radial Nerve**
  - Wrist extension
  - PIN – MP joint extension and thumb extension
Seddon Classification

- Sir Herbert Seddon 1945
  - Neuropraxia
    - Complete recovery
  - Axonotmesis
    - Complete $\rightarrow$ Incomplete Recovery
  - Neurotmesis
    - No Recovery
### Classification of Nerve Injury

<table>
<thead>
<tr>
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<tr>
<td></td>
<td>Degree IV</td>
<td>Complete scar block</td>
<td>None</td>
</tr>
<tr>
<td>Neurotmesis</td>
<td>Degree V</td>
<td>Complete transection</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Degree VI (Mackinnon)</td>
<td>Combination of degree I–IV ± normal fascicles</td>
<td>Mixed</td>
</tr>
</tbody>
</table>
Type of Injury

• Penetrating Injuries
• Crush Injuries
• Stretch/Avulsion injuries.
Penetrating Injuries

For lacerated nerve with obvious transection:
Recommend exploration and repair by day 7
Blunt Penetrating and Blast

• Treated like crush or avulsion injuries
  – Observe for 3 months.
  – NCS/EmG: not until 6 weeks- 3 months
  – Edema and collateral damage can often elicit neurapraxia
Crush Injury

• May injure myelinating schwann cells
  – Leaves fibers intact but unable to transmit impulses (Neuropraxia)
NERVE REPAIR
Does Nerve Repair Work?

- Haighton 1795
  - Bilateral Vagotomy of dogs is fatal (duh!)
  - Bilateral Vagotomy with immediate repair is fatal
  - Unilateral Vagotomy and repair followed by contralateral vagotomy 6 weeks later is NOT fatal
Why Does it Take So Long??
Definitions

• Primary Repair – that which occurs within 1-3 weeks after the injury
• Secondary Repair – after 3 weeks of injury
• Nerve Conduit – tube used to span the gap between nerve ends (vein, artery, synthetic, collagen)
• Nerve allograft – cadaveric nerve
• Nerve autograft – taken from elsewhere to span the gap
Golden Rule

Nerve Repair should occur in a timely manner with a well vascularized tissue bed and no tension!
Types of Nerve Repair

Epineurial repair

Group fascicular repair
Tension is a Killer

- Nerve mobilization
- Nerve transposition
- Bone Shortening
- Joint Positioning 🕷️
Expected Outcomes

- Delay in beginning recovery about 1 month
- 1-2 mm/day
  - Evaluated by an advancing Tinels
- Direct repair with the best outcomes
Allograft

- Near normal 2PD for digital nerve gaps <3cm

Table 1 A summary of all ten nerve reconstructions with defect length, follow-up, and values obtained on final evaluation of static and moving two-point discrimination (2PDs and 2PDM).

<table>
<thead>
<tr>
<th>No</th>
<th>Age</th>
<th>Sex</th>
<th>Side</th>
<th>Injured nerve</th>
<th>Etiology</th>
<th>Length</th>
<th>Diameter</th>
<th>Follow-up</th>
<th>2PDS</th>
<th>2PDM</th>
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<tbody>
<tr>
<td>1</td>
<td>47</td>
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<td>0.5</td>
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<td>2</td>
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<td>R</td>
<td>Dorsal sensory branch of the ulna</td>
<td>Neuroma excision</td>
<td>3</td>
<td>1</td>
<td>8.5</td>
<td>*</td>
<td>4</td>
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<td>*</td>
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<tr>
<td>4</td>
<td>57</td>
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<td>R</td>
<td>Ring finger radial digital nerve</td>
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<td>1</td>
<td>2</td>
<td>12</td>
<td>3</td>
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<tr>
<td>5</td>
<td>57</td>
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<td>Ring finger ulnar digital nerve</td>
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<td>2</td>
<td>12</td>
<td>3</td>
<td>3</td>
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<tr>
<td>6</td>
<td>31</td>
<td>m</td>
<td>R</td>
<td>Long finger radial digital nerve</td>
<td>Laceration</td>
<td>3</td>
<td>2</td>
<td>9</td>
<td>6</td>
<td>6</td>
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<tr>
<td>7</td>
<td>48</td>
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<td>Digital nerve</td>
<td>Laceration</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>65</td>
<td>m</td>
<td>L</td>
<td>Digital nerve</td>
<td>Laceration</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>23</td>
<td>m</td>
<td>L</td>
<td>Thumb radial digital nerve</td>
<td>Laceration</td>
<td>1</td>
<td>2</td>
<td>12</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>23</td>
<td>m</td>
<td>L</td>
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<td>1</td>
<td>2</td>
<td>12</td>
<td>7</td>
<td>5</td>
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<tr>
<td>Ave</td>
<td>43</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.15</td>
<td>1.90</td>
<td>8.95</td>
<td>5.5</td>
<td>4.40</td>
</tr>
</tbody>
</table>

Nerve Conduits

• Benefits
  – No donor site
  – Simple use

• Only for Sensory nerves

• Gaps less than 15mm

• Different types
  – Axoguard – porcine submucosa
  – Neuragen – bovine flexor tendon
Conduit Results

• Compared to Direct Repair
  – Sullivan
    • 17% Good, 30% Fair, 53% Poor
  – Buncke
    • 50% Good, 28% Fair, 22% Poor

Avulsion or Stretch Injuries

- Usually a mixed injury (Grade VI)
- Can be open or closed
  - Open injuries associated with worse outcomes
- Degree of soft tissue injury bears weight on the outcome
  - May require a delay in treatment
Classification by Location of Injury

• Spinal root avulsions are treated very different than peripheral lacerations

• Muscle Belly avulsions
  – Possible nerve transfer with implantation into the muscle

  – Spinal root = Nerve transfer or tendon transfer
Nerve Recovery Based on Class

Table 22.1 Classification of nerve injury

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I – relatively quick, 6-12 weeks
II, III – 1-1.5 mm a day
IV, V – no recovery
Factors Affecting Nerve Recovery

• Age
• Type of Injury
• Comorbidities
  – Renal Disease
  – Diabetes
• Radial>Median>Ulnar
Delayed Presentation
Timeline

• Nerve reconstruction after 6 months of transection decreases the regenerating axons by 2/3.

• Very different for mixed peripheral nerves versus sensory nerves
  – Sensory end organs respond up to 5 years after injury
  – Muscle atrophy occurs over 18-24 months
Treatment Options

• Dependent on the distance to innervation

• Radial nerve
  – End organ receptors generally much closer to the site of injury.

• Ulnar nerve
  – Intrinsic musculature too far for meaningful recovery
Factors in Decision Making

• Time
• Is there a known level of injury?
• Is there pain at the injury site?
• What is the distance to muscle interface?
• Is there still Passive mobility of the Joints?
• Age
• Are there factors preventing reconstruction at the injury site?
Nerve Transfers

• Often a better option in high injuries
  – Time is muscle
  – Muscle fibers replaced by fat cells
  – Faster innervation than grafting
  – Operation outside of the zone of injury
  – Less chance of adhesions from scarring as with tendon transfers
  – Maintains anatomical biomechanics of the muscle
Rules to Nerve Transfers

• Must be either redundant or expendable donor.
  – Several branches to the FCR tendon from the median nerve
  – AIN to the Pronator Quadratus is expendable with active Pronator Teres Function

• Donor Distal / Recipient proximal

• Adequate mobilization with no tension
Nerve Transfer

• Donor Nerves
  – Appropriate size (specifically axonal count)
  – Proximity to the recipient nerve
  – Synergistic muscle
  – Readily accessible fascicular groups
    • Not mixed fascicles
Tendon Transfer

• Tried and True
• Dr. Paul Brand keys to success in tendon transfer
  – Tissue “equilibrium”
    • Stable skeleton, minimize scar, maximize PROM
  – Strength and excursion should match the native muscle
  – Encourage Straight line of Pull
General Principles in Therapy for the Acute Peripheral Nerve Injury

• **Primary objective:**
  – **Protection** of the traumatized or surgically repaired nerve
  – **Prevention** of joint contracture and further injury secondary to decreased sensibility.

  – Example diagnoses include: acute nerve compression, postsurgical decompression and release, postsurgical repair of a lacerated nerve
Required Information  Treatment Implications

**Nerve involvement**
A. Specific nerve injured
B. Classification and level of injury
   - Mechanism of injury; clean vs crush
C. Other structures involved

**Surgical Management**
A. Date of repair
B. Position of joints to allow relaxation of the nerve juncture
C. Type of repair


A. Indicates sensory and motor impairment; provides focus for evaluation
B. Indicates prognosis and facilitates goal setting
C. Indicates degree of tissue reaction and scar to anticipate more damage with crush injuries than with clean
D. Treatment protocols must be integrated to allow appropriate management for all injured structures.

A. Nerve repairs protected from stress for 3-5 wks
B. Tension at the nerve juncture can compromise results; relaxation of the nerve juncture achieved by flexing the joints across which the nerve passes
C. Early repair is superior to late repair; with nerve grafts, axons must regenerate across junctures.
Expected Pattern of Motor Return

- Usually a 3-4 week latent period, after which axonal regeneration occurs at the rate of 1 mm/day.
- Once regeneration begins, the muscle will demonstrate these 4 stages
  1. Observable and palpable contracture without production of motion
  2. Ability to hold a test position without being able to produce that position
  3. Ability to move the joint though the test motion
  4. Ability to move the joint through the test motion and hold the position against resistance.

Baxter-Petralia P: Therapist’s management of carpal tunnel syndrome. In Hunter JM, ed al, editors: Rehabilitation of the hand, St. Louis, 1990, Mosby
Expected Patterns of Sensory Return

- Recovery occurs in the following sequence
  - Deep pressure and pinprick (protective sensation)
  - Moving light touch
  - Static light touch
  - Discriminative touch
Immobilization

• **Purpose:**
  – Minimize tension at the repair site
  – Protect the nerve from disruption
  – In case of nerve compression or following decompression, immobilize or splint to minimize and facilitate the resolution of the inflammatory reaction.

Immobilization

• Positioning with casting or splinting is done to avoid tension at the repair.
• Determined by physician.
• 3-4 weeks of immobilization typical
• consider compromised sensation when splinting to avoid pressure areas.
• Monitor status of immobilized joints, educate on ROM.
Post Immobilization

- Recover lost ROM (consider tension at repair site when progressing motion)
  - If nerve was repaired under tension, therapy approach may be to increase incrementally the amount of ROM.
  - Splints may require serial adjustments to ensure that ROM limits are followed.
- Ex: radial nerve repair at spiral groove or anticubital fossa - immobilize elbow in 90° flex and wrist ext x 6 weeks

General Principles of Splinting for Peripheral nerve injuries

1. To keep denervated muscles from remaining in an overstretched position
2. To prevent joint contractures
3. To prevent the development of strong substitution patterns
4. To maximize functional use of the hand.
• BREAK-
• Repair and reconstruction of the radial nerve.
Radial Nerve

The Radial Nerve

- Muscles innervated
  - Triceps, extensor carpi radialis and ulnaris, supinator, extensor pollicis
- Motor functions
  - Extension at all arm, wrist, and proximal finger joints below the shoulder; forearm supination; thumb abduction in plane of palm

Holstein-Lewis

- Distal 1/3 associated with entrapment of the radial nerve
- Up to 22% see radial nerve dysfunction
- 90% recover within 3-4 weeks
- 1-5cm of soft tissue b/w nerve and shaft of the radius
- Meta-analysis has shown equal incidence in transverse/spiral fx of middle or proximal 1/3
Treatment of Closed Humerus Fx

• Obvious Indication for exploration in open fx., penetrating injury, vascular injury, ipsilateral forearm fx or floating elbow

• Close fx. Controversial.
  – Most agree observation is recommended with NCS/EMG testing at 6 weeks and 3 months
  – 6-25% entrapped on early exploration
  – 20-42 % Lacerated
    • Some tout Ultrasound as helpful

Algorithm for Closed Humeral Fx

• No operative intervention?
  – Adults: 6 weeks NCS/EMG
    • No Recovery: repeat at 12 weeks.
    • No Recovery: follow clinically until 5 – 6 months, if no clinical recovery then explore and graft versus transfers
  – Pediatrics:
    • Same except wait 9 months before surgical intervention

Open Humeral Fracture

• High energy injury
  – SHOULD NOT ATTEMPT PRIMARY NEURORRHAPHY
  – GRAFT, GRAFT, GRAFT!!!
Outcomes of Radial Nerve Grafting

• Better than other Mixed Peripheral Nerves
  – PIN repair recovers better than Radial Nerve proper
  – 66% motor recovery versus 15%¹

Nerve Transfers

- Median Nerve
  - Redundant Branches
    - FDS
    - FCR
    - Palmaris Longus (if present)
- Synergism
  - FCR to EDC
  - FDS to ECRB

Radial Nerve Tendon Transfers

• Goal
  – Digit Extension (Radial Nerve)
  – Wrist Extension (radial nerve or PIN)
  – Thumb Extension (PIN)
<table>
<thead>
<tr>
<th>Table 31-6</th>
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<tr>
<td><strong>BEST COMBINATIONS OF TENDON TRANSFERS FOR RADIAL NERVE Palsy</strong></td>
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</table>

**FCR Transfer** *(Starr, 76 Brand, 15 Tsuge and Adachi, 84)*
- PT to ECRB
- FCR to EDC
- PL to rerouted EPL

**Superficialis Transfer** *(Boyes, 11; Chuinard et al, 24)*
- PT to ECRL and ECRB
- FDS III to EDC
- FDS IV to EIP and EPL
- FCR to APL and EPB

**FCU Transfer**
- PT to ECRB
- FCU to EDC
- PL to reroute EPL
Pronator
Teres

FCR

Palmaris
Longus
Therapy for radial nerve palsy and subsequent rehab after treatment
Radial Nerve

• The radial nerve has the best functional recovery, after repair, of all the nerves in the upper extremity (Adams and Wood, 1981; Burkhalter 1974).

• Average time to recovery has been reported as 7.5 months (Bevin, 1976)
Testing for Radial Nerve Palsy

• Recall muscles that are innervated by the radial nerve:
  – Triceps
  – Brachioradialis
  – Supinator
  – Extensor muscles of the wrist
  – Extensor muscles of the fingers.
Testing for Radial Nerve Palsy

• Inability to *simultaneously* extend the wrist and fingers (drop wrist).
• Inability to simultaneously radially abduct the extended thumb
• Proximal radial nerve injuries at elbow and above will present with motor and sensory impairments
Sensibility Testing of Radial Nerve

- **Sensation testing**
  - Tinel’s sign - assessed by percussion from distal to proximal along the nerve trunk
  - Sharp/dull discrimination
  - Semmes-Weinstein monofilament test
  - Two-point discrimination (static and moving)
    - Normal: <6 mm
    - Fair: 6-10 mm
    - Poor: 11-15
    - Protective: one point perceived
    - Anesthetic: no points perceived.
  - Moberg Pick-up Test
Treatment for Radial Nerve compression palsy

- **Proximal Radial**
  - Regions compressed:
    - Lateral or long head of triceps
    - Lateral intermuscular septum
    - Spiral groove of humerus
  - Deformity:
    - Wrist and hand extensor weakness (early)
    - Dropped wrist and hand (late)
  - Splint and recommendations:
    - Wrist support – early
    - Outrigger splint to assist wrist, finger and thumb extension - late

“Splint to rest- allow to heal- glide nerve” Lastayo P 2001, AAHS Quarterly Surgery and Rehab of the Hand, Philadelphia meeting 2008
Treatment for Radial Nerve compression palsy

- **Radial Tunnel**
  - Regions compressed:
    - RadioHumeral joint fascia
    - ECRB
    - Supinator
  - Deformity:
    - Pain only
  - Splint and recommendations:
    - Dorsal wrist splint
    - Avoid wrist extension and supination.

“Splint to rest - allow to heal - glide nerve” Lastayo P 2001, AAHS Quarterly Surgery and Rehab of the Hand, Philadelphia meeting 2008
Treatment for Radial Nerve compression palsy

**PIN**
- Regions compressed:
  - Radial head
  - Arcade of Frohse (prox supinator)
  - Distal margin of Supinator
- Deformity:
  - Loss of MP ext, fingers and thumb ext
  - Loss of ECRB/L
- Splint and recommendations:
  - Muenster to limit rotation
  - Extention tenodesis splint for MP ext assist
  - Avoid repetitive pro/sup
  - Radial nerve glove
  - Stretch supinator

“Splint to rest- allow to heal- glide nerve” Lastayo P 2001, AAHS Quarterly Surgery and Rehab of the Hand, Philadelphia meeting 2008
Radial Nerve Splinting

• **Why splint for Radial nerve?**
  – Loss of wrist extension: increases risk of overstretching wrist extensors →
  – Increased resting MCPJ extension →
  – Increasing tension placed on EDC →
  – Resulting in shortening of collateral ligaments and, if unrelieved, will lead to contracture of the MCPJ’s
Treatment for Radial Nerve palsy

• Pearls:
  – When associated with extensor tendon repairs, the guideline for extensor tendon repairs should be followed.
  – Non-dominant: consider static splint
  – Nighttime splint: static wrist immobilizer
  – Splint compliance is determined by ensuring
    • Splint functionality (too bulky?)
    • Cosmetically acceptable
Treatment for Post-op Radial Nerve repair

- **Acute stage (1-3 weeks)**
  - **Splinting options:**
    1. maintained in intraoperative cast
    2. Forearm based, static, wrist extension splint (wrist in 0-30°). If repair is tight, increased extension is necessary
    3. High radial nerve injuries (proximal to elbow): also immobilize elbow in 90° for 3 weeks
  - **Exercise:** Hourly active flex and active-assisted extension of digits only
  - **Edema:** position forearm in elevation when sitting/sleeping
  - **Instruction:** single arm use only, maintain ROM of elbow/shoulder regularly

WHAT-OCT-016 Guidelines for Therapy Intervention for Radial Nerve Lesions
Treatment for Post-op Radial Nerve repair

- **Week 3**
  - Complete a functional and sensory assessment

<table>
<thead>
<tr>
<th>At forearm level</th>
<th>Results in</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECU</td>
<td>Loss of ulnar wrist ext</td>
</tr>
<tr>
<td>EDM, EI, EDC</td>
<td>Loss of MCPJ ext</td>
</tr>
<tr>
<td>AbdPL, EPB, EPL</td>
<td>Loss of thumb radial abd and ext</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>At elbow level (see above plus)</th>
<th>Results in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supinator</td>
<td>Weakened supination</td>
</tr>
<tr>
<td>ECRL &amp; ECRB</td>
<td>Loss of ulnar and radial wrist ext</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Proximal to elbow (see above plus)</th>
<th>Results in</th>
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<tbody>
<tr>
<td>Brachioradialis</td>
<td>Weakened elbow flex</td>
</tr>
</tbody>
</table>
Treatment for Post-op Radial Nerve repair

• Week 3
  – Splinting options:
    1. At night- continue volar forearm-based night resting splint
    2. Day- fabricate low-profile dynamic MCPJ ext splint (forearm based if prox to wrist, hand-based if PIN only)
    3. Gradually wean wearing time of splint or consider discarding sections of the dynamic splint as recovery occurs.
  – Exercise:
    • Maintain passive ext of long flexors
    • Active flex of individual joints (avoid composite wrist and finger flex until week 8)
    • Active/ passive thumb palmar and radial thumb abd and thumb ext to maintain thumb web space
    • Commence nerve gliding
Treatment for Post-op Radial Nerve repair

• Week 3 (continued)
  – Scar management
    • Begin once wound is closed

  – Desensitization/ sensory re-education
    • Begin with localization of moving touch using light and deep pressures over the involved area. Once perceived, upgrade to recognizing of shapes (starting with large objects and moving on to smaller objects) and discriminative sensation of different textures.
Treatment for Post-op Radial Nerve repair

- Week 6 +
  - **Splinting options:**
    - Continue with dynamic extension splint or wrist extension splint/wrist brace to promote function.

- **Exercises:**
  - Initiate gentle passive ROM of wrist and digits (if ext tendons are associated, passive flex should be delayed until week 10)
  - Begin resisted exercises
    - Putty strengthening program
    - Progress to activities requiring a stable wrist/digit extension.
• BREAK:
  – Repair and reconstruction of the ulnar nerve. DR:L
Ulnar Nerve

• Most frequent major peripheral nerve injury in hospitalized patients.
• Early repair is paramount for any recovery
• Results much less desirable than other nerves

Ulnar Nerve
Ulnar Nerve

- Flexor Carpi Ulnaris
- Flexor Digitorum Profundus (ring, small)
Ulnar Nerve

- Opponens digitii minimi
- Abductor digitii minimi
- Flexor digitii minimi brevis
- Palmar and Dorsal Interossei
- Adductor Pollicis
- Flexor Pollicis brevis (deep head)
Ulnar Nerve Motor Grafting
Ulnar Nerve Grafting Motor Branch
Nerve Transfer

- AIN to Ulnar Nerve
  - Terminal branch for the AIN supplies the Pronator Quadratus

Nerve Transfers
Nerve Transfers
Tendon Transfers for Ulnar Nerve Palsy

• Goals
  – Restore Thumb Adduction, Index Abduction, MP function of the digits
Thumb Adduction

• Loss of Adductor Pollicis leads to deficiency in pinch strength

• Possible tendon transfers
  – ECRB
  – FDS II
Adductorplasty

- Transverse incisions made to harvest ECRB
- Withdrawn from extensor retinaculum
Adductorplasty

- ECRB lengthened
- Routed through metacarpal space
Adductorplasty

- Tendon routed around, volar to 2\textsuperscript{nd} MC
- Inserted to thumb MCP
- Between add pollicis, 1\textsuperscript{st} dorsal interosseous
Index Abduction

• APL slip or Brachioradialis transferred to 1\textsuperscript{st} DI

• Provides 1\textsuperscript{st} dorsal interosseous function
Bouvier’s Test

- Evaluates extensor hood integrity
- Delineates simple from complex claw deformities
- Surgical implications
  - Transfer will correct MCP ext
    - Simple = insert P1 or A1 pulley
    - Complex = insert lateral bands
  - Simple (+Bouvier’s)
    - Corrected MCP extension
    - Allows for IP jt to extend actively (extrinsic extensors)
    - Good extensor apparatus
  - Complex (-Bouvier’s)
    - MCP extension
    - IP jts UNABLE to extend
    - Insufficient extensor apparatus
Zancolli Lasso Transfer

- FDS released
- Delivered through A2 pulley
- Sewn over A1 pulley to itself
- Corrects MCP claw deformity
Therapy for ulnar nerve palsy and subsequent rehab after treatment

- **Assessment- low lesion**
  - Intrensic atrophy
  - Hypothenar eminence atrophy
  - Clawing of 4\textsuperscript{th} and 5\textsuperscript{th} digits
  - Wartenberg’s sign (abduction of 5\textsuperscript{th} digit)
Therapy for ulnar nerve palsy and subsequent rehab after treatment

• Assessment – high nerve lesion

*Same presentation as with low lesion, plus the following:

  – Clawing less evident due to paralysis of FDP
  – Atrophy of medial aspect of upper forearm.
Testing for Ulnar nerve palsy

- Recall muscles that are innervated by the ulnar nerve:
  - Flexor carpi ulnaris
  - RF/SF FDP
  - Adductor pollicis
  - Interossei muscles
Testing for Ulnar Nerve Palsy

- **Thumb Adduction:**
  - place and hold against palm. (asking pt to add thumb from abducted position could lead to substitution by APB, EPL, FPL)
  - Froment’s sign
  - Jeanne’s sign
Testing for Ulnar Nerve Palsy

- **IPJ Extension**
  - Bouvier’s test: hyperextension of RF/ SF MCPJ is prevented and pt asked to extend finger

- **Finger adduction**
  - Test 5\textsuperscript{th} finger on flat surface (to prevent finger flexor substitution). + Wartenberg’s Sign (inability to adduct the 5\textsuperscript{th} digit)

- **Finger abduction**
  - Test MF radial and ulnar abduction on flat surface (to eliminate EDC compensation
    - Ulnar paradox: higher the lesion, the less the claw
    - Martin-Gruber anastomosis: median nerve fibers ultimately innervate the intrinsic hand muscles
Treatment for Ulnar nerve compression palsy

• **Ulnar Cubital Tunnel:**
  – Regions compressed:
    • Intermuscular Septum
    • Arcade of Struthers
    • Medial Epicondyle
    • Arcuate ligament
    • FCU
  – Deformity:
    • Abduction of small finger (early)
    • Claw hand (late)
  – Splint and recommendations:
    • Buddy tape small to ring – early
    • Medial elbow pad - day
    • Elbow and wrist support splint – night (elbow between 30-60°, wrist neutral)
      – Towel splint
    • Anti-claw splint – late
    • Encourage work with elbow flex < 90°

“Splint to rest- allow to heal- glide nerve” Lastayo P 2001, AAHS Quarterly Surgery and Rehab of the Hand, Philadelphia meeting 2008
Therapy for Ulnar Nerve Palsy

- **Compression:**
  - Buddy tape small to ring – early
  - Medial elbow pad – day
  - Elbow and wrist support splint – night (elbow between 30-60°, wrist neutral)
    - Towel splint
  - Anti-claw splint – late
  - Encourage work with elbow flex < 90°
Treatment for Post-op Ulnar nerve repair

• Acute stage (1-3 weeks)
  – **Splinting**:
    • Immobilization of the wrist in neutral and MCP joints of ring and little in 70° flexion
    • In order to allow flexion of digits, consider replacing the surgical cast with a thermoplastic forearm based dorsal blocking splint
  – **Exercise**:
    • Active assisted ROM of digits only, wrist immobilized
  – **Edema**:
    • position forearm in elevation when sitting/ sleeping
  – **Instruction**:
    • single arm use only, maintain ROM of elbow/ shoulder regularly
Treatment for Post-op Ulnar nerve repair

• Weeks 3-6
  – Splinting:
  • Continue splinting at night time and in ‘at risk situations’
  – Exercise:
  • Active ROM of wrist can be introduced
  • Introduce nerve gliding exercises, avoid tension on the ulnar nerve.
Treatment for Post-op Ulnar nerve repair

- **Weeks 3-6**
  - **Scar management**
    - Begin once wound is closed
  - **Desensitization/ sensory re-education**
    - Begin with localization of moving touch using light and deep pressures over the involved area. Once perceived, upgrade to recognizing of shapes (starting with large objects and moving on to smaller objects) and discriminative sensation of different textures.
Treatment for Post-op Ulnar nerve repair

• Week 6-8
  – Splinting
    • *Night*: splint in POSI to decrease the likelihood of fixed claw deformity.
    • *Day*: an anti-claw splint to little and ring: dorsal hand based blocking splint to prevent hyperextension of the MCP joints but allow full flexion.
  – Exercises
    • Gentle passive ROM of wrist and digits can be introduced. (If flexor tendons are associated passive extension should be delayed until 12 weeks post surgery!)

WHAT-OCT-018; Guideline for Therapy Intervention for Ulnar nerve Lesions and Neurapraxia
Treatment for Post-op Ulnar nerve repair

- **Post splint removal:**
  - Carry out a functional and sensory assessment of the hand. The following deficits can be expected:
    - Clawing of little and ring
    - Loss of arches of the hand and wastage of hypothenar eminence
    - Loss of thumb adductor
    - Wastage of the web spaces
    - At forearm level there will also be a weak wrist flexion and loss of ulnar deviation of the wrist. The clawing may be less if the laceration is at elbow level.
  - **Functional loss:**
    - Decreased power in all grips
    - Loss of writing grip due to loss of thumb adduction
    - Inability to adduct and abduct the digits
  - **Sensory loss:** hypothenar eminence, volar ring and little. At elbow level the dorsal ulnar surface of the hand will be affected.
Treatment for Post-op Ulnar nerve repair

Reinforce importance of protection of the ulnar side of the hand from harm by sharp or hot objects.
Treatment for Median nerve compression palsy

• **Proximal Median:**
  - Regions compressed:
    • Ligament of Struthers
  - Deformity:
    • Hand weakness, loss thumb webb
    • Ishemic attacks
  - Splint and recommendations:
    • Webb spacer (late)
    • Avoid overhead work
    • LAS to rest

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Treatment for Median nerve compression palsy

- **Pronator Syndrome:**
  - Regions compressed:
    - Lacertus Fibrosis of biceps
    - Pronator
    - FDS
  - Deformity:
    - Hand weakness, loss thumb webb
  - Splint and recommendations:
    - Muenster to limit rotation
    - Avoid repetitive pronation/supination
    - Stretch pronator

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Treatment for Median nerve compression palsy

**AIN:**
- Regions compressed:
  - Pronator
  - FDS
- Deformity:
  - Loss of thumb IP and index DIPJ flex
- Splint and recommendations:
  - Muenster to limit rotation
  - Maintain distal joint mobility

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