LSUHSC
Occupational Therapy
Nerve Repair

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Nerve Repairs

Primary nerve repair:
Indicated for clean, sharply cut nerves. Performed immediately after an injury or within 1 to 2 weeks.

Secondary nerve repair:
Usually indicated in the presence of a severely crushed or avulsed nerve. Surgery involves resection of the damaged segment.

Nerve graft:
Performed when a direct repair cannot be done. Often done as a secondary procedure. Nerve tubes may be used.
• Appropriate post operative immobilization is important.

• The expected rate of recovery for nerve repairs is 1 mm per day or 1 inch per month, after an initial period of 3 weeks when the axonal sprouts cross the repair

• Patient must be educated, especially with an insensate hand

• Care must be taken to avoid stretching of the repaired nerve ends. Tension leads to scarring

• Motor retraining, sensory reeducation and desensitization programs should be initiated as sensory and muscle re-innervation becomes evident
Initial Evaluation Post Repair

• Date and mechanism of injury

• Surgery performed- primary / delayed repair, nerve graft

• Patient factors:
  hand dominance, employment, other medical conditions

• Wound and surgical site inspection

• Edema

• Range of motion- active and passive

• Motor examination

• Tinels

• Sensory examination

• ADL’s
Volar

Axillary nerve
Superior lateral cutaneous (C5-6)

Radial nerve
Inferior lateral cutaneous (C5-6)

Lateral cutaneous nerve (C5-7)

Radial nerve
Ulnar nerve (C8, T1)

Median nerve
Palmar branch (C6-7)

Dorsal

Intercosto-brachial nerve (T2) and the medial cutaneous nerve (C8, T1-2)

Medial cutaneous nerve (C8, T1)

Radial Nerve
Posterior cutaneous (C5-7)

Inferior lateral cutaneous

Posterior cutaneous (C5-8)

Lateral cutaneous (C5-7)

Radial nerve
Superficial branch and dorsal digital (C6-8)

Ulnar nerve (C8, T1)

Median nerve

2.83 Green Normal
3.61 Blue Dim. light touch
4.31 Purple Dim protective
6(4.56) Red Loss of protective
6.6 Orange Deep pressure
Red Lined Untestable

LSUHSC-Shreveport
Occupational Therapy

Upper Extremity Semmes Weinstein Right Left

Date:______________

OTR/L:__________________

LSUHSC-Shreveport
Re-evaluation

- Motor
  re-innervation of musculature, assess for compensatory motions and trick movements

- Range of motion—active and passive

- Tinel's

- Sensation

- ADL’s

- Return of sympathetic function—sweat pattern

- Grip and pinch strength testing

- Note any contracture development
Occupational Therapy Intervention

Acute management:

• Immobilization and protection of repaired structures with custom splinting

• Prevention of joint contractures

• Range of motion

• Prevention of injury secondary to decreased sensation

• Activities of daily living

• Patient education on insensate areas

• Begin scar massage
Secondary Phase:

- Increase range of motion – active and passive

- Enhance function using appropriate splint
  
  **Radial nerve**
  - wrist splint
  - dynamic splint

  **Median nerve**
  - opponens splint
  - web space c-bar splint

  **Ulnar nerve**
  - lumbrical bar splint

- Patient education, home program, risks related to loss of sensation

- Desensitization and scar massage

- ADL’s
  - Adaptive techniques
  - Assistive equipment
Third Phase:

- Motor retraining
- Active and active-assistive exercise
- Strengthening
- Desensitization
- Sensory reeducation
- ADL’s
  - Adaptive techniques
  - Assistive equipment to increase independence
- Look at need for re-training to change hand dominance
Long term follow up:

- Evaluate residual deficits
- Compensation
  Assistive equipment for ADL independence
- Splinting to promote function
- Patient education
Ulnar Nerve Innervation

- Adductor pollicis
- Palmaris brevis
- Abductor digiti quinti
- Opponens digiti quinti
- Flexor digitorum profundus
- 3rd & 4th lumbricals
- Palmar & dorsal interossei

Lower cervical root
Brachial plexus
Cubital tunnel
Guyon canal
Deep ulnar motor branch
Medial cutaneous nerve of forearm
Flexor carpi ulnaris
Springer
Ulnar Nerve (median cord C8-T1)

MMS  Flexor Carpi Ulnaris  Forearm  High Lesion
Flexor Dig. Profundus(RF/SF)  

Abd. Digiti Minimi  Hand  Low Lesion
Opponens Digiti Minimi
Flexor Digiti Minimi
Lumbricals 3,4
Interossei (palmar/dorsal)
Flexor Pollicis Brevis (deep)
Adductor pollicis

Froments
Thumb IP flexion during lateral pinch
Positive Froments in hand B
**Ulnar Nerve lesion at the wrist**

- Loss of abduction and adduction due to paralysis of the interossei
- Hyperextension of the ring and small MCP joints with flexion of the IP joints due to unopposed action of the extensor digitorum communis (EDC) and the flexion of the flexor digitorum profundus
- Weak thumb adduction due to paralysis of the adductor pollicis
- Loss of opposition of the fifth finger due to paralysis of the abd. digiti quinti
- Weak thumb opposition due to paralysis of the AdP
- Weak MCP flexion due to paralysis of the third and fourth lumbricals
- Weak pinch due to paralysis of the AdP, deep head of the FPB and the first dorsal interosseous
- Weak grasp due to paralysis of the interossei, third and fourth lumbricals, and the FDP of the ring and small fingers
- Sensory loss of the volar and dorsal aspects of the medial third of the hand, the small finger and the ulnar half of the ring finger

**Ulnar Nerve lesions in proximal forearm involves these additional problems**

- Weak flexion of IP joints of the ring and small fingers due to paralysis of the ulnar half of the FDP
- Weak wrist flexion due to paralysis of the flexor carpi ulnaris (FCU)
Median Nerve Innervation

- Pronator teres
- Flexor digitorum sublimis
- Flexor pollicis longus
- Flexor digitorum profundus
- Pronator quadratus
- Abductor pollicis brevis
- Opponens pollicis
- Sup. Head FPB
- 1st & 2nd Lumbricals
- Palmaris longus
- Flexor carpi radialis
- Flexor digitorum profundus
Median Nerve (medial cord C5-7 and lateral cords C8-T1 of Brachial Plexus)

Muscle/Sensory Innervation

- Pronator Teres (Forearm)
- Flexor Carpi Radialis
- Palmaris Longus
- Flexor Digitorum Superficialis
- Palmar Cutaneous Branch

- Flexor Digitorum Profundus (Index/Long)
- Flexor Pollicis Longus
- Pronator Quadratus

- Lumbricals (1,2)
- Opponens Pollicis
- Abductor Pollicis Brevis
- Flexor Pollicis Brevis (superficial)
- Digital Cutaneous Branch

- Anterior Interosseous Nerve

- Carpal Tunnel

- Median Nerve High Lesion

- Median Nerve Low Lesion
Median Nerve Deficits (wrist level)
* Sensory loss of the central palm area and the palmar surfaces of the lateral three and one-half digits
* Weak MCP joint flexion of the index and middle fingers due to paralysis of the first two lumbricals
* Weak pinch due to paralysis of opponens pollicis, abductor pollicis brevis, and the superficial head of the flexor pollicis brevis
* Loss of palmar abduction due to paralysis of the APB

Anterior Interosseous Nerve (AIN) (Proximal 1/3rd of forearm)
* Loss of DIP joint flexion of the index and middle fingers due to paralysis of the FDP to each digit
* Loss of thumb IP flexion due to paralysis of the flexor pollicis longus (FPL)
* Weak forearm pronation due to paralysis of the pronator quadratus

Median Nerve lesion in the proximal forearm
* Weak forearm pronation due to paralysis of the pronator teres
* Weak wrist flexion due to paralysis of the flexor carpi radialis (FCR)
* Weak finger flexion due to paralysis of the flexor digitorum superficialis (FDS)
Median or Ulnar Nerve Repair

Surgeon dictates wrist position in the OR and a dorsal plaster Kleinert splint applied

0-3 weeks post repair
* OT fabricates a thermoplastic Kleinert dorsal blocking splint. Same wrist position as placed in OR. 
  If associated Flexor Tendon repair follow FTR protocol for splinting and PROM
  If lesion is more proximal include a long arm splint with the elbow flexed to 90°
* If no tendon injury begin AROM/AAROM to digits
* Educate patient on insensate areas. ADL adaptations
* Monitor for thumb adduction contracture with Median nerve injury
* Begin scar massage once wound is healed

3 weeks post repair
* A volar wrist splint is molded with wrist in neutral
* OT performs baseline Semmes and motor examination. Assess Tinels
* Assess grip and pinch (wait until week 6 with tendon injury)
* AROM exercises
* Patient education on insensate hand
* Cocoa butter massage to hand for hydration, desensitization and massage to scar
4 weeks post repair
* Patient education on the expected sensations associated during sensory return
* Serial splint the wrist into extension weekly. Check for complaints of burning and tingling during extension of the wrist while forming splint. Decrease extension and mold splint prior to this point
* Massage to entire hand for skin re-hydration / desensitization
* The hand should be kept warm during cold weather. Patient should use glove or tube sock for warmth.
* Continue patient education on insensate hand. Use of visual compensation
* Continue AROM exercises. Continue PROM with associated tendon repair
* Assess Tinels. Document location

5 weeks post repair
* Lumbrical bar can be added to the volar wrist splint for Ulnar nerve lesion
* Continue AROM exercises. Continue PROM with associated tendon injury
* Continue patient education on insensate hand
* Massage for desensitization, skin re-hydration
* AROM exercises to the wrist
6 weeks post repair
* Volar wrist splint is discontinued
* Lumbrical bar splint for ulnar nerve lesion
* C-bar splint and or opponens splint for median nerve lesion
* Re-evaluate sensation and motor exam. Assess grip and pinch
* Begin sensory reeducation and desensitization program when appropriate
* Continue education on insensate areas
* Assess Tinels’s

7-8 weeks post repair
* Dynamic splinting can begin for ulnar nerve to decrease any extrinsic flexor tightness
* Continue with Lumbrical bar for Ulnar nerve . Opponens splint for Med. N.

6-12 weeks post repair
* Motor retraining as appropriate
* OT repeats sensory and motor examinations every 3 to 4 weeks. Continue to assess and document Tinel’s.
* Functional activities
* Strengthening
* Continue sensory reeducation
* Continue splinting as indicated
Lumbrical bar splint
For Ulnar Nerve

Dynamic splint for ulnar nerve injury with extrinsic tightness
Short opponens for Median Nerve

C-bar for correction of a thumb adduction contracture
Radial nerve innervations
Radial Nerve (Posterior cord) C 5, 6, 7, 8 and T1

MMS  Triceps  Radial Nerve  High Lesion
     Brachioradials
     Wrist Extension
        ECRL  Posterior Interosseous
        ECRB  Posterior Interosseous
     Supinator           Low Lesion
     Ext. Digitorum
     Ext. Digiti Minimi
     Ext. Carpi Ulnaris
     Abd. Pollicis Longus
     Ext. Pollicis Longus
     Ext. Pollicis Brevis
     Ext. Indicis Proprius

LSUHSC-Shreveport
• Most frequently injured nerve in the upper extremity usually from humeral shaft fractures

• 12% of humeral shaft fractures are complicated by a radial nerve paralysis.

• In open humeral shaft fractures the incidence of Radial nerve laceration is about 60%. Can be complete or partial laceration.

• Radial nerve injuries result in a decrease in power grip and pinch related to the loss of wrist extension.
**High Radial Nerve Lesion**

* Wrist drop due to paralysis of wrist extensors
* Diminished abduction and extension of the thumb due to paralysis of the abductor pollicis longus (APL) and the extensor pollicis brevis (EPB)
* Inability to extend MCP joints due to paralysis of the long extensors
* Weak grasp and pinch due to inefficiency of the unopposed flexors
* Loss of sensation of the lateral two thirds of the dorsum of the hand, a portion of the dorsum of the thumb and the dorsum of the proximal phalanges of the lateral three and one-half digits
* Weakened supination due to paralysis of the supinator muscle

**Posterior Interosseous Nerve Lesion**

* Same effects as described except sensation is not lost and wrist extension is present but weakened.
Radial Nerve repair

Patient is placed in volar plaster post op splint by Surgeon in OR

0-3 weeks post repair
* OT fabricates a volar forearm based static wrist extension splint. Wrist extended 60°. If lesion is more proximal the elbow should also be immobilized in 90° of elbow flexion. Dynamic finger extension outriggers may be added
* AROM /AAROM of the digits
* With associated extensor tendon repairs follow splinting protocol for zone of injury.
* Patient education in ADL modifications
* Patient education in wound care progressing to scar massage

3-6 weeks post repair
* Volar wrist splint is molded with wrist in 45° of extension
* Dynamic finger extension outriggers are added to daytime splint
* A volar wrist cock up splint is fabricated for night-time wear
* OT performs baseline motor and sensory evaluation. Assess Tinel’s
* Assess grip and pinch strengths at 6 weeks
* ADL modifications as needed
* Check for Tinel’s. Document advancement
Radial Nerve Repair

6-12 weeks post repair
* Continue with splinting as indicated for positioning and function
* Continue to monitor motor return
* Begin motor retraining when appropriate
* Continue to re-assess sensation, grip, pinch and MMS
* Assess Tinel’s. Continue to document advancement
* Continue to advance ADL’s
Splinting for Radial Nerve

Volar wrist splint
Begin with wrist extension at 60 and serial splint towards neutral

Dynamic splint, no active wrist extension

Dynamic Splint, with active wrist extension
Long arm splint for more proximal Radial Nerve injury
Digital Nerve

Week 1 post op
* Dorsal Blocking Kleinert splint. MCP’s flexed 60° and IP’s in full extension
* AROM exercises within splint 15 reps hourly
* Wound Care

Weeks 1-3 post op
* Dorsal Blocking Kleinert splint
* AROM exercises
* Scar massage
* Patient education on insensate area
* Baseline Semmes Weinstein

Weeks 3-6 post op
* AROM exercises
* Scar massage
* Desensitization/sensory re-education
* Begin ADL’s
* Tinel’s
* Patient education on insensate areas
Digital Nerve

Weeks 6-8 post op
* Repeat Semmes Weinstein
* Extension splinting as needed for flexion contracture
* Continue patient education on insensate areas
* Continue desensitization

Week 8-10 post op
* Strengthening
* Repeat Semmes Weinstein
* Assess Tinel’s
* Continue desensitization/sensory re-education
Outcomes

1. Functional recovery can take up to 2 years, and improvement can occur from nerve injuries proximal to the wrist for up to 4 years.

2. Some generalities that have been made:
   -- distal nerve injuries do better than proximal ones
   -- younger patients <20 years of age do better than older patients
   -- younger patients generally regain a complete recovery of functional sensibility however this is not the case in the adult
   -- sensory or pure motor nerve repair does better than mixed nerve repair
   -- guillotine injury does better than a crush injury or an avulsion injury
   -- protective sensation usually occurs

3. According to a study by Schreaders
   Median Nerve 61% have good motor return and 44% had good sensory return
   Ulnar Nerve 45% good motor return and 41% had good sensory return
   Combined Median/Ulnar had the worse prognosis

4. Sensory reeducation protocols greatly increase the functional outcome
5. Chronic neuropathic pain can be severe and directly influences patient outcome.

6. Nerve regeneration seems to deteriorate with increasing distance to the innervated organ. The more proximal the nerve injury the lower the chances for the axons to re-innervate the adequate terminal receptors. (Lohmeyer, et al.)
References

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