Outline

- What does a Hand Surgeon do?
- Management of:
  - Fractures
  - Tendon Injuries
  - Nerve Injuries
  - Vascular Injuries / Replantation
  - Complex Injuries

Hand Surgeon’s Area of Expertise

- Most hand surgeons undergo a hand fellowship which is a 1 year training program after residency (orthopaedics, plastic surgery or general surgery)
- The AGH Hand Division covers injuries and problems from the fingertip to shoulder (tumors, carpal tunnel)
- Our expertise is site specific so we take care of adults and children
- We are the gentle orthopaedics surgeons because we handle nerve and arterial injuries and provide coverage for soft tissue defects
- Hand surgery is challenging because there is little tolerance for imperfection in the hand and upper extremity
Hand Fractures

Incidence and Location
- 10% of all fractures occur in the hand
  - Distal phalanx – 45-30%
  - Middle phalanx – 8%
  - Proximal Phalanx – 15-20%
  - Metacarpal – 30-35%

Middle and Proximal Phalanx Fractures - Goals of Treatment
- Restore Articular Congruity
- Restore Length
  - For every 1 mm of middle phalanx shortening there is 10 deg of DIP lag
  - For every 1 mm of proximal phalanx shortening there is 12 deg PIP lag
- Restore finger alignment and rotation
- Allow early finger motion
**Surgical Indications**

- Finger malrotation (>50% overlap of adjacent digit) or angulation (> 10 deg)
- Loss of length
- Intra-articular with joint incongruity

**Loss of Length**

**38 yo F s/p MVA**
Fractures that May Need ORIF

- Comminuted fractures
- Fractures with rotational deformity
- Not acute fractures

17 yo male goalie got struck by soccer ball on index finger
Tendon Injuries

- Connects the muscle to bone
- Allow movement of bones
- Has to have excursion to function

3 yo girl who got hand caught in metal gate of elevator

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Nerve Injuries

- Peripheral nerves allow for sensation and innervate muscle to allow motion
- Goals of treatment with nerve laceration:
  - Tension-free primary repair
  - When there is a segmental defect options are:
    - Autograft
    - Conduit
    - Decellular allograft

Digital Nerve Injury

- 43 yo male with laceration. His laceration was repaired in ER and told he just had a superficial laceration.
Digital Nerve Injury

Vascular Injuries & Replants

• Definitions:
  • Replantation – reattachment of a body part that has been totally severed from the body.
  • Revascularization – reconstruction of damaged blood vessels in order to prevent an ischemic body part from becoming non-viable or necrotic.

Replantation

• At level of hand and fingers arteries and veins necessitate 10.0 and 11.0 suture and 20x magnification with a microscope
• For a finger replant need one artery and preferably 2 veins (if bad outflow then may need leeches)
Replant Storage

1. Immerse amputated part in LR in a plastic bag. Place bag on ice.

2. Wrap amputated part in a cloth or gauze moistened with LR or saline solution. Place in plastic bag or sterile cup. Place bag or cup on ice.

* No dry ice

Replant Ischemia Time

Digit
- Warm ischemia – 12 hrs
- Cold ischemia – 24 hrs

Proximal to Finger
- Warm ischemia – 6 hrs
- Cold ischemia – 12 hrs

Replant Indications

1. Thumbs
2. Multiple digits
3. Metacarpal amputations (palm)
4. Almost any body part in a child
5. Wrist or forearm
6. Elbow or proximal arm (only sharp or moderately avulsed)
7. Single digit distal to FDS insertions
### Replant Contraindications

1. Severely crushed or mangled parts
2. Amputation or injuries at multiple levels
3. Patients with other serious injuries or diseases
4. Arteriosclerotic vessels
5. Mentally unstable patient
6. Single finger in adult, proximal to FDS insertion
7. Prolonged warm ischemia

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### 33 yo male getting home by motorcycle when he sees fighting across the street

- In Washington Heights, NYC there is a large Dominican Republic population. Machete carrying is common.

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### Replant Order of Repair

- Bone – shorten and fixate
- Repair extensor tendons
- Repair flexor tendons
- Anastomose arteries
- Repair nerves (I do nerves before arteries)
- Anastomose veins
- Obtain skin coverage
6 hours later . . .

At 3 mos

Complex Injuries
43 y.o. male with meat mixer machine injury with deep laceration to arm just proximal to antecubital fossa. Patient is in the OR with vascular surgery who is performing a saphenous vein graft reconstruction of his brachial artery.

**Case Scenario**

- Median Nerve
- Radial Nerve
- Biceps
- LABC
- Median Nerve

**1st Surgery:**
- Intra-op, after revascularization which occurred about 3 hrs after injury, the forearm became quite swollen volarly.
- Forearm compartment releases were done.
- Median, ulnar, and radial nerve were explored.
- Median nerve was completely severed and avulsed (7 cm gap but 8-10 segments on each end of contused, ecchymotic nerve)
- Radial nerve was partially lacerated.
- Ulnar nerve was intact.
- Biceps, brachialis, BR, ECRL and ECRB are completely lacerated.
- Laceration went down to distal humerus just proximal to coronoid fossa.
Post-op PE:
Ulnar nerve working,
0/5 Finger and thumb extension, wrist extension
0/5 FPL
0/5 IF FDP
4/5 MF FDP
0/5 IF to SF FDS

Assessment:
- Median nerve lacerated and avulsed (MF FDP working?)
- Ulnar nerve intact
- Radial nerve incomplete laceration, clinically no function

Plan:
- Multiple debridements, possible free flap vs STSG
- Median and radial nerve sural nerve cable grafting
- Possible end-to-side AIN to ulnar nerve transfer with a graft
- Muscle and tendon repairs

2nd Surgery (post injury day 2): AIN was dissected out and was avulsed from median nerve near branch point. Nerve stimulation of radial nerve demonstrated wrist extension.
5th operation

Bilateral sural nerves harvested

5th operation – Cable grafting of median and radial nerves. End-to-side of AIN to ulnar nerve with autograft. Biceps, BR, ERCL, ECRB tendon & muscle repairs. RF FDP to IF FDP transfer done. STSG.

Plan

Allow nonsevered radial nerve to recover from neuropaxia. If some radial nerve recovers we may be able to use BR (but muscle was lacerated) to FPL. EIP for opponensplasty.

IF radial nerve/PIN doesn’t recover will use FCU transfer for EDC and EPL. Will fuse wrist. What to use for FPL?

In this case, the only functioning nerve is the ulnar.

• Would one use it in a transfer?
• FCU fascicle for PIN would be possible but for AIN the site is too distal (would need a graft). And would be sacrificing FCU.
• AIN injury is also too distal for brachialis branch transfer.
• Because radial nerve is injured can’t use it to transfer to median (supinator branch/ECRB branch to AIN/pronator branch).
• Because median nerve is injured can’t use it to transfer to radial (FDS br to ECRB, FCR and palmaris longus br to PIN).
At one week post-op visit his biceps tendon is exposed. We debrided him later that week. We wanted to keep tendon for elbow flexion and supination but it was necrotic. Allograft reconstruction in future?

Despite resecting his biceps tendon he has elbow flexion that is 5/5. Pulling through other muscles or scar? His radial nerve also recovered and he regained finger and wrist extension.

At 10 mos I was about to indicate him for brachioradialis (muscle was repaired) tendon transfer to give him thumb flexion but he reports 2-3 wks ago he started to do this . . .
57 yo female consultation to orthopaedics for left arm paresis s/p neck stab wound.
- Was stabbed in the neck while working at regional hospital as greeter.
- Taken immediately to OR
  - Thyrocervical trunk exploration
  - Return to OR for vertebral artery ligation
- Transferred to AGH postoperatively
- Upon extubation, noted to have left arm paresis.

Physical Examination
- 15 cm incision anterior left neck and left chest
- Motor
  - 0/5 left deltoid
  - 0/5 left rotator cuff
  - 0/5 left biceps
  - 5/5 wrist flexors
  - 4/5 wrist extensors
  - 5/5 left triceps
- Sensory
  - was decreased at the C6 sensory distribution.
- 2+ radial pulse

Diagnosis and Plan
- Superior trunk injury (C5/C6)
- Surgical exploration and repair with sural nerve grafting
Brachial Plexus

Lateral Cervical Region (Posterior Triangle)

Goals of Treatment (in order)

- Elbow flexion
- Shoulder stabilization
- Shoulder abduction and external rotation
- Wrist and digital motion
- Sensation distal to elbow
- Therapy immediately to maintain motion
Non-operative Treatment

- Most traumatic BPI
- Gun shot wounds (in absence of vascular injury)
- Advancing Tinel’s sign is best clinical indicator of effective nerve regeneration
- 98% recovery; infraclavicular better than supraclavicular
- Best results with low energy mechanism

Surgical Options

- Direct Nerve Repair
- Nerve Grafting
- Neurolysis
- Nerve transfer
- Functional muscle transfer
- Adjunctive procedures
  - Joint fusions (glenohumeral, thumb CMC or IP, wrist)
  - Tendon transfers (shoulder, elbow, wrist, hand), tenodesis

Direct Nerve Repair

- Seldom possible
- For acute, sharp laceration injuries
Nerve Graft
• For rupture
• Sural nerve or other expendable nerves (medial brachial, medial antebrachial cutaneous)
• Not possible for root avulsion

Nerve Transfer
• Transfer of functioning nerve to new distal connection
• Alternative to nerve grafting
• Places viable motor nerve close to motor endplate
  ➔ rapid recovery
• Extraplexal or intraplexal donor
• Reported results may be superior to nerve grafting
• Example: spinal accessory to suprascapular; triceps motor branch to axillary

Muscle or Tendon Transfer
• Unlimited possibilities, gracilis most common free muscle transfer
• Vascular clip proximal and suture on distal part of superior trunk

• 2 cm gap of C5
• 1 cm gap of C6
Sural Cable Graft

Grafting of C5 and C6

Follow-up

- 4 months
  - Good passive ROM
  - No motor to proximal muscles (biceps, deltoid, cuff)
- 8 months
  - No motor to rotator cuff, deltoid, biceps
  - Plan for nerve transfers
  - EMG- no return of function
Surgical Plan

- Double Fasicular transfer (MacKinnon)
  - Ulnar branch to FCU to brachialis branch (Oberlin)
- Median branch to FDS to biceps branch of musculocutaneous
- Median sensory to lateral antebrachial cutaneous
- Radial to axillary nerve transfer
  - Medial triceps branch to axillary nerve
  - Radial sensory to axillary sensory
- Spinal accessory to suprascapular nerve

Surgical Dissection

Median and Ulnar Nerve Transfers
Medial Triceps to Axillary Transfer

Radial to axillary motor
Axillary Nerve
Radial Nerve
Radial to axillary sensory

Spinal Accessory Transfer

- Suprascapular nerve had significant flicker with stimulation
- Supercharged suprascapular nerve
  - Spinal accessory end-to-side to Suprascapular

Follow-up

- 6 mos started to have biceps flicker
- 9 mos some deltoid function
- No rotator cuff function
Follow-up

• Indicated her for latissimus tendon transfer to provide shoulder external rotation
6 weeks post-op

Thank you!

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