**OITE Hand Review**
**Orthopaedic Hand Conference**
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## Flexor Tendon Injuries

Anatomy
- Blood supply
  - Diffusion most important within sheath
  - Direct vascular supply outside sheath
- Pulley system prevents bowstringing
  - A2 and A4 most important in fingers
  - Oblique pulley most important in thumb

Verdan Injury Zones
- 1 - Distal to FDS insertion
- II - FDS insertion to distal palmar crease
- III- Distal palmar crease to carpal tunnel
- IV - Carpal tunnel
- V - Wrist proximal to carpal tunnel, forearm

Treatment
- Nonoperative
  - Partial lacerations < 60% tendon width
- Operative
  - Acute (< 3 wks) - lacerations > 60% width
  - Chronic finger - tendon reconstruction
  - Chronic thumb - ring FDS to FPL transfer

Technique
- Core suture strands
  - # crossing repair determines strength
  - 4-6 strands adequate for early active ROM
  - Ideal purchase 10 mm from cut edge
- Epitendinous suture
  - Improves strength 20%, tendon gliding
  - Decreases gap formation
  - Simple running is recommended

WALANT Technique - Intraoperative Active Motion
- Intraoperative assessment of gap formation
- Allows debulking bunched repairs, venting of A2 and A4 pulleys
- Allows tendon repair within flexor sheath
- Facilitates postoperative early active motion

Postoperative Rehabilitation
- Early active ROM - mod force, high excursion
- Early passive motion protocols
  - Duran - low force, low excursion
  - Kleinert - low force, low excursion
  - Mayo synergistic - low force, high excursion
- Immobilization - children, noncompliant pts

Complications

Tendon adhesions - most common

Re-rupture - rate 15-25%

- If < 1 cm scar, then resect, revision repair
- If > 1 cm scar, then tendon graft

Joint contracture - as high as 17%

**Fingertip Amputions**

Fingertip Amputations

Treatment goals

- Sensate, durable tip coverage
- Adequate bone to support nail growth

Factors determining treatment

- Amputation characteristics
- Radiographs showing bone involvement

Treatment Options

Nonoperative - secondary intention

- No bone or tendon involved, < 2 cm skin loss
- Children with exposed bone

Operative treatment

- Revision amputation keeping nail bed support
- FTSG hypothenar, > 2 cm skin loss
- Flap reconstruction

V-Y Advancement Flap

Indicated for transverse or dorsal oblique amputations

Flap carried to new position by sliding technique

Thenar Flap

Volar oblique defect

Index or middle fingers

Age < 30 years

Complicated by PIPJ stiffness

Cross Finger Flap

Volar oblique defect

Age > 30 years

Less digital stiffness

Moberg Flap

Volar thumb defect < 2 cm

Advancement flap < 1 cm

Possible IPJ contracture

Krukenberg Procedure

Convert radius, ulna into claw-like pincer

Radius is mobile ray (BR, FCR, ECRL, ECRB)

Ulna is fixed ray (FCU, ECU, EDQ)

Bilateral upper extremity amputee, blind

**Replantations**

Indications for Replantation

Primary indications

- Thumb, any level
- Multiple digits
- Through palm, wrist, proximal to wrist
- All part in children

Relative indications

- Single digits distal to FDS (zone I)
- Some ring avulsions
- Through or proximal to elbow

Contraindications to Replantation

Primary contraindications

- Severe vascular disorder
- Mangled limb, crush injury
- Segmental amputation
- Prolonged ischemia > 6 hrs, large muscle content

Relative contraindications

- Single digits proximal to FDS (zone II)
- Medically unstable, psychiatric, tissue contamination
- Prolonged ischemic > 12 hrs, no muscle content

Sequence of Replantation

Vascular shunt if large muscle content
Bone fixation +/- shortening (after debridement)
Extensor tendon repair
Arterial repair (after bone if ischemia > 4 hrs)
Venous anastomoses
Flexor tendon repair
Nerve repair
Skin +/- fasciotomy

**Scaphoid Fractures**

Scaphoid Fractures

Most frequently fractured carpal bone
Incidence - 15% of acute wrist injuries
Location - 65% waist, 25% proximal, 10% distal
Mechanism - axial load, wrist HE, RD
Prognosis - AVN prox third 33%, prox fifth 100%

Scaphoid Vascularity

Major blood supply

- Dorsal carpal branch of radial artery
- Enters dorsal ridge, prox 80%, retrograde flow

Minor blood supply

- Superficial palmar arch of volar radial artery
- Enters distal tubercle, supplies distal 20%

Scaphoid Imaging

Radiographs - scaphoid view - 30° DF, 20° UD
Bone scan - occult fx at 72 hrs - sp 98%, sen 100%
MRI - most sensitive for occult fx at 24 hrs, assess proximal pole vascularity on T1 sequence
CT scan - best for location fx, size fragments, collapse, progression to nonunion

Nonoperative Treatment
Thumb spica cast - long-arm vs short-arm
Duration of immobilization
- 3 months - distal waist
- 4 months - mid-waist
- 5 months - proximal third

Pulsed electromagnetic field may help
< 1 mm displacement - 90% union rate

Operative Treatment
Unstable fractures
- Proximal pole
- Displacement > 1 mm
- 15° humpback deformity
- Comminuted or oblique fractures

Non-displaced waist fractures
- Decrease time to union
- Faster return to work

Operative Technique - ORIF vs Percutaneous Fixation
Dorsal approach
- Indicated for proximal pole fractures
- Preserve dorsal ridge blood supply

Volar approach
- Indicated for waist & distal pole fractures
- Exposes entire scaphoid

Scaphoid Nonunion w/o SNAC Wrist
Minimal deformity - inlay (Russe) BG - 92% union
Humpback - interposition (Fisk) BG - 72-95%
Proximal pole, AVN - 1-2 ICSRA vascularized BG
Prox pole, AVN - MFC vascularized BG using descending genicular artery pedicle (from SFA)

**Carpal Tunnel Syndrome**

Carpal Tunnel Syndrome - Risk Factors
Gender (3:1, women: men)
Obesity
Hypothyroidism
Diabetes (14-30%)
Pregnancy (50%)
Renal disease
Inflammatory arthritis
Mucopolysaccharidoses
Advanced age (> 50 yrs)
Genetic factors

Carpal Tunnel Syndrome - Causation

- Work causation is controversial - dental hygienists, beef packers, assembly line workers
- Positional, mechanical & repetitive stress
- Hand-held vibrating tools are causative
- Keyboarding is not causative
- Athletics - cycling, tennis, throwing
- Space occupying lesions (e.g., gout)

Carpal Tunnel Syndrome - Clinical Diagnosis

- Median paresthesia aggravated by grasping
- Nocturnal paresthesia
- Morning numbness
- Symptoms relieved by shaking the hand
- Grip weakness, fatigue (thenar intrinsics)

Carpal Tunnel Syndrome - Physical Findings

- Sensory tests (Semmes-Weinstein, 2 PD)
- Provocative tests (Phalen's, Tinel's, Durkan's)
- Motor tests (FPB strength, thenar atrophy)

EMG/NCS is Confirmatory

- Not necessary for diagnosis
- May quantify disease severity
- Serves as a preoperative baseline
- In early CTS or dynamic CTS, may be normal
- If demyelination, increased latencies, decreased conduction velocities
- In late CTS, EMG shows fibrillations, abn MUPs

Methods of Carpal Tunnel Release

- Standard open
- Mini-open
- Percutaneous, ultrasound guided
- Endoscopic (one or two incision)

Not Required in Carpal Tunnel Release

- Release Guyon's canal
- Step-cut lengthening TCL
- Flexor tenosynovectomy
- External epineurotomy
- Internal neurolysis
- Preserve subcutaneous nerves

**Peripheral Nerve Injuries & Repair**

Mechanism of Injury

- Stretch - e.g., neurapraxia of bp (stinger)
  - 8% elongation decreases microcirculation
  - 15% elongation disrupts axons
- Compression or crush
  - 30 mmHg > paresthesia
  - 60 mmHg > conduction block
- Laceration initiates nerve regeneration

Wallerian Degeneration

Axoplasm, myelin are degraded distally
Schwann cells proliferate, line up on BM
Proximal budding (1 month delay, 1 mm/day)
Neurotrophic factors attract sprouting axons

Factors Affecting Prognosis

Age - single most important factor
Level of injury - distal is better prognosis
Type of transection - sharp is better
Repair delay - worse prognosis (limit = 18 mo)

Neuron Morphology

Neuron is functional unit
Cell body contains nucleus
- Motor (anterior horn of cord)
- Sensory (dorsal root ganglion)

Axon propagates action potentials (APs)
Dendrites receive adjacent nerve input

Peripheral Nerve Anatomy - Terminology

Epineurium - surrounds group of fascicles
Perineurium - covers individual fascicles, primary source tensile strength, elasticity
Endoneurium - covers axons, participates in formation of Schwann cell tube
Myelin - made by Schwann cells, insulates axons, increases conduction velocity

Seddon Classification

Neurapraxia - focal nerve compression and demyelination, reversible conduction block
Axonotmesis - axon & myelin disruption, conduction block, Wallerian degeneration
Neurotmesis - complete nerve disruption, no recovery w/o repair

Nerve Conduction Study (NCS) - Focal Compression / Demyelination

Increased latencies
- Distal sensory latency > 3.2 ms (for CTS)
- Distal motor latency > 4.3 ms (for CTS)

Decreased conduction velocity < 52 m/sec
Decreased amplitude
- Sensory nerve action potential (SNAP)
- Motor action potential (MAP)

Limitations of NCS

Evaluates only large myelinated axons
Unmyelinated axons are first affected
May have normal latency w/disease
Study quality is examiner dependent

Electromyograhy (EMG)

Evaluates muscle activity
- Spontaneous activity
- Voluntary activity

Muscle denervation
- Fibrillations
- Positive sharp waves

- Fasiculations

Nerve Grafting

Autologous graft indicated for gaps > 3 cm, gold standard for defects > 5 cm
Collagen conduit indicated for defects < 2 cm, outcomes equal to autologous for gaps < 5 mm
Allograft for defects up to 5 cm

Top Ten Test Taking Hints

1. Pace yourself
2. Skip difficult questions
3. Record answers as you go
4. Answer on basis of first impression unless you have misread the question
5. Correct responses have “may” or “can”
6. Incorrect responses have double negatives, generalizations (“always” or “never”)
7. Eliminate the wrong answers
8. Guess most conservative treatment or the longest answer
9. Choose the completely correct answer
10. Rest before the test!