Objectives

- Review UE Overuse Syndrome in SCI
- Review upper extremity clinical and radiological anatomy
- Discuss treatment options for common upper extremity pathology
- Review essential functional & equipment modifications for managing UE overuse / pathology

Nociceptive Pain above SCI

- Musculoskeletal
  - Spine DJD above fusion
  - Rotator Cuff Impingement
  - Epicondylitis
  - DeQuervain’s Tenosynovitis
  - MCP Dysfunction
  - Myofascial Pain

Managing M/S Pain above SCI

- Prophylaxis
  - Home Exercise
    - Neck & Scapular Stabilization
    - IR/ER Strengthening
    - Conditioning & Weight Mngmt
    - Optimize ROM, Positioning & Sleep
    - Minimize Noxious Stimuli
  - Treatment
    - R-I-C-E-D
    - Judicious steroid application
    - Surgical Options

Neuropathic Pain Above SCI

- Compressive Neuropathy
  - Ulnar Neuropathy
  - Cubital Tunnel
  - Guyon’s Canal
  - Median Neuropathy
  - Carpal Tunnel Syndrome
  - Radiculopathy
  - Central
  - Syringomyelia
    - Abnormal, fluid-filled cavity within the substance of the spinal cord
  - Hematoma
  - Trauma (New)
  - Tumor
Managing Neuropathic Pain above SCI LOI

- Physical Management
  - R-I-C-E
    - Rest
    - Ice
    - Compression
    - Elevation
  - Splinting / Cushioning
  - Positioning
  - Neurotension Release
  - Acupuncture
  - Massage
  - TENS

- Pharmacological
  - NSAIDs
  - Tricyclic Antidepressants
  - Anticonvulsants
  - Surgical Decompression

Table 1: Namely, the following are the main techniques used in managing neuropathic pain above SCI LOI.

<table>
<thead>
<tr>
<th>Technique</th>
<th>Description</th>
<th>% Effective</th>
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<tbody>
<tr>
<td>Pain Management</td>
<td></td>
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</tr>
<tr>
<td>Physical Management</td>
<td>Splinting / Cushioning</td>
<td>85%</td>
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<tr>
<td>Positioning</td>
<td>Acupuncture</td>
<td>75%</td>
</tr>
<tr>
<td>Neurotension Release</td>
<td>Massage</td>
<td>90%</td>
</tr>
<tr>
<td>TENS</td>
<td>Pharmacological</td>
<td>60%</td>
</tr>
</tbody>
</table>

SCI Upper Extremity Recs

- Routine Assessment
  - Function
  - Ergonomics
    - Transfer Techniques
    - WC Propulsion
  - Equipment
    - Wheelchair
    - Transfer Device
  - Level of Pain

- Risk Assessment
  - Nonlevel Transfers/day
  - Techniques & Equipment
  - WC Weight
  - Body Weight
  - WC Setup/Propulsion
  - Overhead Activities
  - Work-Related Activities
  - Exercise Program

WC Positioning for Propulsion

Optimal: Elbow 100-120°

@ Center Pushrim

A Low Seat
B
C High Seat

Ultralightweight WC, Low Seat, Raised & Forward Axle

Long, Smooth Strokes limit High Impact on Pushrim

Allow hand drift downward below Pushrim when not in contact

Semicircular Pattern: ↓ Stroke Freq, ↑ Push:Recovery, ↓ Angular Joint Velocity

WC Propulsion Biomechanics

Transfers

- Perform level transfers if possible
- Avoid impingement by avoiding:
  - Shoulder Internal Rotation
  - Shoulder Flexion
  - Shoulder Abduction
- Avoid hands of flat surface if neutral handgrip is possible
- Vary technique used & arm that leads
- Consider transfer device for all SCI
  - Slide Board
  - Overhead Lifts
- Avoid Trapeze Bars if alternative bed-mobility techniques are available

PVA CPG Preservation of Upper Limb Function, 2005
**Strength Exercise Rx in SCI**

- **Goals:** Personal + Preserve UE + TRM
- **Limitations:** Ortho, Medical, Time
- **Mode:** Isometric, tonic, kinetic
  - Upright Rows (Scapular Stabilization)
  - Internal/External Rotation (Shoulder Depressors)
  - Chest Press, Horizontal Row
  - Biceps & Triceps Curls
  - Limit Overhead Press
- **Frequency:** 2-4x/wk
- **Intensity:** >65% 1RM
- **Reps:** 1-10
- **Sets:** 3-6
- **Recovery:** 2-3 minutes/set
- **Stretch Anterior Chest / Shoulder**
- **Periodization**

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**Resistance Training in SCI**

- **Estenne et al, 1989**
  - Prospective, Controlled
  - Isometric Pectoral M.
  - Improved Pectoral M. isometric strength
- **Wise JB, 2000**
  - N=4 Cervical SCI
  - Interviews after 1 year
    - ADLs, Recreation, Independence
    - Confidence, self-efficacy, body image
- **Duran et al, 2001**
  - N=13 Thoracic ASIA A
  - 16-weeks, 120’ 3x/wk
    - Mobility, Coordination, Aerobic, Strengthening & relaxation
  - Significantly improved
    - FIM
    - Strength
    - Aerobic Fitness
- **Hicks et al, 2003**
  - 9-month, 2X/week
  - N=23 C4-L1 ASIA A-D
  - Prospective, Randomized Controlled trial
  - 1RM strength improved (RT v C)
    - 19-34% on upper body muscle strength
    - 81% improved ACE PO

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**Adaptive Equipment for SCI**

- Wheelchair, Seating Systems
- Appropriate Clothing
- Limb Protectors
- Abdominal Binder
- Leg Wraps
- Modified Grasp for persons with Tetraplegia
- Accessible RT Equipment
- Recreational Therapist

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**Grip Facilitation**
Shoulder Girdle

- Three joints
  - Sternoclavicular joint
  - Acromioclavicular joint
  - Glenohumeral joint
- Scapulothoracic Articulation

AP Views: External Rotation

AP Views: Internal Rotation

Axillary Views

Proximal Humeral Fractures

- Neer Classification of Humeral Fxs
  - Articular Fragment
  - Lesser Tuberosity + Subscapularis
  - Greater Tuberosity + Supraspinatus
  - Humeral Shaft
- Minimal Displacement
  - 4-week Immobilization, then
  - Passive ROM, then
  - Active ROM, Strengthening
- 2-3 Fragment, Displaced Fxs
  - ORIF, then as above
- 4 Fragment Fractures
  - Humeral head prosthesis indicated
Anterior Dislocation GH Joint

- X-ray:
  - AP: Inferiorly displaced humeral head
  - Lat: Anteriorly displaced humeral head
  - Majority: Subcoracoid
  - Other:
    - Subglenoid
    - Subclavicular (rare)

Anterior Glenohumeral Joint Dislocations

- Hx: Forced abduction, external rotation
- Physical Examination:
  - Prominent acromion
  - Guarding
  - Abduction
  - Externally Rotation
  - Usually supported with opposite extremity

Anterior Glenohumeral Dislocations (Cont)

- Reduction Techniques
  - Aronson: Clasp hands at knee, relax shoulder, extend hip for in-line traction
  - Stimson: Prone, weight suspended at wrist
  - Rockwood: Supine, swath at torso & axilla, in line traction at affected arm, may require slight IR/ER or lateral traction
- Medication/Sedation

Anterior Glenohumeral Dislocations (Cont)

- Management
  - Reduce with gentle in-line traction
  - Immobilize x 3 weeks
  - R-1-C-E-D
  - Codman's pendulum exercises
  - Isometric exercises (IR, AD) at 2 weeks
  - Theraband, Isokinetic exercises at 4-5 weeks, focus on Anterior Musculature
Posterior Glenohumeral Dislocations

- Hx: Fall to adducted, internally rotated arm
- PE: Prominent coracoid, posterior fullness, adducted & internally rotated, guarding
- X-ray:
  - AP: Humerus IR, Narrow joint space
  - Lat: Posteriorly displaced humeral head with respect to glenoid

Posterior Glenohumeral Dislocations (Cont)

- Treatment:
  - Reduce with gentle in-line traction, posterior pressure at humeral head
  - Immobilize x 3 weeks
  - R-I-C-E-D
  - Codman's pendulum exercises
  - Isometric exercises (ER, AB) at 2 weeks
  - Manual, Theraband, Isokinetic exercises at 4-5 weeks

Shoulder Ligaments

- Acromioclavicular
- Coracoclavicular
  - Conoid Ligament
  - Trapezoïd ligament
- Coracoacromial
- Coracohumeral
- Sternoclavicular

Acromioclavicular Sprains

- Hx: Direct blow to Acromion, or fall onto elbow/outstretched hand
- PE: Upwardly displaced clavicle
- X-rays: AP stress views
  - G I: Normal
  - G II: Less than 5 mm displacement
  - G III: Greater than 5 mm displacement
AC Sprains

1° Sprain
2° Sprain
3° Sprain

<5mm displacement
>5mm displacement

Acromioclavicular Sprains (Cont)

Rx

Conservative
- R-I-C-E-D
- Sling Immobilization
- Pendulum, ROM exercises

Surgical
- Cosmesis vs pain management
- Suture, wire, pin, screw

Rotator Cuff Injuries

Hx:
- Overhead throwing, reaching, lifting; Abd/ER; deep, lateral aching pain

PE:
- Impingement sign
- Drop arm test

X-rays:
- Ectopic calcification, Greater tubercle DJD
- Edema, calcification, or tear on MRI

Rotator Cuff Injuries (Cont)

Rx:
- R-I-C-E-D
- Subacromial bursae injection
- ROM exercises
- Static, Manual, Theraband, Isokinetic, & Isotonic strengthening exercises of IR/ER, scapular stabilizers
- Surgical Repair
- 6 Month Recovery

Indications for Injection

Diagnostic Pain Relief
- Example: Costochondritis vs Angina
- Example: Occipital Trigger Point vs. Migraine

Therapeutic Intervention
- Articular Conditions
  - Rheumatoid Arthritis, Seronegative Spondyloarthropathies
  - Crystal-Induced Arthritis

- Nonarticular Disorders
  - Fibrosis, Bursitis, Periarthritis, Tenosynovitis
  - Neuritis (Carpal/Tarsal Tunnel Syndrome)

Indications for Joint Aspiration

Diagnosis by Synovial Fluid
- Infection (WBC/ml)
  - Noninflammatory (200-2,000 WBC/ml)
  - Inflammatory (2000K-50,000 WBC/ml)
- Septic (50,000-300,000 WBC/ml)
- Crystalline Arthropathy
  - Gout
    - (-) Birefringent needles under Polarized Light
  - Pseudogout
    - (+) Birefringent Rhomboids under Polarized Light
- Therapeutic Joint Decompression
**Relative Potency of Corticosteroid Preparations**

<table>
<thead>
<tr>
<th>Corticosteroid</th>
<th>Potency</th>
<th>Dose (mg)</th>
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<tr>
<td><strong>Short Acting</strong></td>
<td></td>
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<tr>
<td>Hydrocortisone</td>
<td>1.0</td>
<td>20</td>
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<tr>
<td>Cortisone</td>
<td>0.8</td>
<td>25</td>
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<tr>
<td><strong>Intermediate</strong></td>
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<td></td>
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<tr>
<td>Prednisone</td>
<td>3.5</td>
<td>5</td>
</tr>
<tr>
<td>Triamcinolone</td>
<td>4.0</td>
<td>4</td>
</tr>
<tr>
<td>Methylprednisolone</td>
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<td>4</td>
</tr>
<tr>
<td><strong>Long Acting</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dexamethasone</td>
<td>25</td>
<td>0.6</td>
</tr>
<tr>
<td>Betamethasone</td>
<td>25</td>
<td>0.6</td>
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</table>

**Dosages of Corticosteroid Preparations**

<table>
<thead>
<tr>
<th>Corticosteroid</th>
<th>Strength Tendon (mg/ml)</th>
<th>Small Jts (mg)</th>
<th>Large Jts (mg)</th>
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<tr>
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<td>8-20</td>
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<td><strong>Intermediate</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Prednisone</td>
<td>20, 40</td>
<td>2-5</td>
<td>10-25</td>
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<tr>
<td>Triamcinolone</td>
<td>40, 100</td>
<td>2-5</td>
<td>10-25</td>
</tr>
<tr>
<td>Methylprednisolone</td>
<td>20, 40, 80</td>
<td>0.8-1.0</td>
<td>2-4</td>
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<tr>
<td><strong>Long Acting</strong></td>
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<tr>
<td>Dexamethasone</td>
<td>4, 1.5-3</td>
<td>0.8-1.0</td>
<td>2-4</td>
</tr>
<tr>
<td>Betamethasone</td>
<td>6, 1.5-3</td>
<td>0.8-1.0</td>
<td>2-4</td>
</tr>
</tbody>
</table>

**Contraindications for Steroid Injection**

- Overlying Cellulitis
- Severe Coagulopathy
- Anticoagulation Therapy (Relative)
- Septic Effusion
- Bacteremia
- Joint Prosthesis
- ≥ 3 Injections/year in a weight-bearing joint
- ∅ Response after 2-4 injections
- Unstable Joints
- Inaccessible Joints

**Adverse Effects of Steroid Injection**

- Post-Injection Flare (2-5%)
- Steroid Arthropathy (0.8%)
- Tendon Rupture (<1%)
- Facial Flushing (<1%)
- Skin Atrophy / Depigmentation (<1%)
- Iatrogenic Infectious Arthritis (< .072%)
- Transient Paresis of Injected Extremity (Rare)
- Hypersensitivity Reaction (Rare)
- Asymptomatic Peri-capsular Calcification (43%)
- Acceleration of Cartilage Attrition (Unknown)

**Materials & Equipment**

- Betadine & Alcohol Swabs
- Sterile Gloves
- Needles (1 1/2 “)
  - 18-20 g for Aspirations
  - 25 g for Injections
- Syringes
  - 3-50 cc for Aspirations
  - 3-5 cc for Injections
- 1-2% Lidocaine
- Corticosteroid Preparation
- 2x2 gauze, Bandages

**Subacromial Bursitis/Supraspinatus Tendonitis**

- Cause: Overuse
- Findings:
  - Impingement on Abduction
  - Worse with Int. Rotation
- Technique
  - 2 cc 1% Lidocaine, 1 cc 4 mg/ml Dexamethasone
  - Inject laterally 1” below acromion @ 15° angle
- Aftercare:
  - IR/ER HEP in 5 days
Acromioclavicular Joint Inflammation

- **Cause:** Trauma
- **Findings:**
  - (+) Scarf Sign
  - Point tender @ AC Joint
- **Technique:**
  - 1 cc 1% Lidocaine, 0.5 cc 4 mg/ml Dexamethasone
  - Inject 1/2" medial to top of acromion @ 30° angle through AC joint space
- **Aftercare:**
  - 1 week relative rest, ROM

Sternoclavicular Joint Inflammation

- **Cause:** Trauma, Overuse
- **Findings:**
  - Painful protraction/retraction
  - Point tender @ SC Joint
- **Technique:**
  - 0.5 cc 1% Lidocaine, 0.5 cc 4 mg/ml Dexamethasone
  - Inject @ 90° angle through SC joint space
- **Aftercare:**
  - 1 week relative rest, ROM

Adhesive Capsulitis

- **Cause:** Trauma, Disuse
- **Findings:**
  - Painful loss of ER, IR, abduction
- **Technique:**
  - 2-3 cc 1% Lidocaine, 1 cc 4 mg/ml Dexamethasone
  - Inject below posterior angle of acromion toward coracoid process
- **Aftercare:**
  - Gentle, progressing to assisted ROM after 1 wk

Biceps Tendonitis

- **Cause:** Overuse
- **Findings:**
  - (+) Yergeson's Sign
- **Technique:**
  - 2 cc 1% Lidocaine, 1 cc 4 mg/ml Dexamethasone
  - Inject @ point of maximal tenderness, parallel to the bicipital groove
- **Aftercare:**
  - Begin ROM HEP in 5 days
Imaging the Elbow

Elbow Joint Inflammation
- **Cause:** Trauma, Overuse
- **Findings:**
  - Painful elbow ROM
- **Technique:**
  - 2 cc 1% Lidocaine, 1 cc 4 mg/ml Dexamethasone
  - Inject parallel to the radial head in space between radiohumeral joint
- **Aftercare:**
  - Begin ROM HEP in 5 days

Lateral Epicondylitis (Tennis Elbow)
- **Cause:** Overuse
- **Findings:**
  - Lateral elbow pain on active wrist extension
- **Technique:**
  - 1 cc 1% Lidocaine, 0.5 cc 4 mg/ml Dexamethasone
  - Pepper injection along tendon @ lateral epicondyle
- **Aftercare:**
  - 1 week relative rest, then ROM; PRE when a pain

Medial Epicondylitis (Golfer’s Elbow)
- **Cause:** Overuse
- **Findings:**
  - Medial elbow pain on active wrist flexion
- **Technique:**
  - 1 cc 1% Lidocaine, 0.5 cc 4 mg/ml Dexamethasone
  - Pepper injection along tendon @ medial epicondyle
- **Aftercare:**
  - 1 week relative rest, then ROM; PRE when a pain
Monteggia Fracture

- Proximal ulna fracture with radial head dislocation
- Mechanism: Direct blow or axial loading of forearm with forced pronation
- Treatment:
  - ORIF with careful anatomic alignment, then x-rays with 90° elbow flexion to assess radial head reduction
  - Immobilize @ 90° flexion with full supination x 3 weeks
  - Customized orthotic to control flexion/extension

Galeazzi Fracture

- Distal radial fracture with distal radioulnar joint dislocation
- Mechanism: Direct blow to dorsal radial aspect of distal forearm; occasionally due to fall on outstretched hand
- Treatment:
  - ORIF with compression plate
  - Kirschner (K) wires may be required to stabilize radioulnar joint
  - Long arm cast with 90° elbow flexion, hand supination

Colles Fracture

- "Silver fork deformity;" Distal radial extension-compression fracture
- Mechanism: Fall on outstretched hand
- Treatment:
  - Closed reduction & immobilization in mild flexed, ulnar deviation, & neutral rotation(?)
  - ORIF with External Fixator, or with buttress plates, screws an wires
**Smith Fracture**

- "Garden spade deformity;" Distal radial flexion-compression fracture
- Mechanism: Fall on the back of the hand or direct blow to dorsum of flexed hand
- Treatment:
  - Closed reduction & immobilization, or
  - Percutaneous pin fixation

**Imaging the Wrist**

- **Scaphoid Fracture**
  - Middle 1/3 fracture most common
  - Mechanism: Fall on outstretched hand with impact at thenar eminence
  - Treatment:
    - 8-12 weeks immobilization in snug thumb spica cast, wrist in 20° flexion and slight radial deviation
    - If > 1mm displaced, Herbert Screw is placed
    - Ruse bone graft may be employed to preserve dorsal blood supply

- **Scaphoid Lunate Dissociation**
First Metacarpophalangeal Joint

- **Cause:** Trauma, Overuse
- **Findings:**
  - Painful loss of adduction, extension
- **Technique:**
  - 1 cc 1% Lidocaine, 0.5 cc 4 mg/ml Dexamethasone
  - Inject gap between metacarpal & trapezium
- **Aftercare:**
  - Splint x 1 week, then ROM; PRE when ∆ pain

Wrist Joint Injection

- **Cause:** Trauma, Overuse
- **Findings:**
  - Painful loss of ROM
- **Technique:**
  - 1 cc 1% Lidocaine, 0.5 cc 4 mg/ml Dexamethasone
  - Inject 1cm from EPL in gap between radius & scaphoid
- **Aftercare:**
  - Splint x 1 week, then ROM; PRE when ∆ pain

Carpal Tunnel Syndrome

- **Prevalence in SCI**
  - 40-66%
- **Time since SCI**
  - ↑ Likelihood of CTS
- **Etiology**
  - Multifactorial
    - WC propulsion
      - 90° wrist on Transfers

Carpal Tunnel Injection

- **Cause:** Overuse
- **Findings:**
  - Nocturnal Pain
    - (+) Tinel’s, Phalen’s signs
- **Technique:**
  - 0.5 cc 1% Lidocaine, 1.0 cc 4 mg/ml Dexamethasone
  - Inject @ 45° angle just medial to FCR tendon at proximal wrist crease
- **Aftercare:**
  - Splint; ROM in 1 week
DeQuervain’s Tenosynovitis

- **Cause:** Overuse
- **Findings:**
  - (+) Finkelstein’s Test
- **Technique:**
  - 1 cc 1% Lidocaine, 0.5 cc 4 mg/ml Dexamethasone
  - Inject peritendinously @ 30° angle along EPL/APL
- **Aftercare:**
  - Splint x 1 week, then ROM; PPT when @ pain

Imaging of the Hand

Rheumatoid Arthritis

- **Boutonnière**
- **Swan Neck**

Trigger Finger Injection

- **Cause:** Idiopathic
- **Findings:**
  - Painful clicking/locking finger; unable to extend
- **Technique:**
  - 0.5 cc 1% Lidocaine, 0.5 cc 4 mg/ml Dexamethasone
  - Inject into trigger nodule
- **Aftercare:**
  - No restrictions; Paraffin Baths
Bennet’s Fracture
Intra-articular Fracture Base MC1

Rolando’s Fracture
Intra-articular Comminuted Fracture Base MC1

Boxer’s Fracture
Fracture of Neck MC5

Mallet Finger
Extensor Tendon Tear @ DIP

Gamekeeper’s (Skier’s) Thumb
Ulnar collateral ligament tear MCP1
**UE Healing Considerations**

- Mobility
  - Bed Mobility
  - Transfers
  - WC Mobility
- ADLs
  - Feeding
  - Bathing
  - Grooming / Hygiene
  - Dressing
  - Toileting

**Pressure Injury Healing**

- Source / Etiology
  - Pressure Relief
  - Fix the Etiology!!
- Nutrition
- Infection
- Irrigation / Debridement
- Scar Fragility
- Progressive Seating
- Pressure Mapping

**Surgical Interventions**

- Pre and Perioperative Care
  - Necrotic bone excision
  - Fill with fascia / muscle
  - Improve vascularity
  - Minimize bony prominence
- Postoperative Care
  - Air Fluidized bed 3-6 weeks
  - Progressive Sit Protocol
    - 15' bed; Monitor skin
    - 30' bed; Monitor skin
    - 45' bed; Monitor skin
    - 60' bed; Monitor skin
    - 75' bed; Monitor skin
    - 90' bed; Monitor skin
    - 120' bed; Monitor skin

**Happy Days!**


**Final Point!**

“All the education and all the knowledge in the world can't help the poor soul who has no common sense.”

Benjamin Franklin
American Inventor

**Bibliography**