Hemiplegic Shoulder Pain and Subluxation

Salvador Bondoc, OTD, OTR/L, BCPR, CHT, FAOTA
Professor of Occupational Therapy
Quinnipiac University

Outline

Shoulder Basics in Relation to Hemiplegia
- Overview of Shoulder Conditions in Hemiplegia
- Shoulder Anatomomechanics
- Pathomechanics of the Hemiplegic Shoulder

Literature Review of Common Interventions
- Positioning
- Orthoses including slings
- Taping or Strapping
- Electrical stimulation

Multi-disciplinary and Function-based Approach Intervention
- Case Report
Objectives
At the conclusion of this course, participants should be able to:
1. Identify the pathomechanics of shoulder pain and subluxation
2. After this course, participants will be able to recognize a systematic process of assessing shoulder pain and subluxation.
3. After this course, participants will be able to list evidence-based options in managing shoulder pain and subluxation.

Hemiplegic Shoulder: The Basics
Overview of Shoulder Conditions in Hemiplegia
Shoulder Anatomechanics
Pathomechanics and Assessment of the Hemi Shoulder
Hemiplegic Shoulder: The Basics

Overview of Shoulder Conditions in Hemiplegia
Shoulder Anatomechanics
Pathomechanics of the Hemiplegic Shoulder

The Shoulder

- Shoulder function is a prerequisite to many of our daily life activities…

- We need a functioning shoulder to enable
  - Effective hand placement during reach-to-grasp
  - Dynamic support for the body during mobility
  - Funneling of bodily forces to project or strike objects

- Thus, shoulder impairment → disability
Hemiplegic Shoulder

- Two common conditions:
  - Hemiplegic shoulder pain (HSP)
  - Glenohumeral subluxation (GHS)

- Hemiplegic Shoulder Pain
  - With or without GHS is associated with poor functional outcomes

---

Hemiplegic Shoulder

- Hemiplegic shoulder pain (HSP)
  - (a.k.a. post-stroke shoulder pain or PSSP)
  - Incidence rates varies – 48% to 84%
  - Typical onset of 2-3 months
  - Some resolve by 6 mos, some persist > 16 mos

- Glenohumeral subluxation (GHS)
  - Incidence rates varies – 29% to 58%
  - Most associated with flaccid paralysis* - early onset

[EBRSR, 2016]
HSP vs. GHS Caveats

- Presence of GHS does not predict HSP
  - Patients with HSP are not always subluxed
  - Patients with GHS may not have pain

- Many patients with spasticity have GHS
  - Pattern of GHS is not always vertical
  - GHS is most common in anterior-inferior

- Mechanism behind HSP is poorly understood

Hemiplegic Shoulder: The Basics

Overview of Shoulder Conditions in Hemiplegia
Shoulder Anatomomechanics
Pathomechanics and Assessment of the Hemi Shoulder

Bondoc (2017)
Shoulder Anatomy

TRUE JOINTS
- STERNOCLEAVICULAR
- ACROMIOCLAVICULAR
- GLENOHUMERAL

QUASI ARTICULATIONS
- SCAPULOTHORACIC
- SUBACROMIAL

Functional Shoulder requires...

1. Normal orientation of the scapula on the thorax
2. Balance of forces among scapular stabilizers and glenohumeral mobilizers
3. Centralization of the humeral head with glenoid fossa
Functional Shoulder requires…

1. Normal orientation of the scapula on thorax

2. Balance of forces among scapular stabilizers and glenohumeral mobilizers

3. Centralization of the humeral head with glenoid fossa

Scapular Orientation

Bondoc [2017]
Scapular Orientation

- Anterior Tipping: $15^\circ$
- Upward Rotation Tilt: $5^\circ$

Scapular Orientation

- Scapular plane 30-35 degrees
- Humeral retroversion
Functional Shoulder requires…

1. Normal orientation of the scapula on the thorax

2. Balance of forces among scapular stabilizers and glenohumeral mobilizers

3. Centralization of the humeral head with glenoid fossa

Functional Groups (Jobe & Pink, 1993)

1. Scapular pivoters
   - Serratus Anterior (Up, Low)
   - Trapezius (Up, Mid, Low)
   - Rhomboids Major/Minor
   - Levator Scapula

2. Propellers – axiohumeral
   - Pectoralis major
   - Latissimus dorsi

3. Glenohumeral protectors
   - Supraspinatus
   - Infraspinatus
   - Subscapularis
   - Teres Minor

4. Humeral positioners
   - Anterior deltoid
   - Posterior deltoid
   - Middle deltoid
Scapular Kinematics

- **PROTRACTION – RETRACTION**
  - Pushing - pulling

- **ELEVATION – DEPRESSION**
  - Shrugging - Downward Reach

- **UPWARD - DOWNWARD ROTATION**
  - Reaching up and forward – Reaching down and back

---

Scapular Elevators

Upper trapezius
Levator scapulae
Rhomboïds

Rhomboïds rotate scapula with latissimus dorsi and pectoralis minor

---

Bondoc (2017)
Scapular Depressors

LOWER TRAPEZIUS

PECTORALIS MINOR

Scapular Retractors

MIDDLE TRAPEZIUS

UPPER TRAPEZIUS + RHOMBOIDS + LOWER TRAPEZIUS

Bondoc (2017)
Scapular Protraction

SERRATUS ANTERIOR

Upward Rotation

- force coupling among upper and lower trapezius and serratus anterior

Bondoc (2017)
EMG ACTIVITY OF UPWARD ROTATORS


Scapular Tilting/Tipping

Ante-tilting
Associated with
- Increased scapular protraction
- Tightness of or overactive pectorals

Posterior tilting
- Combines
  - Scapular retraction and depression
  - Provides clearance to the HH during elevation

**PECTORALIS MINOR**

**LOWER TRAPEZIUS**
Functional Shoulder requires…

1. Normal orientation of the scapula on the thorax

2. Balance of forces among scapular stabilizers and glenohumeral mobilizers

3. Centralization of the humeral head within glenoid fossa (glenohumeral joint)

Glenohumeral (GH) joint

- Complex synovial joint

- “Ball and Disc” configuration
  - convex humeral head
  - concave glenoid fossa

- Loosely fitted, very mobile requires dynamic stabilization

https://commons.wikimedia.org/wiki/File:Blausen_0797_Shoulderjoint.png
To add stability to the GH Joint...

"STATIC" STRUCTURES
1. Glenoid Labrum
2. Capsulo-ligamentous Complex (CLC) or the "Capsule"

"DYNAMIC" STRUCTURES
4. Rotator Cuff Muscles + Biceps Brachii (long head)
5. Scapular Stabilizers

3. STATIC LOCKING MECHANISM

1. Glenoid Labrum
- Deepens the articular surface of the glenoid fossa
- Reduces humeral accessory translation (traction effect)
- Blends with long head of the biceps
2. Capsulo-ligamentous Complex (CLC) 
[a.k.a. the Glenohumeral Capsule]

- Fibrous and elastic
  - Allows for joint distraction without disarticulation

- COMPONENTS
  - Coracohumeral Ligament
  - Superior glenohumeral lig.
  - Middle glenohumeral lig.
  - Inferior glenohumeral lig.
  - Forms an “axillary pouch”
    - anterior – inferior GH lig
    - Posterior – inferior GH lig

---

3. “Static Locking Mechanism”

1. Superior CLC + Gravity = Resultant compressive force (CF)
2. Maintenance of scapular tilt of ~ 5 degrees
3. Negative intra-articular pressure
4. Rotator Cuff

- Based in the scapula
- Cuffs the GH joint
- Creates a passive barrier effect antero-posteriorly

---

Proximal and Distal Attachments of the Rotator Cuff

---
Rotator cuff + Deltoid coupling = Centralization of the glenohumeral joint

Coupling action of the Rotator Cuff especially
- Subscapularis
- Infraspinatus
- Teres minor

5. Balancing the Kinetic Mechanisms of the Shoulder:
- Rotator Cuff
- Deltoids
- Serratus Anterior
- Rhomboids
- Trapezius

Bondoc (2017)
Hemiplegic Shoulder: The Basics

Overview of Shoulder Conditions in Hemiplegia
Shoulder Anatomomechanics
Pathomechanics & Assessment of the Hemi Shoulder

Hemiplegic Shoulder

Glenohumeral Subluxation
- Disruption in the mechanical integrity of the GH joint
- Leads to an incomplete disarticulation of the humeral head vs. glenoid fossa
- Associated with loss of muscle function

Hemiplegic Shoulder Pain
- May occur with or without subluxation
- May be centrally- or peripherally-mediated; can be both
- Associated with multiple risk factors
Glenohumeral Subluxation

- PATHOMECHANICS
  - Flaccid Paralysis
  - Disruption of the “static locking mechanism” / disruption in the glenohumeral alignment
  - Overstretching of the rotator cuff
  - Overstretching of the superior capsular structures

***Multiple studies indicate that scapular orientation does correlate with +/- subluxation***

Glenohumeral Subluxation

- Disruption in the integrity of the capsule and rotator cuff

Bondoc (2017)
Patient with anterior-tilted and medial-winged scapula and spastic paralysis

Patient with normal scapular orientation and normal reflexes (no paralysis)

Hemiplegic Shoulder Pain

Neurogenic Pain
- Central post-stroke pain
- Complex regional pain syndrome (shoulder-hand syndrome)
- Sensory-perceptual disorders

Musculoskeletal Pain
- Rotator cuff tendinopathy
  - Tendonitis/tendinosis
  - Partial tears
- Biceps tendinopathy
- Bursitis
- Capsulitis

Bondoc (2017)
Loss of Motor Control
Spastic or Flaccid Paralysis
Loss of or altered motor function

→ Neurologic Pain
  • Centrally mediated pain

→ Musculoskeletal Pain
  • Soft-tissue disruptions

Hemiplegic Shoulder Pain

---

**Hemiplegic Shoulder Pain**

1. Muscle Imbalance due to Spasticity

- Subscapularis spasticity
- Pectoralis Major spasticity
- FLEXOR SYNERGY PATTERN

2. Impingement Syndrome

- Glenohumeral instability
- Acute tendinopathies

3. Abnormal Posturing

- Contractures
- Secondary Frozen Shoulder

---

Bondoc (2017)
1. Muscle imbalance:
**Subscapularis and Pectorals**

- **Subscapularis**
  - Internal rotator
  - Limits external rotation, abduction, flexion

- **Pectoralis Major**
  - Adductor, internal rotator
  - Limits external rotation, abduction

---

**Destabilized Glenohumeral Joint**

As spasticity evolves, the glenohumeral joint continues to destabilize in the pattern of spasticity

Bondoc (2017)
2. Impingement due to Synergy Influence

- Spastic pectorals and infraspinatus → spontaneous internal rotation with shoulder elevation

- Provocative maneuver to test for impingement → “Hawkins-Kennedy” test

---

Subacromial Impingement

Bondoc (2017)
Biomechanical Sources of Shoulder Pain

Rajaratnam et al. (2007) identified three factors that predict (98% accuracy) HSP:

1. Positive Neer test
2. Significant pain with hand-behind-neck maneuver
3. Difference of >10° of passive external rotation between shoulders

Maladaptive Posture

Posture & Hemiplegic Shoulder Pain

- Lack of movement out of synergy results in maladaptive UE posturing:
  - Scapular retraction, depression, and/or anterior tilting
  - Humeral internal rotation and adduction

- Maladaptive posturing → restricted ROM → pain
Poor posture impacts mobility!

In Summary,
- Hemiplegic shoulder pain and subluxation are complex, multi-factorial, and potentially cyclical:
Key Points for Positive Outcomes

- Shoulder biomechanical function depends on
  1. Balance of forces: prime movers + scapular stabilizers
  2. Kinematic linkage of shoulder complex and trunk

- Hemiplegic shoulder pain and subluxation must address the above biomechanical functions while addressing:
  1. Pain and movement restrictions
  2. Motor control

Outline

**Shoulder Basics in Relation to Hemiplegia**
- Overview of Shoulder Conditions in Hemiplegia
- Shoulder Anatomechanics
- Pathomechanics of the Hemiplegic Shoulder

**Literature Review of Common Interventions**
- Positioning
- Orthoses including slings
- Taping or Strapping
- Electrical stimulation

**Multi-disciplinary and Function-based Approach Intervention**
- Case Report
Common Neurological Shoulder Interventions
Literature Review and Clinical Pearls

Common Rehab Interventions

1. Positioning Techniques and Devices
2. Mobilization & Range of Motion Techniques
3. Strapping or Taping
4. Sling and Related Orthotic Devices
5. Electrical Stimulation
1. Positioning the Shoulder

- Positioning for comfort (loose-packed position)
  - Horizontal adduction of 30° and humeral elevation (scaption) of 45°

- Positioning devices
  - Examples: arm troughs, half-trays, lap-board
  - Purposes: provide protection, reduce effect of gravity
  - Evidence: not effective at reducing pain or dysfunction, but not harmful either

Clinical Pearls: Positioning to Prevent Contracture

- Target muscles with propensity to get contractured
  - Subscapularis
  - Pectoralis Major

- Links to resources:
  - Strokefoundation.org.nz
  - Stroke Network SW Ontario
Evidence-based Recommendation

- Prolonged positioning in max comfortable ER maintained ROM
- Proper positioning of the hemiplegic shoulder with firm support helps to avoid further injury

(Ada et al, 2009; EBRSR, 2016)

2. Mobilization and ROM

- Goal: properly align the scapulothoracic articulation and the glenohumeral joint

- Must address the following points:
  1. Trunk and pelvic alignment
  2. Alignment of scapula to neutral tilt and rotation
  3. Alignment of humeral head to neutral rotation
  4. Approximation of humeral head with glenoid fossa
  5. Reproduction of scapulohumeral rhythm
Precautions

- Excessive weight-bearing or axial loading on the GH joint
  - May cause bursitis

- Humeral elevation while rotated internally
  - May cause impingement

- Humeral elevation with limited scapulothoracic rotation (e.g., overhead exercises or pulleys)
  - May cause impingement and instability

Evidence-based Recommendation

- *Aggressive ROM may result in increased pain*

- Gentle ROM is recommended/pREFERRED to reduce pain

*(Teasell, Foley, Bhogal & Salter, 2008)*
Protocol to Prevent Shoulder-Hand Syndrome After Stroke


- Shoulder PROM by therapist:
  - stay within 90 degrees of elevation
  - rotation performed at adducted humerus;
- Elbow, forearm, wrist:
  - No restriction, stop if pain ensues
- Hand:
  - Proximal joint is held at neutral - one joint at a time
  - Composite movement in modified tenodesis

Clinical Pearls:
Strategies for Shoulder Mobilization

Mobilizing the Tight Scapula

Mobilizing the Humerus into Neutral

Bondoc (2017)
Clinical Pearls: Strategies for Shoulder Mobilization

Mobilizing the GH joint with the Scapula
Integrating functional movement patterns

Work on recruitment of scapular stabilizers
Avoid capsular adhesion – placed shoulder in abduction and external rotation
Encourage controlled movement
3. Strapping and Taping

- Most were designed to either:
  - Prevent anterior displacement of the humeral head (Ancliffe, 1992);
  - OR
  - Pull the humerus distally to proximally by anchoring the tapes at the clavicle and spine of the scapula (Morin & Bravo, 1997; Hander et al, 2000; Hayner, 2012)
Strapping

Ancliffe, 1992:

- 5-cm wide lightweight adhesive tape (Fixomul Stretch)
- "the first length of tape was applied to the shoulder half way along the length of the clavicle, continued across the deltoid muscle in a diagonal direction... the tape was terminated approximately one-quarter of the way of the along the spine of the scapula.
- A second length of tape was applied in the same direction as the first but 2 cm below. A small length of tape was applied over the shoulder to secure the ends."

Morin & Bravo, 1997:

- "A 10 cm-wide Elastoplast adhesive bandage was applied under tension from the forearm under the olecranon laterally to the top of the shoulder.
- Two other 7.5 cm-wide bandages were applied from the olecranon under the forearm to the forearm to the top of the shoulder, with one passing anteriorly over the clavicle and the other posteriorly covering the spine of the scapula. No free space was left between the bandages."

---

Strapping

Hanger et al. 2000: Three lengths of nonstretch Elastoplast Sports tape were used.

- "The two main supporting tapes were applied first. Both were applied using a lifting action, starting 5 cm above the elbow, and moving up the arm front and back, crossing at the top of the shoulder.
- The posterior arm tape was then anchored down past the clavicle whereas the tape from the anterior aspect of the arm came across the shoulder and down past the spine of the scapula.
- They were both supported at the lower end by a short tape to prevent them peeling off."

Hayner 2012: Three pieces of rigid tape over self-adhesive cotton tape: Mefix and Leukotape P.

- "The first piece (medial) was applied from 1.5 in. below the deltoid tuberosity running straight up the middle of the arm to 2 in. above the top of the glenoid fossa between the clavicle and the spine of the scapula.
- The second piece (posterior) was located from 1.5 in. below the deltoid tuberosity to 1.5 in. above the middle of the spine of the scapula. The medial border of this second piece ran along the acromial process.
- ...the third piece (anterior) was located from 1.5 in. below the deltoid tuberosity to run around the front of the humeral head and over the coracoid process, up to 1.5 in. above the clavicle."
Rigid Nonpliable Tape

- Requires layering
- Good for stabilization and re-alignment
- May also be good for pain relief by restricting movement

Bondoc (2017)

Bondoc's Application

Bondoc (2017)
Evidence-based Recommendation

- Strapping the hemiplegic shoulder reduces pain, prevents its further development, or delays the onset.

- Strapping/rigid taping is neither a high benefit nor a detriment to shoulder ROM or functioning

(Appel et al, 2014; EBRSR, 2016)

Clinical Pearl:
Strapping or taping may also be used to retrain or correct posture

Bondoc (2017)
Kinesiotaping

- Predominantly used in musculoskeletal cases

- Evidence of Kinesiotape use in neurorehabilitation is emerging or preliminary for these purported benefits:
  - Supports or inhibits muscle function
  - Supports joint structure
  - Provides somatosensory input for kinesthetic awareness

Kinesiotaping Features

- Needs 1 layer

  - Elastic in one direction, mimics skin's pliability and thickness

  - May support lymphatic flow and produce analgesic effect (Thelen, Dauber & Stoneman, 2008)
Emerging State of Evidence

- No clear benefit to manage foot spasticity (Karadag-Saygi et al, 2010)

- No direct effects on sitting posture of children with Cerebral Palsy (Simsek et al, 2011)

- May be beneficial to correct scapula (Lee & Yoo, 2012)

- May contribute to ankle stability in MS (Cortesi, Cattaneo & Jonsdottir, 2011) and stroke (Kim, et al, 2012)

Original Article

Effect of kinesiology taping on hemiplegic shoulder pain and functional outcomes in subacute stroke patients: a randomized controlled study

Yu-Chi HUANG 1, Chao-Peng LI 2, Lin WANG 3, Lin-YU WANG 3, Yv-Chien YANG 1, Choe-YU CHUANG 1, Yu-Fang IBEN 1

- N=40 sub-acute stroke survivors
- Treatment: KT 5 days/week x 3 weeks
- Results:
  - KT may reduce pain
  - KT did not improve UE Function
  - KT did not improve QoL
4. Slings and Shoulder Supports

**PROs**
- Used to assist with transfers
- Protect the arm from getting caught during mobility tasks
- “Sense of security”

**CONs**
- Reinforces lack of use
- Can lead to tightness of immobile joints/muscles
- Shifts center of gravity and body alignment
Various Forms of Slings

Elbow pouch bears >75% of UE weight
Bolster reduces the gravitational pull

Bondoc (2017)

Various Forms of Shoulder Supports

Gravitational pull is not "restrained"

Bondoc (2017)
Evidence-based Recommendation and Clinical Pearl

- “Limited evidence that shoulder sling influences outcomes” (EBRSR, 2016)
- Pain relief may be temporary and must be weighed against muscle tightness/contractures → pain

---

GivMohr Design

- Diagram showing the GivMohr design with arrows indicating movement and support.
GivMohr vs. Hemi-Cuff

- PARTICIPANTS:
  - 25 flaccid upper limb due to CVA or other pathology.

- DESIGN:
  - X-ray analysis of the affected vs. unaffected shoulder
  - Affected shoulder was suited with GivMohr sling, Rolyan humeral cuff or no sling.

- OUTCOMES:
  - Positive effect on vertical subluxation but no effect on horizontal subluxation
  - GivMohr sling measures were similar to measures for the uninvolved shoulder
  - GivMohr and Rolyan measures of involved shoulder were statistically different

**Fig. 1:** Shoulder orthosis.

- N=40 subacute stroke
- Design: Pre-Post
- Treatment: 4 weeks of daytime wear, inpatient
- Findings:
  - Minor impact on gait
  - ~50% rated + comfort
  - Decreased vertical subluxation cleft (~8mm)
  - Increased MMT
5. Electrical Stimulation

- **Most common methods:**

  1. Functional/neuromuscular electrical stimulation (FES/NMES)
     - Targets key muscle contraction
     - Alternatives: High Volt Galvanic Stim (HVGS), implantable E-Stim, and EMG-Triggered E-Stim (ETMS)

  2. Transcutaneous electrical nerve stimulation (TENS)
     - Targets pain control
     - Alternative: Interferential E-Stim

---

**Functional Electrical Stimulation (FES)**

- **Targeted muscles:**
  - Supraspinatus
  - Deltoid (posterior v. anterior)

- **Dose intensity:**
  - 4-6 hours/day, 5x/week for 6 weeks.
  - Typical dose is 35 to 50 Hz (Paci et al, 2005)
Evidence-based Recommendation

NMES or FES
- Most effective at reducing subluxation when delivered in sub-acute condition
- May improve ROM and reduce contracture
- Not effective on pain

TENS/IES
- TENS may improve pain tolerance at high intensity
- Interferential ES is effective at reducing pain with movement and at rest

Clinical Pearl
- With strong evidence for E-Stim, incorporate this in practice for pain and function
- E-Stim use may continue at home for self-management
EMG-Triggered Electrical Stim (ETMS)

Common Rehab Interventions

1. Positioning Techniques and Devices
2. Mobilization & Range of Motion Techniques
3. Strapping or Taping
4. Sling and Related Orthotic Devices
5. Electrical Stimulation

HOW ABOUT ACTIVE THERAPIES – I.E., TASK-ORIENTED TRAINING?
Effect of Task Oriented Training on Shoulder Subluxation: Case Reports

Matthew Healy
Salvador Bondoc

Methods

- A-B-A single case designs
- 6-8 sessions of task-oriented forced use intervention program with home exercise program
  - 1.5 hours of supervised in-clinic sessions
  - 300 repetitions of shoulder movements (home program)
  - Adaptive equipment to encourage more use
- Assessments used:
  - Fugl-Meyer Assessment of Motor Function (FMA)
  - Diagnostic ultrasound
  - Stroke Specific Quality of Life (SSQoL)
“Exercise” Program

[Images of individuals performing exercises]

[Images of individuals performing exercises]

Bondoc (2017)
Cases

- 1A: 55 y/o male 5 years post-stroke
  - Right hemiparesis
  - Expressive aphasia
  - Drives independently, on disability benefits

- 2B: 54 y/o female 19 years post-stroke
  - Left hemiparesis
  - Duly-employed
  - Also takes on role of Homemaker, Caregiver

Results: Fugl-Meyer Assessment

Participant 2B FMA Results

Data Collection Points
Results: Range of Motion

Degrees of AROM

AROM Movements
Bondoc (2017)

Diagnostic Ultrasound Results

Initial A Phase
Completion of B Phase
Bondoc (2017)
Interprofessional Consideration

- Orthopedic Consult
  - Corticosteroid (triamcinolone acetonide) injection

- Physiatry or Neurology Consult
  - Botox Injection
  - Current evidence is still not definitive; dose-response not yet evaluated
  - Pearl: May require multiple trips

- Pain Management
  - Subscapular nerve blocks

Review and Conclusion
Outline

Shoulder Basics in Relation to Hemiplegia
- Overview of Shoulder Conditions in Hemiplegia
- Shoulder Anatomomechanics
- Pathomechanics of the Hemiplegic Shoulder

Literature Review of Common Interventions
- Positioning
- Orthoses including slings
- Taping or Strapping
- Electrical stimulation

Multi-disciplinary and Function-based Approach Intervention
- Case Report

Thank you! Questions?
- Salvador.Bondoc@quinnipiac.edu