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Session 105: Postural & Movement Deficiencies in the Neck & Scapular Region
Sue Dupont, MS, MBA, PT, ATC, LAT

Neck & Shoulder pain affects >60% of adult population

Strong correlation between:
- Neck & Shoulder pain ➤ Scapular dysfunction

Lack of Diagnostic Evidence:
- X-ray findings often do not correlate w/ symptoms.

“To be effective, treatment must somehow reach & reverse the painful process at its source in a lasting fashion.”

--Dr. James Cyriax, MD

ICF Impairment-based Classification for Neck Pain:

- **Mobility Deficits**
- **Neck Pain**
- **Headaches**
- **Movement Coordination Impairments**

**Neck Pain with Mobility Deficits**

- **Diagnosis:** Neck pain, Thoracic pain
- **Findings:**
  - Restricted Upper Cervical spine mobility
  - Poor performance on CCFT test (deep neck flexors)
  - Limited rotation in Upper Cervical Spine
Neck Pain with Movement Coordination Impairments

- **Diagnosis:** Cervical Spine sprain/strain
- **Findings:**
  - Chronic (>12 weeks)
  - **Strength, Coordination, Endurance deficits** in Scapular Stabilizers (Mid- & Lower Trap, Serr. Ant.)
  - **Flexibility deficits** (scalenes, UT, Lev Scap, Pecs)
  - **Postural imbalances** ("Upper Crossed Syndrome" - Janda)

Importance of Alignment, Posture & Muscle Activation in Upper Quadrant Pain:

- Uncoordinated Movements
- Faulty Alignment C/T region
- Neck Pain due to:
  1. Mobility Deficits
  2. Movement Coordination Impairment
- Weak Stabilizer Muscles
- Muscle Imbalances

2 "SCHOOLS" FOR MUSCULOSKELETAL MEDICINE:

1. **Structural Pathology**
   - Based on anatomy & biomechanics
   - Able to visualize lesion w/ static diagnostic testing
   - Treat lesion with immobilization, surgery, rehab.
   - **If "structural" treatment fails or inconclusive:**

2. **Functional Pathology**
   - Impaired ability of structure or physiologic system to perform it's normal function.
   - Can't be observed directly with structural methods.
**Functional movement assessment**

REHAB based on Movement Dysfunction, not PAIN or Dx:

- Muscle Weakness vs. Muscle Inhibition?
- Weakness in Prime Mover Result of dysfunctional Stabilizer?
- Poor Agonist function Antagonist dysfunction?
- Muscle tightness Protective tone, guarding, poor coordination?
- Faulty technique Only option for performance?


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**Importance of movement**

“When there is variety in stresses & directions of movement, the supporting tissues are more likely to retain optimal kinesiologic behavior.”

Sahrmann, 2002.

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**2 Effects of sustained forces & postures**

1. **Time-Dependent** deformation of soft tissues
2. **Soft tissue adaptations** (involving protein synthesis)
   - “Creep” of soft tissues after 20 min. in position of sustained flexion.
   - Requires >40 min. for full recovery!!!
3. Maintaining precise movement patterns—
   - minimizes abnormal stresses on body surfaces in motion.

(Sahrmann, 2002)
Can movement cause pain?

PATHO-KINESIOLOGIC MODEL
- related to abnormal movement
- Pathologic abnormality is the source of the pain
- Disease & injury produces impaired movements
- Results in disability & dysfunction

KINESIO-PATHOLOGIC MODEL
- Repetitive movements, (incl. fitness & sports), & sustained postures cause tissue stress & overload.
- Tissue overload & movement impairments ➔ Microtrauma.
- Eventually ➔ Macrotrauma.
- Results in pain & disability.

Sahrmann, 2002

Effect of chronic pain & dysfunction

Structural Pathology ➔ Functional Pathology

Muscle Imbalance Response

Hypertonicity & Inhibition

Altered Movement Patterns & Adaptive Change


What is Typical Posture?

POSTURAL MODEL
INFLUENCE OF GENETICS
INFLUENCE OF BIRTH & DEVELOPMENT
Aspects of Good Posture

- Minimum of muscle force
- Balance between agonist & antagonist muscle groups
- Sufficient “relative flexibility”
- Adequate coordination of movement
- Well-developed postural reflexes

Ideal Head Posture

Dependent on horizontal orientation of 3 parallel lines of reference:
- Bi-pupilar plane
- Vestibular plane
- Transverse Occlusal Plane
- Permit visual gaze & vestibular system to remain level w/ ground.

Rocabado, 1984

Ideal head posture & Body Asymmetry

- Check level of ears, eyes & mouth.
- Any change in normal horizontal & parallel relationship of 3 planes to each other & to ground–
  - Results in compensatory adaptations in spine

Example:
- Patients with shorter R leg develop L-sided loss of vertical dimension in jaw; altered alignment shoulders, hips & pelvis
Common pain patterns assoc. with shorter leg

Due to opposing torsional forces at junctions & causing overload stress:
- Atlanto-Occipital
- Cervical-Thoracic
- Thoraco-Lumbar
- Lumbo-Sacral
- Foot & ankle pain shorter leg
- Pain & OA in longer leg
- Shoulder pain on longer leg
- TMJ dysfunction & pain on shorter side

Postural Control

- **Anti-gravity function** = to remain erect & balanced
- Most stable segment in an adult is the head
- Displacement of head < trunk during balance activities
- Multi-sensory pathways (visual, vestibular, somatosensory)
- CNS uses info to create internal frame of reference; regulates COG
- Feedback from neck & lower limb provide additional input

Antigravity functions

**Antigravity Extension**
- Maintained by:
  1. Monosynaptic stretch reflexes @ spinal cord level
  2. Excitatory ipsilateral input from vestibular organs
  3. Inhibitory input from neck proprioceptors & frontal cortex

**Antigravity Flexion**
- Controlled by Motor cortex

R. Pope, 2003
Effect of Dominant Hand/Foot

- With general ADLs:
  - one leg/hand is used for **postural support** (vestibular dominance)
  - other leg/hand is used for **voluntary activities** (motor dominance)

Posterior & Anterior Spiral Spring System

- Need stretch on iliopsoas during gait for spring effect
- Swing phase/pushoff – Utilize AOS and POS myofascial slings
- DLS active @ Heel strike (eccentric loading)
  - Ipsilateral gluteals co-contract with opposite Lat. Dorsi
  - Counter-rotation of arms assists with this energy spring system

**OBSERVE:**
- Patient walking, or marching in place– Is arm swing symmetrical?
- If not, problem with Anti-Gravity Spiral Spring System!!

IF joint dysfunction or malalignment exists:

- **Lose our anti-gravity spring!!!**
- Muscle spindles –
  - > concentration in Postural muscles; slow twitch, oxidative
  - Better designed for sustained, compressive loads
- **Muscle Spindle Dysfunction** in deep, postural stabilizers = **SPASM!!**
- Anti-gravity function shifts to Global muscles; fast-twitch
- Fatigue quickly, then shift load back to overloaded Postural muscles
Origins & Causes of Compensatory Postures & Malalignment

Origin of Compensatory Posture:

• Genetic Potential
• Stresses on Fetus during childbirth
• Developmental Influence – crawl to walk
• Structural Asymmetries– from injuries, leg length difference, etc.
• Tight muscles unopposed by inhibited muscles– leads to imbalance & compensation.

3 Common Regions for Postural Dysfunction
1. Lumbo-sacral junction
2. Lower extremities
   • Leg length, foot arches & malalignment
3. Cranio-cervical mandibular junction (CCMJ)
   • Occlusion & mandibular rest position closely related to posture of head & neck.
   • Fascial strains prod. by structural asymmetries can directly contribute to CCMJ dysfunction

www.erickdalton.com “Puzzle of Perfect Posture”
Other Biomechanical & Structural Changes

- Untreated joint laxity & torsional deformities
- Prolonged computer use & sedentary jobs
  Create possible structural changes in soft tissue:
  - Collagen shortening; muscle fibrosis
  - Reduced "Flexion-Relaxation Phenomenon" (FRP)
- Produce symptoms due to premature DJD
  - Caused by overload & break-down of joint structures
  - Asymptomatic DDD common in Cervical spine >30 y.o.


Upper Crossed Syndrome— Janda

Asymmetry between line A & line B allows postural dysfunction:

- **Line (a): Line of Hypertonicity**
  - Passes through neck extensors, levator scapulae, upper trap & pectorals
  - Sustained hypercontraction in typically tonic muscles elevates & protracts shoulders.

- **Line (b): Line of Inhibition**
  - Passes through deep neck flexors & lower shoulder stabilizers

Page, 2003

Chronic pain linked to:

- Reduced movement speed
- Increased background activity of stabilizing muscles to minimize use of painful muscle
- Temporal isolation of painful joint movement outside of kinetic chain.
Effects of Neck Pain (NP) & Cervico-Cranio-Facial Pain (CCFP):

- n=64 subjects with 1) chronic, mechanical neck pain (NP), 2) those with CCFP, 3) asymptomatic controls
- Evaluated Cervical ROM, Mandibular opening, Neck Disability Index (NDI)
- Higher NDI scores for NP and CCFP vs. controls
- Significant difference for NP and CCFP for all ROM measurements, especially Cervical Extension & Rotation
- Mandibular opening signif. lower in NP & CCFP

Whiplash

- Soft tissues injured by sudden “whipping” of the head.
- Flex/Ext ROM most limited (sagittal plane)

Symptoms:

- Pain & stiffness in neck & shoulder
- Altered muscle activation in Upper & lower trap, Ser. Ant
- Dizziness & Headaches

Altered Cervical APA with Chronic NP & Whiplash Disorder (WAD)

- 3 groups (n=273): 1) WAD, 2) CNP and 3) controls
- Measure max Neck AROM, conjunct motion in other planes, and Joint Position Sense error (JPE)

RESULTS:

- Conjunct motion > during rotation, and flexion/extension.
- Reduced conjunct motion in pain groups vs. controls, especially for SB during rotation
- No difference in JPE testing.
Age-Related Variance in Max Cervical ROM (53%) & Conjunct Motions (9%)

Possible Reasons:
1. Age-dependent Muscle atrophy
2. Decrease in # motor units
3. Changes in muscle fiber composition
4. Degen. Alterations in flexibility
5. Impaired vestibular function
6. CNS altered motor planning
7. Fear-avoidance behaviors


Proprioception & Kinesthesia

EFFECTS OF NECK & SHOULDER PAIN POSTURAL MALALIGNMENTS MOTOR CONTROL ADAPTATIONS (MCA'S)

• Contributes to posture & body alignment

• Includes:
  1. Joint Position Sense
  2. Kinesthesia
  3. Sense of tension
Motor Control Adaptations (MCAs) with Neck & Shoulder Pain

- Linked to movement repetition, posture & muscle fatigue.
- Local joint & global movement patterns change over time with repetitive-motion-induced fatigue.
- Increased co-activation of Agonist-Antagonist
- Decreased inhibition between Synergist muscles
- Changes in inter-muscular coordination b/w Agonist groups

Motor Control Adaptations (MCAs) with Neck Pain

- Loss of proprioception in neck alone may not explain MCAs
- Altered response in Motor Cortex related to chronic pain may contribute to MCA’s.

Head Repositioning Test

- Test for Proprioception & Kinesthesia of Head & Neck
- Use of head-mounted laser pointer
- Target chart 90 cm away from patient’s head
- Test ability of patient to return to “neutral” target with eyes closed
- Performs max ROM, then asked to return to target
- Cervical Rotation is most sensitive for testing

www.rehabmeasures.org
Motor Control Adaptations (MCAs) & Neck Pain

- **Conjunct motion:** used to assess motor coordination during primary plane movement.
- Cervical rotation requires motor control of facet joints
- **With Chronic NP:**
  - Stiffer, more guarded movement patterns with conjunct motion

Altered Cervical APA with Chronic NP & Whiplash Disorder (WAD)

- 3 groups (n=173): 1) WAD, 2) CNP and 3) controls
- Measure max Neck AROM, conjunct motion in other planes, and Joint Position Sense error (JPE)

**RESULTS:**

- Conjunct motion > during rotation, and flexion/extension.
- Reduced conjunct motion in pain groups vs. controls, especially for SB during rotation
- No difference in JPE testing. 

Forward Head Posture (FHP)

- Defined as the head being anterior to a vertical line through the center of gravity
- **Correlated to:**
  - Headaches
  - TMD
  - Myofascial Pain
  - Scapular Dyskinesia
  - Neck & Shoulder pain
Other Problems induced by FHP:
• Loss of reposition sense
• Dizziness
• Lack of coordination
• Balance problems

Effects of FHP on Proprioception

FHP EFFECTS:
• Increased extension in Upper Cervical Spine
• Shortened SCM & Ant. Scalene
• Lengthening of Post. Extensors (Lev. Scap, Semi spinalis)
• Altered activity in Scapular Stabilizers (Trapezius, Serr. Ant)

PRODUCES PROBLEMS IN PROPRIOCEPTION:
1. Mechanoreceptor dysfunction
2. Altered muscle spindle sensitivity
3. Loss of kinesthetic acuity with neck ROM

FHP Affects Neck Kinematics & SCM activity
• FHP can induce changes in frontal plane motion & SCM activation during neck rotation.
• STUDY: n=28, with & without FHP
• Tested Neck rotation R & L; SCM activity via sEMG
• RESULTS:
  1. Maintaining FHP increased rotation/lat flex ratios in both directions
  2. FHP group had faster onset time for lat. flexion motion in both directions
  3. EMG values for SCM in FHP group for contra-lateral SCM

Clinical Application of Results:

- Consider Quality and Quantity of Cervical ROM
- Primary problem with FHP = shortening & hyperactivity in SCM!
  - Induces Neck Rotation/contralateral sidebending with ipsilateral activation
  - Induces lower cervical flexion with bilateral activation
- Global muscles are overactivated!!
  - Produce large movements vs. precise motion
  - Local, deep stabilizers of neck are inhibited or weak
- Can cause overload, overuse, mechanical dysfunction

Why are SCM & Scalenes a Problem???

- SCM and Ant. Scalene are superficial muscles
  - typically substituted for weak deep neck flexors
- BUT:
  - SCM has an Extensor Moment
  - Ant. Scalene is NOT attached to cranium
  - Can’t flex head on the neck
  - Can’t control FHP

CCFT: Change in Muscle Thickness SCM vs DCF

FHP associated with Loss of Reposition Sense

- **Used Head Repositioning Accuracy (HPA) Test**
  - Head-to-neutral test
  - n=41, age 20-30, with FHP, no neck pain
  - Subjects seated, hips & knees at 90 deg, feet hip-width apart
  - Laser headset used to locate neutral target at eye level
  - Subject closed eyes & instructed to remember target
  - performed full AROM (flexion, extension, SB, Rotation) held for 5 sec, and return to neutral position

Results of HPA Test:

- Found significant change in *Lumbar posture* assoc. with compensatory change in *Cervical position*.
- Neck SB assoc. with pelvic side tilt angle.

Lee, et al. 2015

HPA Results: Why Posture Changed

- **Tonic Neck Reflex** - alters tone of trunk & extremities via Muscle Spindles & Upper Cervical afferents
- **Myofascial Chain Reaction** - (Tom Myers’ Anatomy Trains)
  - **Fascia**: agonist muscle of Neck SB & Pelvis side tilt angle are connected via fascia on Lateral Line
  - **Quad Lumborum**: not directly on Lateral line, but works as Lateral flexor of trunk
  - **Scalenes**: also work as lateral flexor of Neck
Deep muscles of Spine & Thorax

- **Quadratus Lumborum**
  - Lateral flexion and extension of spine

Tom Myer’s Myofascial “Anatomy Trains”

- **Lateral Line** – balances posture in frontal & sagittal planes; helps create lateral flexion, hip ABD, Ankle EV; decelerates trunk lat. flex & rotation
- **Spiral Line** – wraps body into double spiral to maintain balance in all 3 planes; mediates oblique spiral & rotational movements
- **Superficial Front & Back Lines** – provides postural support in standing
- **Deep Front Line** – plays major role in support of arch, LE’s, lumbar spine, abdominal-pelvic region, chest/breathing, head & neck.

Consider Trunk Posture w/ Neck & Shoulder Problems!!

- Over 20 muscles attach to head/neck; 30 muscles to scapula
  - **Lat Parietal** attaches thru T-L fascia, lumbar & sacral vertebrae, pelvis, scapula
  - **Quadratus Lumborum** attaches to lower ribs, lumbar vertebrae, and pelvis
  - **Trapezius** attaches to occiput, cervical & thoracic vertebrae, scapula
    - Innervated by C2-3-4
  - **Serratus Anterior** attaches to upper 8-9 ribs, medial border of scapula
    - Innervated by C5-6-7-8
  - **Levator Scapula** attaches to T.P. C1-4, and medial border of scapula
    - Innervated by C3-4-5

Kendal & Kendall, 3rd Ed., 1983
Muscle Imbalance Continuum

- Muscle Imbalance
- Tissue Damage & Pain
- Altered Movement Pattern

Effect of Arm Position & Sitting Posture

- Pain, fatigue & joint position affect proprioception
- Changes in body posture affect proprioception
- **STUDY**: Measured Cervical-Cephalic Kinesthetic Sensibility (CCKS) Test
  - Test subjects Cervical AROM (Rot, Flex, Ext) in 3 positions:
    1. Slouched sitting w/ arms at side (SS)
    2. Slouched sitting w/ arms supported (SS-AS)
    3. Upright Sitting w/ arms at side (US)

Effects of Sitting Posture & Arm Position:

- **Proprioception of Neck is affected by Trunk & Arm posture**
- FHP causes greater positioning sense error vs. Upright posture
- Supporting weight of UE’s while sitting leads to decreased tension between neck & shoulder girdle
- Improves overall AROM
- Improves CCKS in rotation, flex, extension

Effect of Sitting Posture on Spine Stability

- Recruitment of DCF & Lumbar Multifidi are affected by sitting posture.
- 2 sitting positions tested (n=10; surface EMG):
  1. Self-corrected sitting “up straight”
  2. Therapist-facilitated sitting via verbal & manual cues to correct neutral lumbo-pelvic position
- *Activation of DCF & Multifidi muscles were signif. > with Therapist-facilitated postural correction*

  Falla, et al. 2007

Strategies Used for Sitting Posture

- **Self-Corrected:**
  - Tend to initiate movement with Thoraco-Lumbar Extension
  - Less activation of deep spinal stabilizers (Multifidus, DCF)
- **Therapist-Facilitated:**
  - Increased activation of deep spinal stabilizers
  - *No change in Thoraco-Lumbar extensor activity*

Measuring Motor Control Adaptations

**DELAYED ANTICIPATORY POSTURAL ADJUSTMENTS (APA'S)**
Dynamic stability

- “The ability to be balanced, stable, lengthened, centered & free to move” – Medoff, 2014.
- Allows postural corrections to take place to perturbations.

To TEST:
- Give small perturbation, observe new behavior of stability system.
- If it differs from previous behavior, then system is **UNSTABLE**.

Anticipatory Postural Adjustments (APAs)

- Involuntary adjustments that occur prior to predictable postural perturbations (PPP)
- **Delayed APAs** have been identified in neck & spine patients
- Evidence: \( n=64; \text{18-50 y.o. recurrent LBP vs. controls} \)
  - 8-week training program: Specific Ex Program vs. General Ex
  - Use of rapid arm flexion movements for PPP
  - Measure sEMG: Rect. Abd, Lumb Ext, Tran Abd, Int. Obliq, Ant. Deltoid

Results of Study on APAs

- Pain levels reduced in both groups, but 30% > in Specific Ex Group
- Self-rated disability improved in Specific Ex Group only
- APAs **not** delayed in LBP patients at baseline
- APAs changed in **both** groups after training, show > coordination

Clinical Application:
- Abdominal bracing (“drawing in”) should NOT be mandatory inclusion in Specific Ex Group.
Problem with “routine exercise”

- Routine Exercises create **GLOBAL muscle dominancy** over DEEP Local Stab. System (DSS)
- Alter muscle coordination & increase PAIN!
- Do **not** increase endurance or cross-sectional area of DSS.
- Specific Stab. Ex. can correct movement pattern & then **DECREASE PAIN**. (via Motor Control ex)

McGill, 2009; Javadian et al, 2012; Sahrmann, 2002; Lee, 2010

Evidence for stabilization

- **DYNAMIC** stab. @ varied movement rate vs. Conventional tx. (n=141)
- Both groups **signif. improvement** in QOL (SF-36) & Pain (VAS):
  - Stab group better!
  - SF-36 >50% difference
  - VAS >25% difference

Kumar, 2010

Testing for Postural Asymmetry
Initial Postural Assessment of Patient:

- Assess alignment of COG
- Assess participation of muscles based on line of gravity

**Example: Acquired Thoracic Kyphosis**

- Alignment of thorax is major factor in neck pain
- Dynamic condition; can be changed!
- Requires compensation of head/neck extension to maintain horizontal plane of eyes and mouth

**Dynamic Posture Test – Slant Board**

**NORMAL STANCE**
- Poor postural alignment, FHP & Kyphosis
- Leans back into excessive lordosis, pelvis pushed forward, standing back on heels, COG is posterior.

**STANCE ON SLANT BOARD**
- Core stabilizers engage on slant board.
- Improved alignment of COG, more neutral pelvis, head/neck.

"Extensor Bias"

- Hyper-extension Lumbar
- Hyper-extension Knees
- Plantar flexion Ankles
- Anterior Pelvic Tilt
- COG shifted anterior
**Flexion Bias**
- Flattened lumbar spine
- Increased kyphosis
- Posterior pelvic tilt
- Flexed knees & hips
- Ankles flexed (DF)
- COG moves posterior

**Evidence of Motor Recruitment Changes**

- **Hypertonic T/L extensors**
  - Classic sign of global muscle over-activation & inhibition of deep stabilizer system (DSS)

- **Slumped Posture**
  - Inhibits diaphragm, affecting DSS function

- **Hypertonic Quadratus Lumborum and/or Piriformis**
  - Classic sign of lack of hip extension & "Gluteal Amnesia"

_Liebenson 2002; Janda 2004; McGill 2009; Sahrmann 2010; Brookbush 2013._

**Standing Arm Elevation Test**

**Look for compensation:**
- Forward head
- Increased cervical extension
- Increased lumbar lordosis
- Rib cage elevation
- Inhalation
- Scapula abduction/depression
Scapular Balancing Index

6-part test—degree of Scapular Control:
1. Lateral Scapular Slide Test
2. Neuromuscular Evaluation (PNF)
3. Strength & Endurance (10 reps)
4. Cervical Posture
5. Thoracic Posture
6. Thoracic Segmental Mobility

TOTAL SCORE: Part 1-6
= 0 - 20 points

Brownstein & Bronner, 1997

Scores:
0-10 pts Possible neurologic Involvement
11-12 pts Poor Scapular Control
13-16 pts Fair Scapular Control
17-18 pts Normal Scapular Control
19-20 pts Excellent Scapular Control
**Movements that Stabilize the Scapula**

- **Upward/Downward Rotation**
  - Axis perpendicular to spine of scapula; movement of inferior angle of scapula
  - Controlled by force couple: UT, LT, SA
- **Anterior/Posterior Tiltting**
  - Occurs around axis thru spine of scapula; movement of superior border
  - Controlled by force couple: LT, SA (lower fibers)
- **Internal/External Rotation**
  - Occurs around vertical axis, movement of lateral border of scapula
  - Controlled by MT, LT
- **Superior/Inferior Translation**
  - Occurs at SCJ, clavicular elevation or depression

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**What is Scapular Dyskinesia (SD)?**

- 61% of overhead athletes have evidence of SD vs. 33% non-overhead athletes
- **Movement Dysfunction of Scapula:**
  - Change in Post. Tilt (+/-)
  - Change in Upward Rotation (+/-)
  - Increased Internal Rotation/Medial winging
  - Increased Superior Translation at SCJ


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**3 Tests for Scapular Dyskinesia**

1. Dynamic Scapular Dyskinesia Test (SDT)
2. Scapular Assistance Test (SAT)
3. Scapular Relocation Test (SRT)

Scapular Dyskinesia Test
• Patient actively elevates arms to 90-100 deg flexion or abduction
• Observe dysrhythmia, non-smooth or ratcheting motion, medial winging of scapula, rotation of inferior angle of scapula
• Yes or No result

Scapular Dyskinesia
During weighted flexion & abduction:
A = Normal Scapular motion
B = Scapular Dyskinesia on LEFT side

Scapula Assistance Test (SAT)
• Test for Impingement
• Altered scapular motion in upward rotation and ant/post tilting contributes to impingement
• Therapist uses hands to assist post. Tilt and upward rotation during AROM scaption/Abduction
• If symptoms decrease with assistance, then test is POSITIVE
**Scapular Relocation/Retraction Test (SRT)**

- Test for GHJ instability, dislocation, subluxation
- Used in conjunction with Apprehension Test
- In supine, Therapist repositions scapula by applying post. force to humeral head during max ER
- If Apprehension symptoms improve with SRT, then test is POSITIVE

**Motor Retraining for Postural Asymmetry**

- With decreased proprioception after injury or inactivity:
  - ↓ tonic (SMU) muscle recruitment
  - Hyperactivity in global phasic (FMU) muscles
  - » INSTABILITY!

**Neuromuscular Re-Education**

- Need to retrain SMU to improve stability
- Recognize substitution patterns & retrain early and often
Common Substitution Patterns in Cervical & Scapular Regions

- Hyperactivity in extensor muscles
- Weakness in deep neck flexors
- Increased upper trap tone & scapular elevation/ant. tilt/abduction
- Poor control of scapular depression, retraction, & adduction
- Rib cage elevation
- Kyphosis or flattened Thoracic spine

Progression of spinal stability programs

Motor Control → Static Stabilization → Dynamic Stabilization

Motor control vs. stabilization ex.

- Motor control training (Isolated activation) of DSS necessary to restore altered activation patterns.
- Increased activation of DSS occurs w/ functional & loaded postures.

Bystrøm, 2013; Crommert, 2011.
Pressure biofeedback for motor control DSS

![Graph showing Change in Pain (VAS) with Core Stab vs. Pressure Biofeedback (n=30)]

- Significant diff. in Pain levels after 8-wk training.


EBP for pressure biofeedback (cont.)

![Graph showing Change in Function (ODI) with Core Stab vs. Pressure Biofeedback (n=30)]


Treatment for Postural & Movement Deficiencies in Neck & Scapular Region

MANUAL TECHNIQUES
Core rehab vs core strengthening

- You can’t strengthen something that isn’t working!
- **PAIN**—inhibits optimal motor patterns, prevents re-establishing “healthy” patterns.
- **CORE STRENGTHENING** with altered movement patterns can create injury!
- Reinforces “inappropriate” movement patterns & motor control errors.
- **CORE REHAB** improves motor control & re-establishes correct movement patterns.

Functional Rehab focus:

- Establish proper **postural alignment**
- Establish proper **motion** at all involved segments
- Work **proximal to distal** for sequential muscle activations in UE & LE.
- Utilize **closed chain exercise early**
- Work in **multiple planes**

Proper Progression is the KEY!

- Identify abnormal motion or motor pattern.
- Restore normal joint & tissue mobility.
- Perform corrective exercises to retrain neuromuscular patterns & improve proprioception.
- 1st Rep IS the provocation test!
- Do NOT allow compensation—perform with **PERFECT** form!

McGill, 2010
Rehab Progression: Stage 2

- Retrain normal movement & motor patterns to ensure stability.
- Two levels of Stab:
  1. Joint Stability - Spinal Stability
  2. Whole Body Stability
- Use Co-contractions for > durations (10 sec. or less)
- Maintain perfect form

Soft Tissue Mobilization

- Muscle Energy Release
  - Scalenes
- Tissue Unwinding
  - Suboccipital triangle

Mobility Testing

**TMJ Measurement:**
- Mandibular open
  - (35-40 mm)
- Lateral excursion (~1cm)

**Rib Cage mobility**
- Palpate over First rib with
  - Inhale/Exhale
- Apply downward pressure w/exhale
C-T Junction Mobilization

- With cervical rotation & arm elevation
  - "Arm Pit Sniff" MET

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Thoracic Spine Mobilization (TSM)

- Evidence for immediate improvement of neck pain after TSM
- Evidence for immediate, significant increase in strength of LT after TSM
- Neurophysiological Effects:
  - Inhibition of hypertonic muscles
  - Reduction of pain
  - Improved scapular position & function

Cleland, et al. 2007; Puntametakul, et al. 2015

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Cervical Thoracic Junction

Cleland, et al. (2007):

- 6 criteria for neck patients who may benefit from thoracic spine mobilization:
  1. Duration < 30 days
  2. No symptoms distal to shoulder
  3. Cervical Extension does not increase sx's
  4. FABQPA score <12 (fear-avoidance beliefs)
  5. Diminished T-spine kyphosis (T3-T5)
Biomech. Link in C-T Junction

- If pt had 4 of 6 criteria = 93% prob. Success
- If 5 or 6 of 6 criteria = 100% prob. Success

NDI and Pain levels significantly decreased with single (T6-7) & multi-level mobilization @ 1-week post treatment.

Cleland, et al. 2007; Puntumetakul, et al. 2015

PNF Scapular Pattern

Exercises for Postural & Movement Impairments

NECK REPOSITIONING
DEEP NECK FLEXOR
TMJ COMPLEX
Joint Position Sense Training for C-spine

- Use laser pointer attached to head piece
- Have patient move head to various targets in mid-ROM
- Use cervical rotation especially for conjunct motions.
- Practice with eyes open, and eyes closed to return to neutral target.

Rocabado’s 6 x 6 TMD Complex exercises

1. Tongue “clucking”
   - Tongue on roof of mouth; position for nasal & diaphragmatic breathing
   - Teeth slightly apart, lips closed; prevents excess jaw retrusion & mouth breathing
2. Controlled TMJ Rotation on Opening
   - Tongue “cluck” position; slowly open and close mouth
3. Mandibular Rhythmic Stabilization
   - Apply light resistance w/ opening/closing/lateral excursion with jaw in rest position
4. Upper Cervical Distraction
   - Perform upper cervical flexion (“chin nod”) while stabilizing cervical spine with “hand collar”
   - Relieves neurovascular compression in upper C-spine by distracting A-O joint
5. Axial Extension C-spine
   - Cervical retraction (upper C-spine flexion with simultaneous lower C-spine Extension)
   - Goal to normalize upper quadrant posture & mechanical relationship
6. Shoulder Girdle Retraction
   - Scapular retraction and depression of scap relative to rib cage (“Cobra” position or standing shoulder extension with retraction at wall)
Biofeedback for Neuromuscular Re-education

**Pressure Biofeedback**
- teaches patients how to activate stabilizers with right amount of force

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**Stabilizer for TA Bracing**
- Fold Stabilizer in three sections or BP cuff at bladder.
- Place Stabilizer under neck - inflate to **20 mmHg**.
- Gently nod head, “look down” without lifting head. Increase the pressure in 2mm increments and hold steady.
- Relax and repeat. Increase up to 22-30 mmHg.
- **GOAL**: Hold for 10 seconds, repeat 10 times on highest pressure target that can be held steady without compensation of SCM or Ant. Scalenes.

---

**CCFT - Deep Neck Flexors**
- Fold Stabilizer in three sections or BP cuff at bladder.
- Place Stabilizer under neck - inflate to **20 mmHg**.
- Gently nod head, “look down” without lifting head. Increase the pressure in 2mm increments and hold steady.
- Relax and repeat. Increase up to 22-30 mmHg.
- **GOAL**: Hold for 10 seconds, repeat 10 times on highest pressure target that can be held steady without compensation of SCM or Ant. Scalenes.
Other uses for Stabilizer

- **Scapular stabilization with arm elevation:**
  - Place cuff under spine of scapula
  - Inflate to ~30 mm Hg
  - Maintain with AROM flexion.

- **Scapular stabilization with External Rotation:**

Other Neck Stabilizer Exercises

1. **CCFE—Cranio Cervical Flexion Exercise**
   - Supine-chin "nods" with head, neck and thoracic spine in neutral
   - Teach patient to monitor for SCM and Ant. Scalene excess activation

2. **CCEE—Cranio Cervical Extension Exercise**
   - Prone with forehead on hands stacked
   - Perform chin-nods with retraction
   - Monitor for scapular depression/retraction

3. **Quadruped "Synergy Retraining" of deep neck flexors**
   - Advanced position for CCEE

Hidalgo-Perez, et al. 2015

Cervicogenic Headache Exercise Progression

1. **Start with the CORE!**
   - Diaphragmatic breathing to decrease activity in accessory muscles (SCM, Scalenes)

2. **Cervical Stabilization w/ Chin Nod** (Forehead on mini ball against wall)
   - Resistance band at wrists, elbows flexed, perform bilateral scap retract in ER

3. **Dynamic Cervical Extension Exercise**
   - Seated in hip hinge with (red) resistance band around head, resist 4 directions
   - Hold 5-5 sec

4. **Sensorimotor Training** on unstable surfaces
   - Promotes reflexive stabilization & postural stability for head righting

Page, 2013
Exercises for Postural & Movement Impairments

SCAPULAR REBALANCING
SCAPULAR STRENGTHENING
KINETIC CHAIN MOTOR REPROGRAMMING

Top 3 Exercise for % MVIC for Trapezius & Serr. Anterior

2 Best Exercise for Upward Rotation of Scapula

1. **Prone "Y"**
   - All 3 parts of Trapezius @ 79-101% MVIC
   - SA levels could not be reliably measured

2. **Scaption >120 deg**
   - Trapezius levels 49-79% MVIC
   - SA @ 96%

Ekstrom, et al. 2003
Is Max % MVIC the GOAL for Scapular Stab?

- Low levels of SA & LT @ 20-40% MVIC are associated with kinematics of scapular dyskinesia
- Scap Dyskinesia is a motor control issue, not strength!

If >20-40% MVIC:
- Produce strength, & recruit other, global muscles
- Contribute to adaptive movements & imbalances!
- Scap Stab Exercises should maintain 20-40% MVIC in LT & SA


Scap Stab: Ideal Exercises for 20-40% MVIC in LT & SA

<table>
<thead>
<tr>
<th>Exercise</th>
<th>% MVIC for LT &amp; SA for 5 Key Exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mod Crucifix</td>
<td>7</td>
</tr>
<tr>
<td>Scaption 120</td>
<td>6</td>
</tr>
<tr>
<td>Mod Mil Press</td>
<td>4</td>
</tr>
<tr>
<td>Pullover</td>
<td>13</td>
</tr>
<tr>
<td>Low Row</td>
<td>10.5</td>
</tr>
</tbody>
</table>

Why not the Prone “Y”?

- Prone “Y” recruitment % MVIC >20-40% for motor control:
  - SA = 43%
  - LT = 97%
- Excess activation could lead to co-activation of UT & increased cervical extension
- Best exercises for LT & SA co-activation include combination movements for Flexion/Adduction/ER
Other Ideal Exercises for Lower Trap (LT):

- Mod. Prone Cobra = 44.7% MVIC
- Prone Row = 36.5% MVIC
- Lat Pulldown = 35.2% MVIC

% Muscle Contributions for Shoulder Abduction

Mid Deltoid, 50
Subscapularis, 30
Supraspinatus, 25
Infraspinatus, 10
Ant Deltoid, 2

Mid Deltoid
Subscapularis
Supraspinatus
Infraspinatus
Ant Deltoid

Compare % MVIC for LT & SA w/ Free Motion Exercises

Quad Shld Flex
Lawn Mower
Robbery
Abduction

LT-3
LT-5
SA-3
SA-5

Tsuruike & Ellenbecker, 2015.
**Force Couples During Scap Stab Exercises**

With injury & during early phase rehab, important to:

1. **minimize UT activity**
2. **promote MT, LT, & SA activity**
   - Establish balance among these muscles early to promote better motor activation of lower scapular stabilizers.


---

**% MVIC of Trapezi & Serr. Ant. w/ GHJ Injury**

<table>
<thead>
<tr>
<th>Exercise</th>
<th>UT</th>
<th>MT</th>
<th>LT</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>ER Scap Squeeze</td>
<td>27.2</td>
<td>39.3</td>
<td>39.3</td>
<td></td>
</tr>
<tr>
<td>Lawnmower</td>
<td>17.3</td>
<td>20.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Robbery</td>
<td>21.9</td>
<td>16.6</td>
<td>24.3</td>
<td></td>
</tr>
<tr>
<td>Bow Arrow</td>
<td>73</td>
<td>23.4</td>
<td>23.4</td>
<td>19</td>
</tr>
</tbody>
</table>

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**Bottom Line: Does Scapular Stabilization work?**

- Teaching conscious correction of scapular orientation during rehab to balance force couples:
  - UT/LT
  - UT/MT

4. **Exercises for training Trapezi:**
   1. Prone extension
   2. Prone Hor. Ext/ER
   3. Sidelying ER
   4. SL Forward Flexion

**% Change in % MVIC of Trapezi after Conscious Correction of Scapular Position**

<table>
<thead>
<tr>
<th>Prone Ext</th>
<th>SL ER</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.9</td>
<td>6.7</td>
</tr>
<tr>
<td>13.8</td>
<td>13.3</td>
</tr>
</tbody>
</table>

**Other BEST Exercises for Scapular Rehab**

- **Scap Squeezes in “Row” position** (MT, LT, Rhomboids)
- **Low Row** – Shoulder extension bilateral w/ scap squeeze (LT)
- **Dynamic Hug** – bilateral standing chest press w/ arms forward as if hugging a tree (SA & LT)
- **Scap Punches** – band @ shoulder ht., punch w/ full protraction (SA)
- **Cheerleader Exercise** – perform alternate diagonal patterns w/ both arms pulling outward w/ one horiz. ABD motion b/w each diagonal (LT & Rhomboids)

*Paine & Voight, 2013*

**Summary for Neck & Scap Rehabilitation**

- Start with the Core–DCF, Diaphragmatic breathing
- Minimize SCM and Scalene accessory activity

**Focus on Main Scapular Stabilizers:**

- Serratus Ant– scapula abduction/protraction
- Rhomboids– scapula adduction/retraction; stabilize medial border
- Lev Scapula– elevate/rotate scapula downward
- Upper Trap– Upward rotation/elevation of scapula
- Mid Trap– Retraction of scapula
- Lower Trap– Upward rotation/depression of scapula
Summary for Neck & Scap Rehabilitation

- Focus on GHJ "Protectors" – Rotator cuff muscles
- Rebalance tissues, maintain alignment & mobility of structures

Summary & Conclusions

- QUESTIONS & ANSWERS

Thank YOU

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