Dynamic Stability of the Cervical Spine
Anatomical Considerations

Bony configuration (biomechanics)
Muscles (neuromuscular)
Accompanying structures (kinetic chain)
Cervical Vertebrae

C1

C2

Articular facet for dens of axis
Posterior tubercle
Posterior arch
Transverse process
Inferior articular facet
Anterior tubercle
Vertebral canal
Transverse foramen
Costal process

Centrum (body)
Lamina
Vertebral canal
Pedicle
Dens (odontoid process)
Superior articular facet
Posterior articular facet
Spinous process
Transverse process and foramen
Spinal Vertebrae

Cervical Spine

Thoracic Spine

Lumbar Spine
Neurological Considerations

- Extensive Wiring
- Extensive Mechanoreceptor and proprioceptive networking
- Multiple sources for PAIN
Neurological Connections
Musculature
Anterior Cervical Spine

Deep Cervical Flexors = Vertebral Flexors (local) vs. Cervical Spine Flexors (global)
Anterior Cervical Spine

Deep Cervical Flexor Muscles
Longus Colli & Capitis (intervertebral)

Superficial Flexor Muscles
Posterior Spine

U. Trapezius & Levator Scauplae “tether”
Kinetic Chain Implications

Interfacing with:
- Rib Cage
- Scapula
- GHJ Function

Anterior Loading Of C-Spine with Shoulder Girdle
Shoulder Girdle Dyskinesia

- Scapulo-humeral Rhythm
- Rib Cage
- GHJ Function

Link to:
- Upper Extremities
- The Lumbar Spine
Force Closure

- Spinal Stability
- Core Stability
- Lower Extremity Influences


Janda’s Pelvic Crossed Syndrome
Spinal Stability


Spine Stabilization

- Neural Sub-System
  - Controls active & passive sub-systems
    - Feedback mechanisms
    - “Force transducers” in ligaments, muscles, tendons & neural control centers
  - Compensates to maintain stability …..of the system
    - May compromise locally for global stability
    - Resultant tissue and joint degeneration, abnormal muscle loads, fatigue, etc.
Spine Stabilization - cont

- Passive Sub-System
  - Vertebrae
  - Facet articulations
  - Intervertebral discs
  - Spinal ligaments
  - Joint capsules
  - Passive mechanical properties of the muscles

- Active Sub-System
  - Muscles & tendons
  - Surrounding spinal column
Neutral Spine

“the posture of the spine in which the
- overall internal stresses in the spinal column and
- the muscular effort to hold the posture are
- minimal”

What does that look like clinically??
Functional Zones

- Neutral Zone
  - Minimal internal resistance
- Elastic Zone
  - End of the neutral zone up to the physiological limit
- Note: repeated physiological loading
  - Residual displacement of tissue
Clinical Implications

- Displacement beyond the neutral zone due to compensation would result in damage, degeneration, abnormal muscle loads and muscle fatigue.
- Spinal ROM that is typically measured clinically, encompasses the available displacement from both the neural & elastic zones.
- The current clinical model is insensitive to ongoing physiological adaptation & damage and that when changes in spinal ROM are seen clinically, irreparable damage may already be done, precluding prevention intervention strategies.
Putting It All Together: The Game Plan

- **Local Intervention: Cervical Spine**
  - Deep cervical flexor activation
  - Suboccipital mobility

- **Global Intervention**
  - Posture
  - Thoracic Spine
  - Shoulder Girdle
    - Scapula stabilization
  - Core Stability
    - Local
    - Global
    - Form & Force closure

- **Secondary considerations of the Lower Extremity**
  - Pelvic Inclination
  - Foot Mechanics
Muscle Impairment

- Diminished Deep Cervical Flexor Activity
- Delayed onset of neck muscle contraction with associated movement of the upper limb
- Increased superficial cervical flexor muscles during functional activities
- Increased fatigability of cervical flexors in neck pain patients

Falla, D., Manual Therapy, 9:125-133, 2004
Feedforward Activation with Upper Extremity Movement

- SCM & Cervical Extensor
  - Co-contraction
  - Within 50 ms of Deltoid Onset
  - Automatic feedforward response delayed in chronic neck pain subjects

- Transversus Abdominis
  - Feedforward activation with all GHJ motions


Falla, et al
J. Of Electromyography & Kinesiology
14: 463-474, 2004

Cervical Spine Intervention

- Joint Mobilization as Needed
- Deep Flexor Activation
  - Longus Colli
  - Longus Capitis

Clinical Application and Intervention
Deep Cervical Flexors

Upright Head Nod
Deep Cervical Flexors

Palpate for SCM to AVOID recruitment
Deep Cervical Flexors: supine to start

Head Weighs ~ 10 lbs.

Initiate Deep Cervical Flexor Work in Supine
✓ Motor Learning: New Task
✓ Motor Control: Automaticity
Deep Cervical Flexors

Support as Needed

Palpate for SCM
Functional Cervical Flexion

C - Spine
Limited mobility

Thoracic Spine
Limited mobility
Sub-Occipital Mobility

2 - tennis balls in a sock    2 - potatoes in a sock
Postural Intervention and Education

- Belly button to spine
- Squeeze cheeks together
- Equal weight both feet
- Feet straight ahead
Postural Intervention and Education
Thoracic Spine: Joint Mobilization
Thoracic Spine: Functional Mobilization

Kneeling Thoracic Rotation

Lumbar flexion
Thoracic rotation
Shoulder Girdle Intervention

- GHJ Mobility
  - Wall
  - Foam rollers

- Scapula Stability
  - Wall
  - Prone
    - GHJ Extension
  - Quadruped
    - T
    - I
    - Y
  - Modified Quadruped
    - Planking
    - Scapula Retraction
Glenohumeral Joint Mobility: Foam Roller

GHJ Flexion and Extension

GHJ: Abduction/Adduction

Lengthening of anterior thorax musculature
Pectoralis major and minor stretch
Glenohumeral Joint Mobility: Wall Exercises

Watch for Compensations
Glenohumeral Joint Mobility: Wall Exercises

Incorporate Vision

Watch for Compensations
Scapula Stability: Prone GHJ Extension

- Stiff Thoracic Spine
- Belly Button to Spine

Watch for C-Spine Compensation
Scapula Stability: Prone
Scapula Stability: Quadruped
Scapula Stability: Quadruped D2 PNF Pattern
Modified Quadruped

- Co-contraction
  - triceps
  - biceps
- Scapula Stabilizers
- Spine Stabilizers

Planking
Modified Quadruped

Push Up Plus

Serratus Anterior
Scapula Stability: Wall Exercises

Combines GHJ ROM/S-H Rhythm

Add Resistance/Long Lever Arm
Accompanying Structures

- The Core
  - Core Stability

- The Pelvis
  - Pelvic Inclination
  - Pelvo-femoral considerations
Core Stability

- Local
  - Transverse mm fiber orientation
    - Tr Ab*
    - Multifidus
    - Lower IO
    - Piriformis
  - Pelvic floor mms

- Global
  - Vertical mm fiber orientation
    - EO
    - Erector Spinae
    - RA

Other Considerations:
- Diaphragm
- Form and Force Closure

* Feedforward activation with all GHJ motions
Core Stability

- Foam Roller: Postural Alignment
  Transverse Abdominis
  External Oblique

- Pelvic Floor Muscles: Kegel Exercises

- Diaphragmatic Breathing
Force Closure: Bird Dog
Force Closure: BW Walking
Pelvic Inclination: Neutral Pelvis

- Activation of lumbar multifidus
  - Small and gentle lumbar curve
- Activation of erector spinae
  - Long and accentuated lumbar curve
  - Resultant thoracic and cervical adaptations

Foot
Summary

- Local Intervention: Cervical Spine
  - Deep cervical flexor activation
  - O-A mobility
- Global Intervention
  - Posture
  - Thoracic Spine
  - Shoulder Girdle
    - Scapula stabilization
  - Core Stability
    - Local
    - Global
    - Form & Force closure
- Secondary considerations of the Lower Extremity
  - Pelvic Inclination
  - Foot Mechanics
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