

## Hinge Theory: Case Study Analysis

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## About Hinge Theory

- Normal spine motion is an equally force dispersed curve
- Arch happens from hand to foot
  - Hips, spine, and shoulders need to share the stress
- Position will happen anyway and force will find the easiest path of least resistance
  - In an athlete that demands an arch position usually focuses between L3 and S1
- In gymnastics, spine flexibility is forced and hip and shoulder are often overlooked

## Etiology of Gymnastics Biomechanics

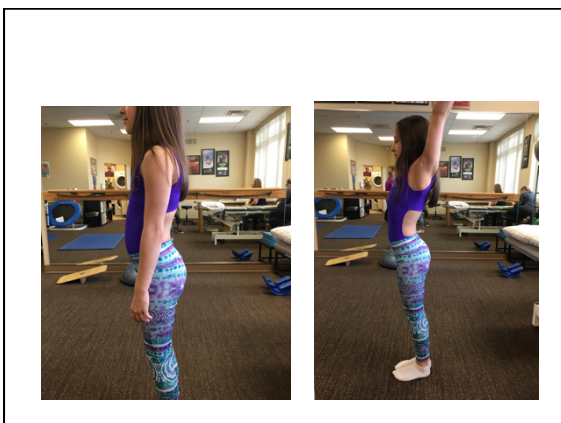
- Balance between strength and flexibility
  - ex. hip flexors have to be very strong yet demanded flexibility with the acro and dance elements
  - ex. shoulders: often the athlete will get stronger without balancing that strength with ROM
  - naturally, the lumbar spine lordosis but an arch position requires a reversal of thoracic kyphosis and pelvic and SI involvement

## Outline

- 1. Standing anatomy
- 2. Active Extension Testing
- 3. Resting Supine Hip
- 4. Resting Supine Shoulder
- 5. Prone Shoulder Active ROM/Strength Fight
- 6. Thomas Relative Ilium Flexibility
- 7. Sport Specific
- 8. Injury Prediction
- 9. Skill Limitation
- 10. Phase IA: Stretches
- 11. Phase IB: Strength (TBC)

## 1. Standing Anatomy

- Hip flexors tight, leads to:
  - Lordotic curve increase
  - Anteriorly tipped pelvis
  - Excessive thoracic kyphosis due to compensatory pattern in spine with L/K alternating “balance” to vertical and center of gravity alignment
- Effects:
  - Vertical positioning in standing and handstand



## 1b. Handstand



- Upside down standing
- If it's bad in standing, it will be just as bad in handstand
  - Requires strength to counter the passive range issues
  - Abdominal strength and understanding of neutral positioning is key in verticality

## 2. Active Extension Testing

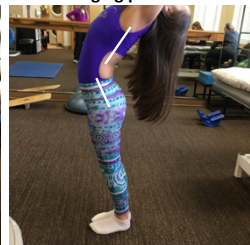
- Standing posture:
  - Tight hip flexors
  - Increased lumbar lordosis
- Active extension:
  - Hip extension
  - Flat thoracic spine
  - Hinge point where movement is coming from
  - Flat lumbar spine

## Active extension

160 degrees resting hip flexion - tightness leads to anterior pelvic tilt



Visual hinging present



## Anatomical Domino Effect

1. How you stand predicts what your handstand will look like
2. How you stand predicts the increased amount of GRF that will be lost to a lack of being "stacked"
3. Lordosis leads to hip flexion, leads to hyperextended or tonic paraspinals, leads to increased sacral flexion, leads to decreased gluteal activation.....and on...

## Why Tightness?

- Psoas attachments:
  - T10-Lumbar
  - Anterior shifting "moment" to the lumbar spine, leading to relative lordosis
  - Special concern for spondy category: conundrum
    - Need to lengthen the psoas but you can't stretch it
- Extensor series adaptive shortening
  - QL: unilateral side flexor but bilateral spine extensor
  - ILS: unilateral extension
  - Multifidi: powerful intersegmental secondary extensor when contracted bilaterally

## Primary Spinal Positioning Reversal

- Important for relative intersegmental motion
- Positions in sports, and in flexibility, demand reversal of these adaptively shortened positions
- Lordosis needs to at least be able to be neutralized
- Kyphotic T spine as well needs to be neutralized
- Extension thoracic (total - nonsegmental) between 30-45 (research meta-analysis)
- Nutation/Counternutation concept: as Lordosis increases, sacral kyphosis increases

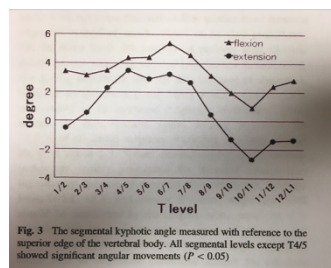


Fig. 3 The segmental kyphotic angle measured with reference to the superior edge of the vertebral body. All segmental levels except T4/5 showed significant angular movements ( $P < 0.05$ )

Range of motion of thoracic spine in sagittal plane

Eur Spine J (2014) 23:673-678

## 3. Resting Supine Hip

- Unable to maintain flat spine in supine with shoulder flexion
  - Anterior pelvic tilt
  - Hip flexion present
- Goniometric measure:
  - Femoral shaft to pelvic tilt
- Differences in standing vs supine positioning
  - If postural muscles are removed, anticipated lordotic measures should decrease



## 4. Supine Shoulder PROM

- Shoulder flexion angle
  - Goniometric measure:
    - Humerus to rib tilt angle
- Unable to maintain flat spine in supine
  - Lack of passive shoulder flexion range
  - Forced lordosis due to hip flexion
  - Integrity of the joint

## Measure- Supine 163 degrees



### Etiology of Lack of Sh Flex

1. Lack of passive shoulder flexion range (like overhead extension)
  1. Subscapularis, latissimus dorsi, teres major and minor, pec major, posterior fibers of deltoid
2. Forced lordosis due to hip flexion
  1. Lumbar lordosis effects position of rib "tilt" due to shared musculature, including vertical length of PSP
3. Integrity of the joint
  1. Capsule
  2. Labrum
  3. Joint mobility of the humeral head
  4. Focus: ability for inferior glide

### 4A. Angle Similarity

- Even with patient in perfect neutral spine, "angle" of hum/rib stays same
  - Measurement rocking
- Shoulder flexion ROM keep spine flat on the table
  - At times may even decrease due to activation of intercostals, leading to increased relative anterior hip tilting due to approximation of ribs
- Precursor to handstand issues, lack of verticality (Jenga stacked, whether standing or inverted)

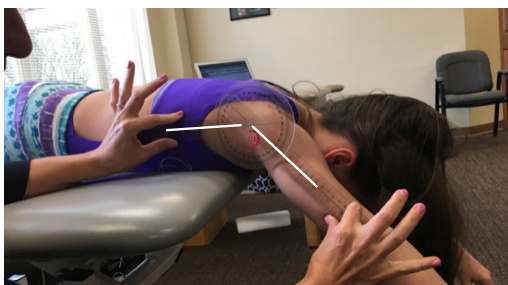
### Measure in Pelvic Neutral



### 5. Prone AROM testing

- Shoulder flexion ROM keeping chest flat
- Also testing shoulder strength
- ROM is less in prone than in supine
  - Strength component as well is added
- Compensations seen:
  - Hyperextension of lumbar
  - \*\*Follow the goniometer landmarks, measure will literally "see-saw" and be same

### Prone chest flat- 136 Degrees

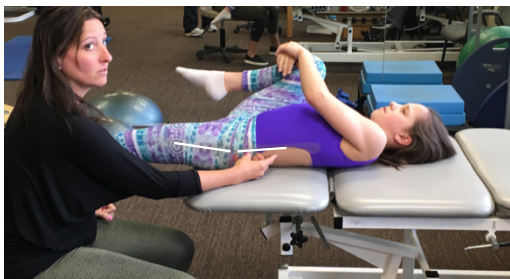


### Lack of Hip Extension

- Hip flexor tightness
- Joint capsule limitation
- SI joint dysfunction
- Tailbone dysfunction
- Labral tear issues
- Easiest general assessment tool is Thomas stretch because it's functional



Thomas



### Assessment of Functional Bridge/ Arch

- Things we are looking for:
  - Open hip angle: goal of 20-30 degrees
  - Shoulder angle: at least 20 degrees from thoracic spine and 20-30 degrees from glenohumeral
  - Smooth curve of the spine: 45-60 degrees

Feet as close to hands:  
92 degrees total at 3 Lumbar Levels!!!!



### What's wrong with this picture?

- Open hip angle
- Hinge point in spine still present
- No shoulder angle

Holding feet from sliding- same, 92d



### 7. Sport-Specific

- Gymnastics requires:
  - 30 Degrees of true hip extension (arabesque position, back leg leap, etc attained with combination of lordosis, hip tilt and true hip flexor and capsular flexibility)
  - Up to 210 degrees of shoulder flexion
    - Attained by reversal of thoracic kyphosis, true shoulder extensor muscle flexibility into flexion, GH joint integrity and available ROM without compromising stability requirements of the same sport)
  - Spine Extension
    - Actually want only 2-6 degrees per segment of lumbar spine for arch (T10-L1, L1-2, L2-3, L3-4, L4-5, L5-S1 minimal)

## 8. Injury Prediction

- Spinal fractures/spondy
  - Excessive stress on lumbar spine
- Vertebral end plate fracture
  - Excessive kyphosis
- Shoulder impingement
  - Loaded overhead activities and weight bearing with lack of flexibility
- Hip labral tear
  - Poor mechanics leading to increased force to achieve ROM necessary to complete skills
- Elbow issues
  - Loading with poor biomechanics
- Wrist and TFCC
  - Loading with poor biomechanics

## 9. Skill Limitations

- General
  - Limited forced arching
  - Pain with skills requiring hyperextension
  - Difficulty achieving hip extension with backward kicks and leaps
  - Handstand position will not be straight vertical
  - Pounding and rebounding skills
  - Overhead positioning will be altered due to lack of axillary flexibility

## 9. Skill Limitations

- Vault
  - Difficulty with vault entry due to lack of hands getting to vault table and lack of arch
  - Yurchenko
  - Handspring front vaults because of optimal block positioning

## 9. Skill Limitations

- Bars
  - Achieving vertical handstand
    - Blind changes
    - Pirouettes
    - Bail landings
  - Giants (verticality)
  - Interbar work
    - Pak salto (open arch position)
    - Shaposhnikova
  - Front giants (difficult to learn because lack of shoulder opening)
  - Release moves
    - Tkatchev (replacement option of Hindorff or Ray)
    - Jaeger (replacement gienger)

## 9. Skill Limitations

- Beam
  - Back/front walkover, backhandspring (requires open shoulder position and arch/curve)
  - Front aerial (requires hip extension to place landing foot underneath gymnast)
  - Achieving 180 degrees in jumps or leap (lack of hip extension)
  - Achieving vertical handstand
    - Press handstand

## 9. Skill Limitations

- Floor Exercise
  - Front tumbling (open positioning required for upward trajectory)
  - Double layout (will be hollow instead of arched)
  - Ability to achieve 180 degree leap or jumps with proper form
    - Sheep jumps or ring positioning requires greater flexibility of 2-joint hip flexor

## 10. Phase IA: Stretches

- Start lengthening muscles
  - This must be done in parallel with assessing and treating joint and capsule integrity
- After you gain motion, you must then strengthen the joint in its new end range to prevent strains and injury
- Goal is to counter whatever is preventing opening of the joint



### Teaching neutral pelvic position for all exercises

Based on the Sahrman biofeedback program, the goal is to teach pelvic neutral especially to people living in excessive lordosis. Not only is this for abdominal muscle training but proprioceptive training for ribs and pelvis as well. If the hip flexors work harder than the abs, the spine lordoses. If the abs work harder than the spine, neutral is maintained

## Prone Shoulder Flexion



- Laying on stomach with chest and head relaxed, place arms on a higher surface (box, Stall Bars, panel mat, etc.)
- Arms should be straight and not hyperextended as this will place too much stress on elbows
- Relax the lower spine

## Active Shoulder Lifting

- Keeping chest flat on table to prevent hyperextension of back, lift arms above head
- Focus on scap squeezing
- Keep abs tight to counter arching



## Roller



- Start with roller in mid back
- Keep hips in contact with ground
- Arch over the top with hands behind neck to support head
- Repeat in multiple locations (up and down) of the upper back

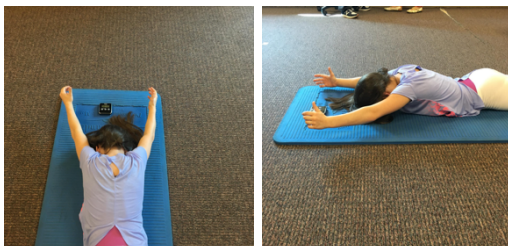
## Arch Overs with Swiss Ball



- Arch over the ball with straight elbows, arms by ears, and straighten legs
- Touch hands to the floor

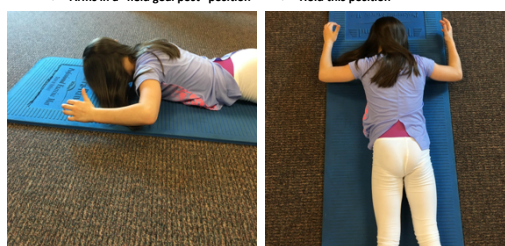
### Straight Arm Superman

- Lay on stomach
- Arms above head in "Y" position with thumbs turned up toward ceiling
- Lift arms off floor without shrugging shoulders
- Keep chest flat. Do not arch back
- Hold this position

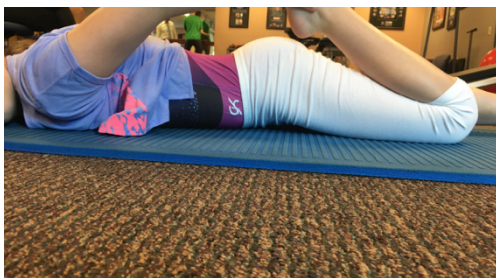


### Bent Arm Superman

- Lay on stomach
- Elbows bent to 90 degrees and shoulders abducted to 90
  - Arms in a "field goal post" position
- Lift arms off floor without shrugging shoulders
- Keep chest flat. Do not arch back
- Hold this position



### Prone Quad Stretch



- Lay on stomach and pull foot up towards buttock
- Keep hip turned under (posterior pelvic rotation) in order to decrease lumbar lordosis and keep hip flat on table
- Hold this position

### Thomas Stretch



### Thomas Stretch

- Goal is to protect the spine by rotating one half of your "hips" (ilium) posterior to focus the stretch on the down leg
- Lay on the end of the table with bottom at the very edge
  - Table must be high enough to drop leg
- Pull one leg up to your chest when you lay down to protect your back
  - Grab tightly! This blocks the one side of your hip, or ilium, so that the other side (Left in picture) is stretching independently
- Partner pushes bent leg (right in picture) up and lower knee (left) down
- To add the stretch to the two-joint hip flexors (that also extend the knee), try to flex the knee gently with the partner's leg

### Bent Knee Hip Roll Under

Side view



Front view





### Bent Knee Hip Roll Under

- Kneel as shown in picture
- Body should be in line with femur
- Do not "arch" and lean forward
  - Hip flexors shorten with increased lumbar lordosis or arch
    - Defeats the purpose of stretching the hip flexors
- Tilt your pelvis under
  - Bring pubic bone up toward breast bone
    - Undoing lumbar lordosis/arch
- Keep chest upright
  - Do not drop rib cage or breast bone when tilting pelvis
- Hold - do not bounce or lean

### Unsquare split position Demo



### Square split realization!

**Square Measure:** R=80, L=85  
Use mats or something to prop you up



**Unsquare Measure:** R=140, L=145



### Partner Stick Up Stretch



- Sit up straight with legs straight out
- Partner stands behind you, places their knee to block your upper spine (not to arch your lower back)
- Place hands clasped behind head with elbows out
- Partner holds arms and pulls back
- Goal is to fulcrum at the armpit
- Try to keep abs tight to avoid arching

### Overhead Hold



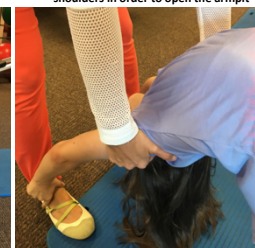
- Sit up straight with legs straight out
- Hold bar overhead with hands shoulder width apart
  - Keeping abs tight to avoid arch position
- Hold this position

### Partner Bridge

- Place hands on partner's ankles
- Push up to bridge with straight elbows



- Partner - pull back toward you to counterbalance with hands on their shoulders in order to open the armpit



- Walk feet away from hands so there is enough counterbalance - want no low back pain

### Additional Treatment - Further Steps

- McKenzie technique for intersegmental spine motion
- ART for spine, axilla, hip flexors
- Joint mobilization for spine, GH, fem-acet, SI joint
- Possible Graston for fascial release
- TPDN for tone, guarding, muscle memory
- Neurodynamic stretching to reset MT junction feedback and myotatic stretch reflex
- MFR
- Possible chiropractic adjustments

### Summary

- Back pain can potentially be predicted based on developmental biomechanical assessment
- If pain is already occurring, a full body sport specific evaluation treating the cause and not just the pain is necessary
- taking the time to allow flexibility, nervous system change, and strengthening is necessary
- phase 1 being between 6-8 weeks

### Beyond Phase 1

- Phase 2: dynamic motion and strength and body positioning
- Phase 3: sport specific return to body shaping, basics, and additional strength
- Phase 4: progressive skill return with monitored range, reps, and intensity
- Phase 5: ramp up to full sports return

### Return to Sport

- Cautious progression with constant video analysis
- Skills limitations: some forever and some temporary such as (on the watch list)

- Jaeger  
 - Tkatchev  
 - Pre-flight for Yurchenko  
 - Backhandspring  
 - Onodi  
 - Front walkover  
 - Repetitive (on unnecessary or unreplaceable back handsprings)  
 - Uneven bar skills with high tagging  
 - Uneven bar skills with arch in air (release)  
 - Front giants