Hinge Theory!

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Description

- Low back pain, and its relationship to shoulder and hip flexibility with regards to the Performing Arts Athlete (Gymnastics, Dance, Figure Skating, Cheer). All activities that are a mix of sport and art, requiring a delicate balance of strength and flexibility of both joints and soft tissue. This is all necessary for skill performance, as well as attaining various arm, leg and spine positions for the execution of end ranges of motion. The lack of available range of motion for the Gleno-humeral joint, scapula, ribs, thoracic spine articulations and hip capsule/flexor complex lead directly to focused intersegmental stress to the lower lumbar spine. Injuries that will be discussed include facet sprain, spondy-category injuries, fascial restrictions and more. Key examination observations and physical diagnosis techniques are demonstrated.

So… what is it?

- Knowledge of the etiology of injury combined with treatment (what works and what doesn't) including
  - passive stabilization
  - manual therapy
  - Strength
  - biomechanics
- Perfecting the mix between mobility and stability
- The delicate focus in a sports environment with constrained time, to focus on needed balance of flexibility of lower flex areas
- The awareness and understanding of mechanics of the sport combined with arthokinematics of joints in the body to teach layman coach/instructor and medical professional analysis
- Understanding the arthrokinematics of the spine, shoulders and hips as well as sacrum in combination to create the total motion of the "Arch"
- Decreasing pin point pain, lowering predisposition to spine injuries in arching or hyperlordotic demanding activities/sports

How does it relate to Skating?

- Spine flexibility is demanded for the skater from
  - Choreography
  - Performance
  - Technical jump takeoff positions
  - Spin positions
- The spine endures a large amount of intersegmental stress with jump take off and landing positions (compression)
  - Jenga theory of alignment
- Stress of spine in lordosis

Three-Joint Flexibility

- Sermeev (1966): There was a trend that within the ages of 12-15, shoulder, knee and hip flexibility decreased over this period of time
  - Puberty
  - Estrogen, testosterone
  - Muscle development
  - Height/growth
  - Skill development

State of Mind

- 3 parts to an arch (in gross motion terms)
  - 1) Shoulder opening (anatomical flexion)
  - 2) Back bending, or lordosing
  - 3) hip opening (or anatomical hip extension)
- Break it down further to nutation, scapula, and more
- Most sports coaches or instructors stretch the arch positioning by increasing the low back flexibility
  - You are stretching 50% muscles and 50% trying to change the kinematics of the spine
  - Shoulders and hips- muscular flexibility – MUCH more of a chance to actually make a change without pain!

Notable Facts!

- Xxx
- Xxx
- xxx

History

- Started in classroom at Marquette in school with 1999 Kinesiology course with Don Neumann (Author of infamous Kines Textbook
- Theory began in clinic, between both locations, treating over 250 spondy-category injuries or facet dysfunction
- Began to realize that fractures are often not caused from hypermobility (hyperflexible children, excessive available range of motion, which the public is often worried about)
- Literature review was done
- To the contrary- simultaneous symptoms were often noted of lack of shoulder flexion and hip extension, when grossly measured in clinic

Research in Review

- In the 1980-90's, research showed that injuries in skating were 50% acute (trauma, falls, cuts, breaks) and 50% chronic (overuse musculo-tendinous and spine pain mostly)
  - Brock et. Al, 1986; Fortin and Roberts 1987; Garrick 1982; Hukko 1987, Lipetz and Kruse 2000 to name a few in review
- If 50% then, assumed, are preventable by a combination of periodization, control in numbers (analysis) and injury prevention techniques – why do we not spent more time on that?

Points of Concern

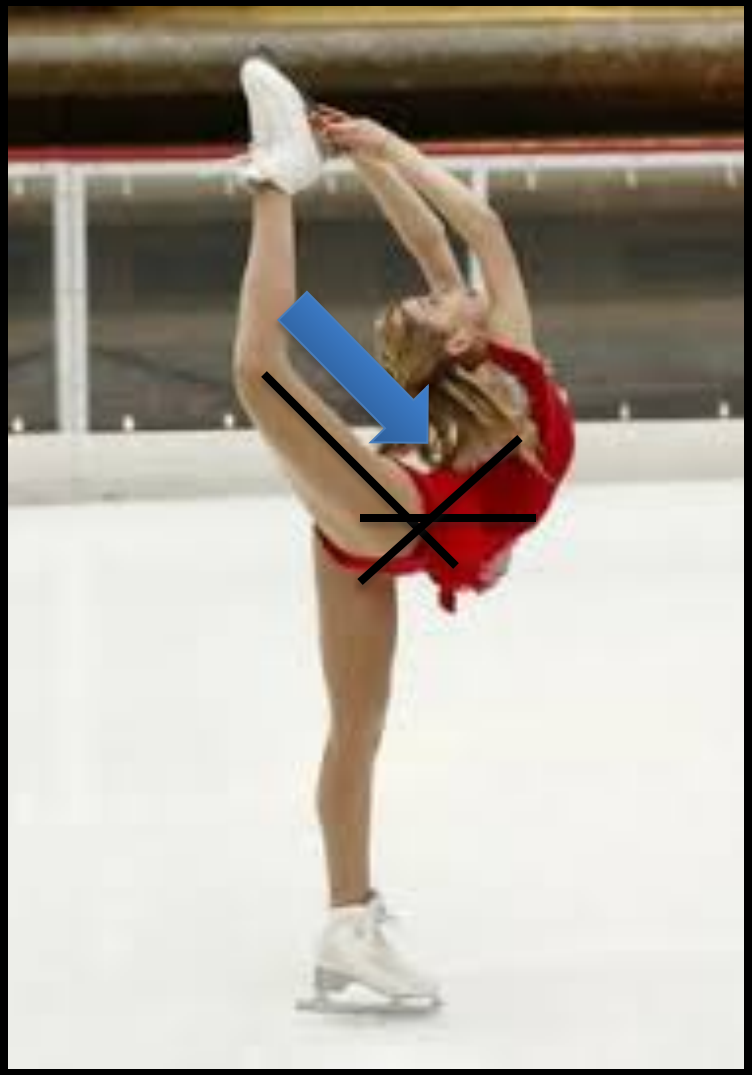
- Choreography
- Spins
  - Biellmann
  - Layback
- Jumps
  - Prep for takeoff with leg too high
  - Especially in pairs

Jumps

- Reachback for flip or lutz
  - Leg should be relatively horizontal, or “levered” with torso
  - Incorrect technique leads to arching back to lift leg high to “perceivably” get more torque for pick
  - Too high of a “kick” is repeat stress into extension on facets and other aspects of spine
  - IF combine this with tight hip flexors (psoas, iliacus, rectus femoris), increase torque even more

Relevance

- Think of a slinky- where each piece takes a "piece" of the pie, and the result is a curve, or circumferential "piece" of a circle
- If one piece is stuck, or is not working, the others have to chip in
- Look- what is the torso to pelvis angle – a sharp 110deg+??



Watch the angles form quickly with thoracic spine, lumbar spine, pelvis, and femur into extension

Are the forces evenly distributed? Shoulders?

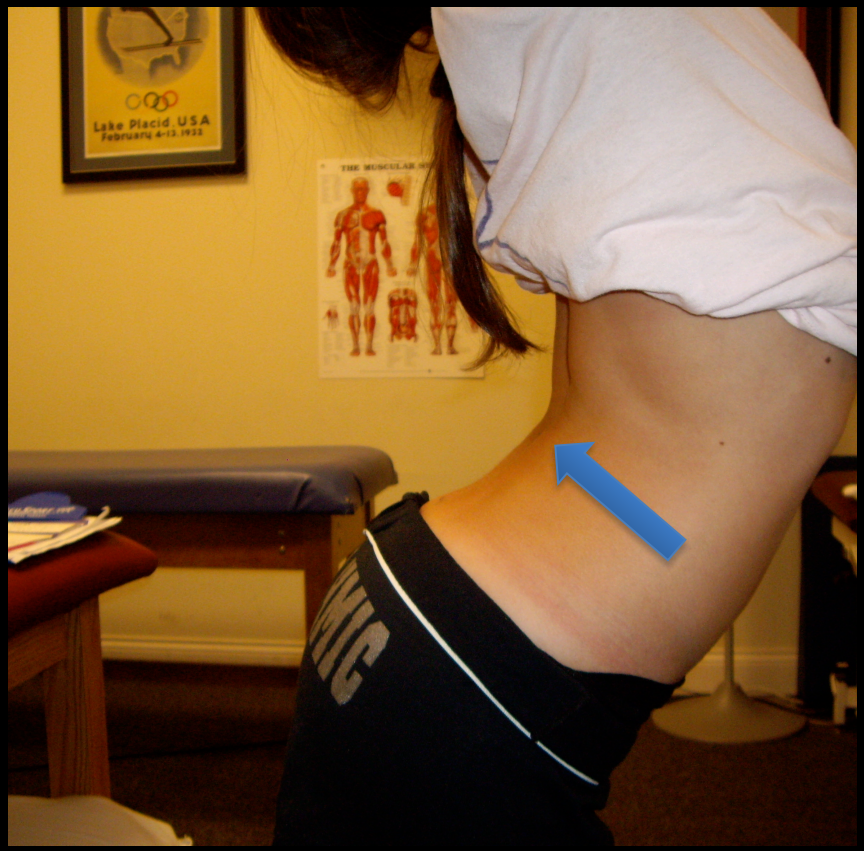
Pictures of hinging, external

Natural resting arch/lordosis

Flat above, flat below

Arch to flat?

Excessive hinge, can you find it? (Remember…T spine = min Ext



Lack of Ability to reverse curvature from anatomical predisposition to lumbar lordosis to kyphosis (flexion)

Hinge Theory

- Shoulder flexibility
- Hip flexibility
- Assessment
- Significance to other sports??

Biomechanics Comparison

- Splits
  - Requires hamstring flexibility of the front leg
  - Requires hip flexor flexibility of the back leg
- Biellman
  - Requires hamstring flexibility of the standing leg in spin
  - Requires hip flexor available ROM of the back leg OR the spine takes more force!

Comparison: Pics

Split position

Biellmann

Case Study (gymnastics)

- Performed with Level 10 Gymnast
- Negative to true fracture on MRI, CT
- Focused pain at L4 spinous process and L3,4 TP, bilaterally
- Measured shoulder and hip flexibility, treated with tissue release of shoulders, scap, and hip flexors
- Treated with joint mobilizations to the T spine, PA's, focusing on TL junction
- Measure of angles progressively throughout treatment = improvement in self reported pain symptoms, frequency of pain effecting gymnastics with regards to arching positions, and increased tolerance of resuming hours of workout

JOINT BREAK DOWN

1) Shoulder

2) Hip

3) Spine

A View on Stretching

- Stretching is actually the elongation process that occurs to make the length of the soft tissue increase. (Alter 1996).
- (Sermeev 1966)

Limitations on shoulder- thoughts

- Roll and glide not kinematically efficient or blocked
  - Impingement
  - Lack of full flexion
  - Lack of full abduction
  - Combination of F and ABD limitations?
- Strength imbalance in upper/lower trap and more

The Hip

- Femuro-acetabular joint (ball and socket, acetabulum cave on femur vex)
- Range of motion of concern:
  - Extension of femur should be 0-45
  - Extension to “90” in split position is combination
- Ilium
  - Bilateral activation (posterior and anterior pelvic tilting)
  - Unilateral activation (standing kick, intentional agonist, opposite stabilizes with oppositional force isometric)
  - Opposite simultaneous activation (split position)

Example - HIPS

- Hips:
  - The more flexibility in the capsule and anterior musculature, the more the hip can work without the lower back arching, or jamming, and without the hips turning out, or externally rotating

Example- Hips/Split

Should be unable to see right (far) ASIS from opposite side lateral view

Example- Hips – leap-base

- Look at turn out of back leg and “hinge” in back, assumed stress point on right facet L3-5

Hip- Causes for Issues

- Labral issues- internal
- Spurring (causing athlete to purposely limit extension of femur and/or add ER component
- Hip flexor adhesion, scar tissue, tightness, impingement (causing scarring and lack of flexibility)
- Lack of gluteal strength, hamstring
- Lack of ability to allow for simultaneous A and P rotation of ilium, L and R
- **very rare internal issue, mostly mechanics**

SPINE

- Thoracic
- Lumbar
- Facets
- Sacrum
  - Flexion = Nutation
  - Extension = Counternutation
  - Axis!
    - Left Diagonal, Right Diagonal
    - Important in relative “split” position (Next..)

Iliopsoas

- Hip flexor
- Tilts the hips anteriorly
- Arches/lordoses the back
- Prevents reversal of lordosis when tight
- Needs to stretch in split position
- Attaches at T12-L5
  - Anterior bodies, parts of disc, and TPs

Side bending flat as well, all locked up

Left SB

Right SB

The Forgotten Sacrum

- (Clippinger 2007, p. 95)
  - Sacrum tilts anteriorly an average of 30deg
  - Necessary for full range of lordosis of the lumbar spine

- Very rarely do coaches understand this 4th "piece" of the curves of the spine and its relative importance to lordosis available movement capability and attainment of end ranges

Injury Etiology Example

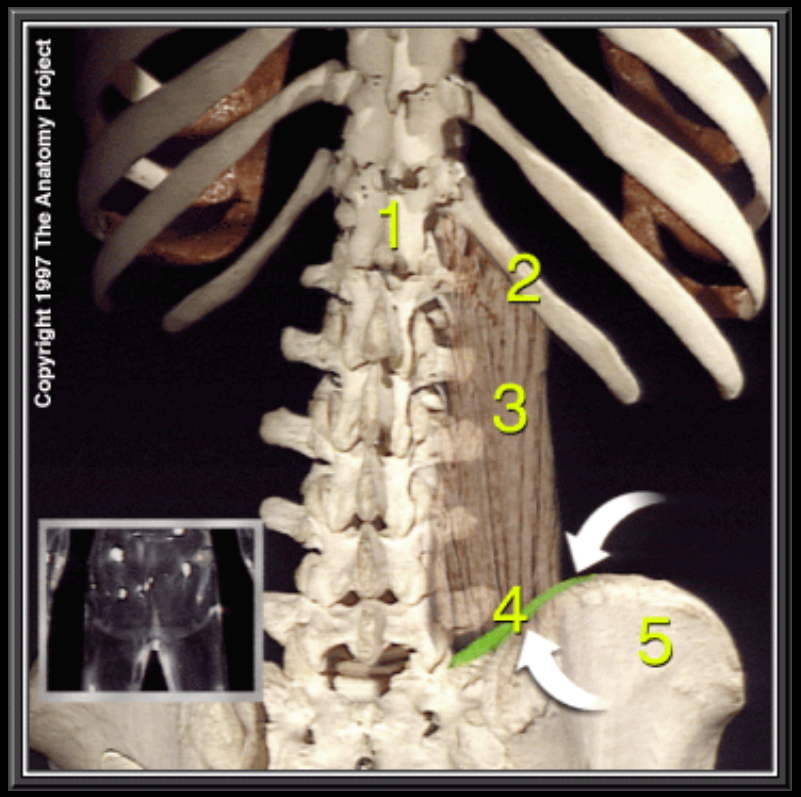
(Hamill and Knutzen 1995)

Lordosis increases shear forces

- Between 10-20 degrees LS joint can take forces up to 75% body weight from around 50%

Arch of back and shoulder flexibility

Psoas tightness from T10-T12 leads to effect on lats, subscap, GH flexion



Spondylogenic LBP –Diff Dx

Spondylolisthesis

- Displacement of a vertebrae, forward
  - "retro"listhesis is backwards displacement
- Bilateral Spondylolysis
- "Scottie Dog" in appearance

Spondylolysis

- May be a cause of "listhesis" or the slip
- Pars fractures (interarticularis) allows vertebrae to slip

Compensations

- If the low back is not flexible, joint above and joint below can help
  - Thoracic spine
  - Hips
- If the upper back is not flexible, joints can help as well
  - Lower back
  - Shoulders

Spine Functional Anatomy

- When the spine is lordosed, the following happens:
  - Facet joints close down
  - Abs are stretched
  - Hip flexors are stretched (lumber and sacral)
  - Muscles can work to get the spine there
  - If too much of an angle, you can have approximation, touching, or jamming (never good!) of the spinous processes

Spine Arthokinematics (always good to review)

- Lumbar spine rotation has been cited as being very limited (Fitt 1996). The guidance to limitations of motion in the lumbar spine are directly related to anatomy
- Flexion and extension are easily allowed (sagittal plane)
- Lateral flexion is also allowed (left and right SB)
- Most “rotation” that one will see in the lower spine (think split position) occurs relatively in the femur ER, hyperextension of the spine, and iluim shifting
- “the inferior articulating facets fitting inside the angle of the superior articulating facets of the vertebra below limit most rotation in the lumbar region (p. 67)

Spine Kinematics (1 OF 2)

Table 1.0 Normal ranges of movement in the vertebral column and hips

	Cervical (°)	Thoracic (°)	Lumbar (°)	Hips (°) (excluding ab and adduction)
Flexion	0-60	0-50	0-60	0-110
Extension	0-75	0-45	0-25	0-30
Lateral Flexion	0-45	0-40	0-25	n/a
Rotation	0-80	0-30	0-18	Internal = 0-40 External = 0-50

Adapted from ACSM (2006) and Magee (2006).

Spine Kinematics (2 OF 2)

	Flexion/extension		Lateral bending		Axial rotation	
Interspace	Limits of ranges (degrees)	Representative angle (degrees)	Limits of ranges (degrees)	Representative angle (degrees)	Limits of ranges (degrees)	Representative angle (degrees)
T1-T2	3-5	4	5	6	14	9
T2-T3	3-5	4	5-7	6	4-12	8
T3-T4	2-5	4	3-7	6	5-11	8
T4-T5	2-5	4	5-6	6	4-11	8
T5-T6	3-5	4	5-6	6	5-11	8
T6-T7	2-7	5	6	6	4-11	8
T7-T8	3-8	6	3-8	6	4-11	8
T8-T9	3-8	6	4-7	6	6-7	7
T9-T10	3-8	6	4-7	6	3-5	4
T10-T11	4-14	9	3-10	7	2-3	2
T11-T12	6-20	12	4-13	9	2-3	2
T12-L1	6-20	12	5-10	8	2-3	2

From White AA III, Panjabi MM. Spine 1978;3:12.

Summary of Kinematics

- Groups have average motion of
  - Flexion/extension
  - Rotation
  - Side bending
- Each segment must take the brunt
  - Cannot be overtaxed or “something must give”

HANDS ON LAB TIME!

Let's Move!

Movement and Testing

1.Shoulder Motions

2.Pelvic Motions

3.Spine Motions

Palpation

1.SP

2.TP

3.Axilla- lat/subscap

Hip Flexibility – Rotation of the pelvis

- Anterior Rotation
  - Place hands on hips, fingers in front (ASIS) thumbs in back around hips
  - Dump the bucket forward
  - Fingers drop below thumbs
  - Arch in back (lordosis)
- Posterior Rotation
  - Dump bucket backwards
  - Do not “Frump” with upper body, wrong part
  - Fingers rise above thumbs, or thumbs relatively drop
  - Pubic bone comes closer to breast bone
  - Rounded back (kyphosis)

Spine

- Palpation
  - Sacral landmarks (base)
  - Spinous process
  - Facet (location)
  - Feel “bounce” of a PA mob, difference T to L spine
  - Kinesiology of three planes of motion- vary per level
- Motion
  - Stand and “arch”
    - Combo rib tilt, anterior pelvic, nutation, thoracic reversal kyphosis, lumbar lordosis
    - Activation of ES and hip flexors
  - Reverse
    - Activation of abs and hamstrings

Assessment

- Skin fold observation?
- Pain- pin point?
- Difference in arch with humeral flexion and without (subscap, lat, intercostal, etc)
- Hip extension true vs. with ER component
- ??

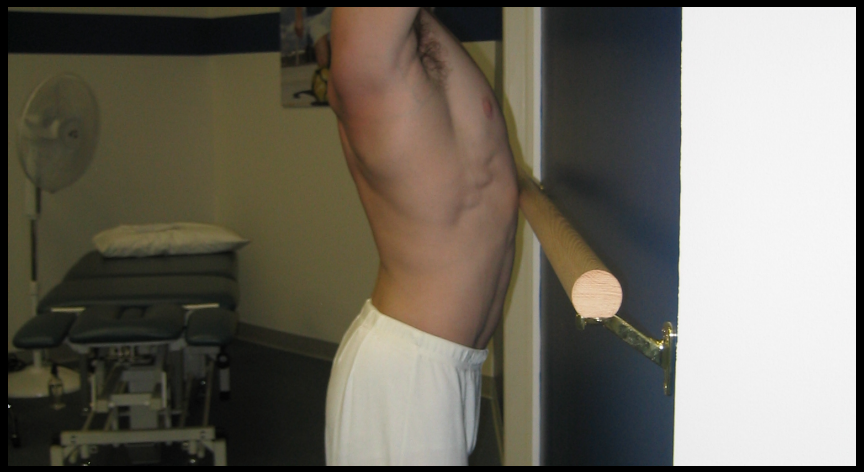
Shoulder Motion

- The shoulders should be able to move above the head, with the spine at least in neutral, to 180 degrees
- Lets try –
  - 1) floor
  - 2) wall
  - 3) handstand example
  - SLIDES…

Testing!
Wall

- Stand against the wall, lift arms overhead
- Try to keep all of the following:
  - Feet 6 inches from wall
  - Butt on wall
  - Low back pressed against hand, or towel, or better yet –wall!
  - Shoulder blades start on wall
  - Head on wall in neutral
- Lift arms overhead, keeping all on the wall
- How far are you away?

Wall testing



- Arms overhead, Humerus bone straight in line with femurs (relative vertical alignment from CC axis point)
- Look at arch in low back
- THIS is what the handstand looks like – familiar?
- 2nd pic- straight spine
- Flexed shoulders! But, better…

Floor

- Lay on floor (gravity assist)
- Keep low back as flat as possible, or smash something – neutralizes spine
- Lift arms overhead, STOP when back comes off of floor
- How far did you go?

Practical Testing

- First pic- flat back, about 150 degrees
- 2nd pic- arched back

- FAKE 180 degrees, look at the ribs tilt backwards- the spine is already in lordosis
  - Still about 150!

Proper and Improper Evaluation and Strength Technique

Example:

- Shoulder ankle open, but still stress
- Lats are stretched here, effects spine

2) Pelvic Motion
Split Position- RIGHT

- Front Leg
  - Flex: Hamstring
  - Ilium: Posterior
  - Facets: Open, relativel
- Back Leg
  - Flex: Hip Flexors
  - Ilium: Anterior
  - Facets: Compressed

Body

Rotate relatively:

- Lower ½ torso opposite (Left)
- Upper ½ torso same (Right)

Palpation!

- Standing:
  - Spinous process
    - Lumbar- ex: rotation right
  - Extension of the hip
    - With rotation allowed
    - Without rotation allowed
- Stork test:
  - Single leg stance, flex hip
  - Watch ilium rotation
  - Bottom leg buckle

- Standing:
  - Extension- gross assessment skin fold
  - Side bend
    - Comparison L to R

Measure the rib angle to the humerus bone – NOT the spine- visually confusion/convincing

(Magee 1997, re: measures)

Evaluation - Hips

- Need to make sure that the spine is in neutral, for reliability of measurement
- Need to make sure the athletes understand this position
- Need to make sure the back leg is never in external rotation, or compensation patter, will skew results

Splitz example

Square with the use of mats to raise body, un-”arch” the back, and square the hips to as high as the athlete needs- MEASURE angle between two femurs (thighs)
**although SPIRALS, for ex, are done in turnout of back leg, still want the available ROM (AvROM)

Pairs- The MEN!

Evaluation - Spine

- Measure the distance between heel of hand and heel of foot
- Measure height from belly (highest point) to floor
- Just for knowledge
- Pictures are best (side view)
  - Measure the shoulder angle and hip angle there, too

Pictures & Measurement

- Take picture of athlete doing a back bend
- Measure the shoulder and hip angles, and record
- Feet must be flat
- Knees must be straight
- Elbows must be locked out

Functional assessment

- Try to take pics in action, and still frame, or video so that you can still frame the exact moment!

MD Evaluation

- Make a form for anticipated measurements

Explain the importance of tackling this early to the athlete and the parent

- Differentiation between SP and TP pain
- FB vs BB
- Twisting skills, rebounding
- Brace vs no brace

Skill assessment: Developmental

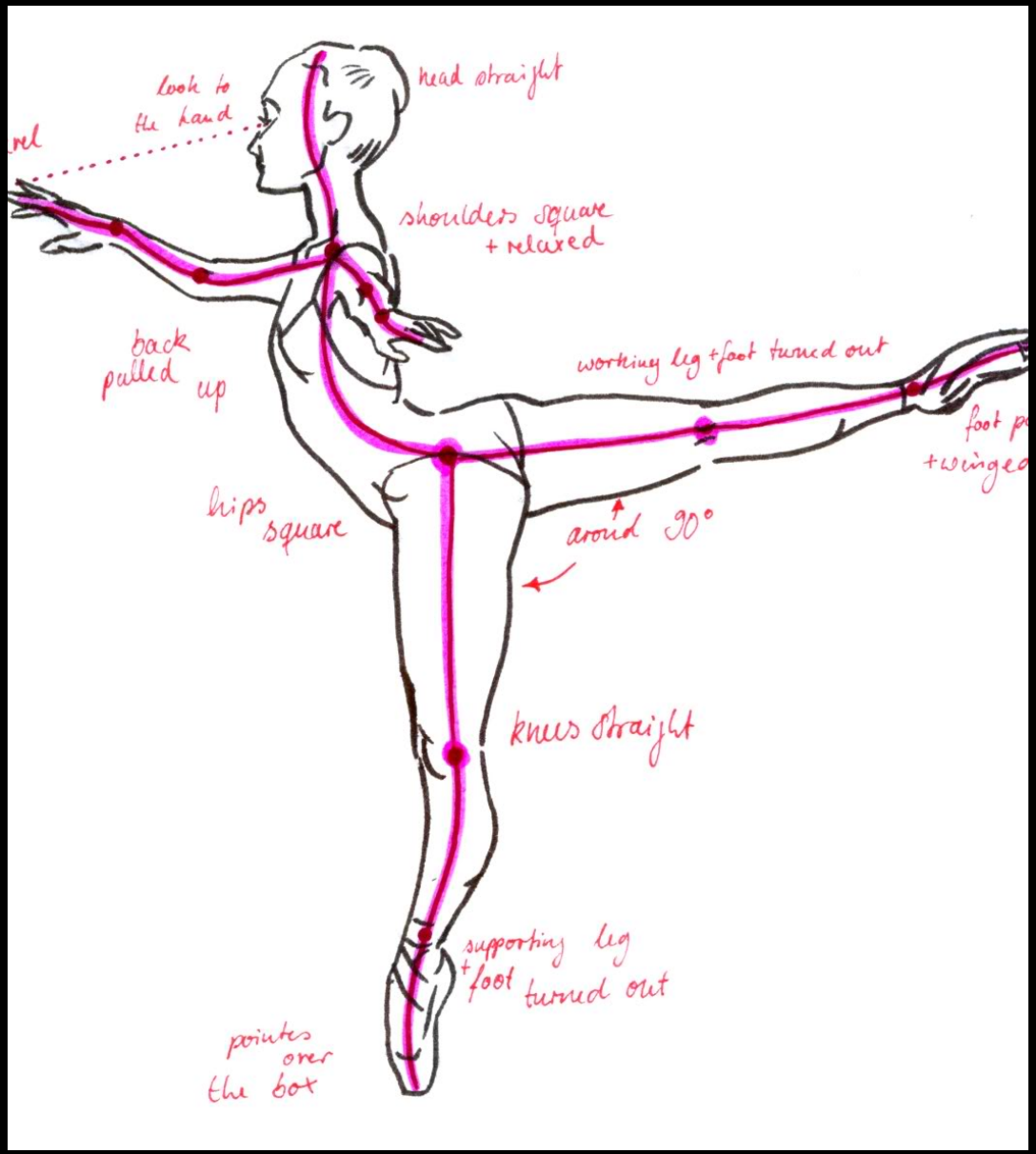
- Let's discuss: Gymnastics
  - Arching over a swiss ball
  - Starring "bridging" on floor
  - Moving to standing back bend
    - Need ab muscles to eccentrically lower and stand up
  - Kickover
    - Sheer forces if not balanced in strength
  - Backhandspring
  - Layout in the air (back or front flipping)
  - Layout on beam, stepped out (uneven distribution of force)
  - Double layouts

Skill Assessment: Optional to Elite

- Free hip opens, transition
- Vault reaches for yerchenko – take side still pictures

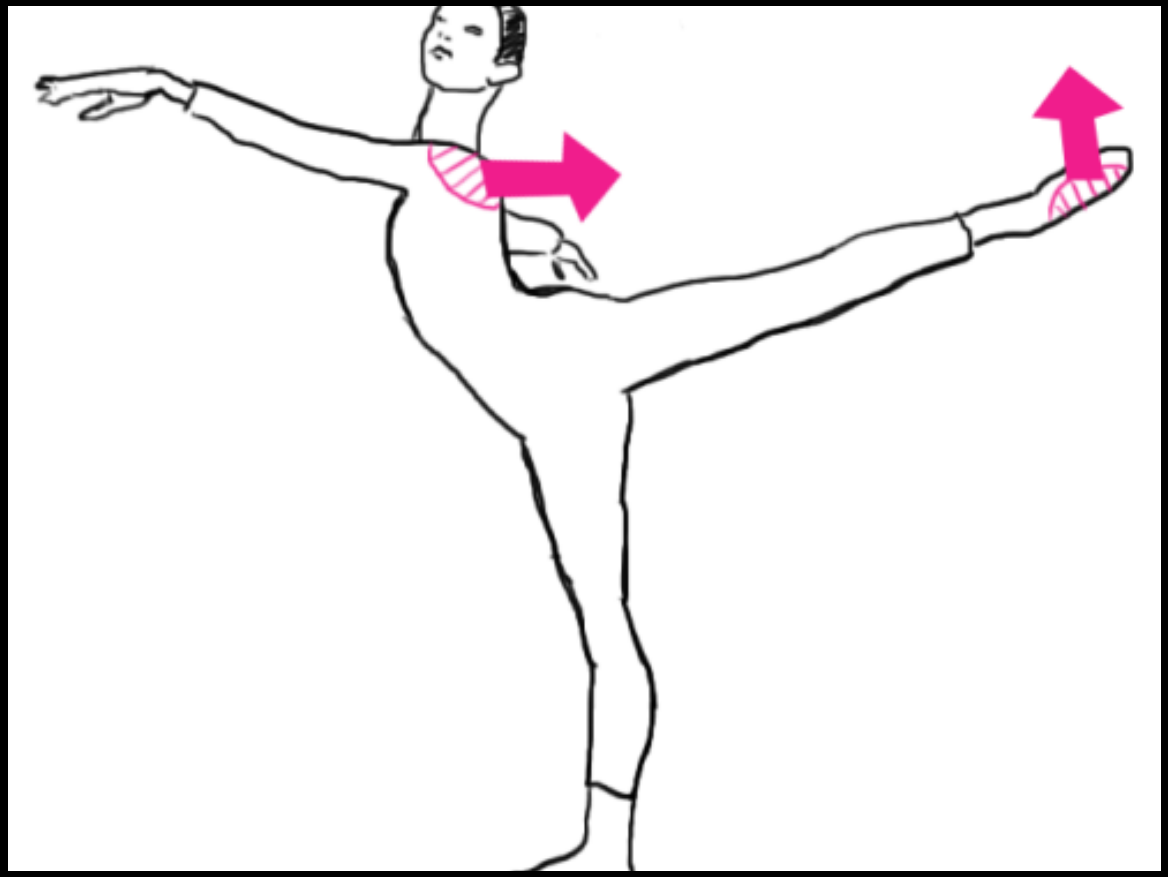
Skill Assessment: Dance

- Arabesque positions as a child
- Standing position- hyperlordosis
- Port de Bras- correct position, simple arm motion
- Arabesque
- Motion with arabesque = kicking



Hinging in weight bearing gravity assisted "Arching"

(Courtesy of danceproject.ca)



Forces not in the same direction parallel

Moderately perpendicular in nature, need to focus on gluteal activation and segmental motion of hamstring, multifidi, erector spinae, etc.

Summary

- Take the pressure off of the spine- release the muscles from tension, and increase surrounding flexibility
- Watch skills, and watch for compensation patterns
- Treat with a combination of rest, functional strengthening, and joint mobilization/reeducation early!

Summary

- Performing arts is a delicate balance between sport and art, between technique of repetition, and variance of motion
  - It is a mix between (1) flexibility, (2) joint range of motion, (3) strength, (4) stability, (5) endurance of heart, (6) endurance of orthopedic musculature, (7) neuro systems (feed forward mechanism, reflexes, MT junction feedback) and (8) genetic skeletal alignment.

How do we FIX it?

- Make sure that time is spent stretching the hips and shoulders properly
- Make sure that this is done EARLY
- Ensure that your athletes understand the concept (even just standing them against a wall helps!)
- Test and measure the flexibility and chart it – in public, so they can keep track
  - Measure with a goniometer, or have your PT do it for you to ensure accuracy and repeatability

Skill Discussion

- If extension is limited…
  - Gymnastics:
    - Back Handsriping, Yerchenko Vaulting (pre-flight)
      - Back Handspring especially if in learning stages taking from floor to beam, repetition watch and concern
    - Front handspring vaulting (block)
    - Front tumbling, bounding especially
    - Bar releases: Tkatchev, Jaeger (M and W), Kovacs (M), Pak Salto (W)
  - Dance/Gymnastics Combo
    - Leaps, ring, even switch dep on sensitivity
    - Arabesque positions
  - Skating
    - Bielman
    - Spin in leg position?
    - Arched flying camel
  - Cheer
    - Positions for flyer
    - Back tumbling
    - Base- vertical alignment without extension “moment”

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