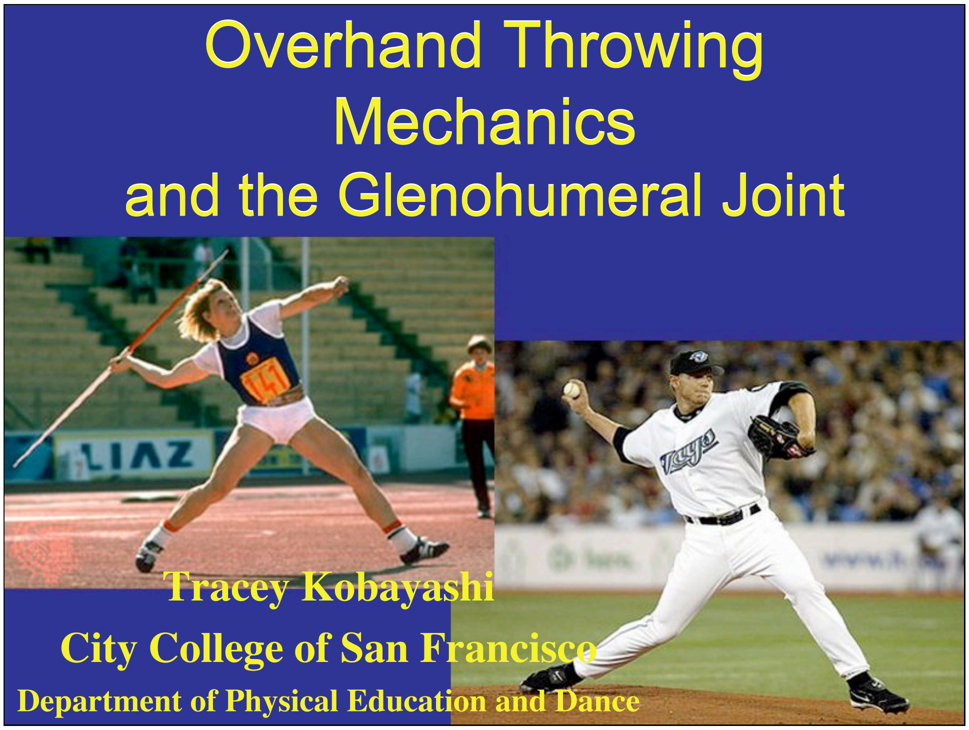
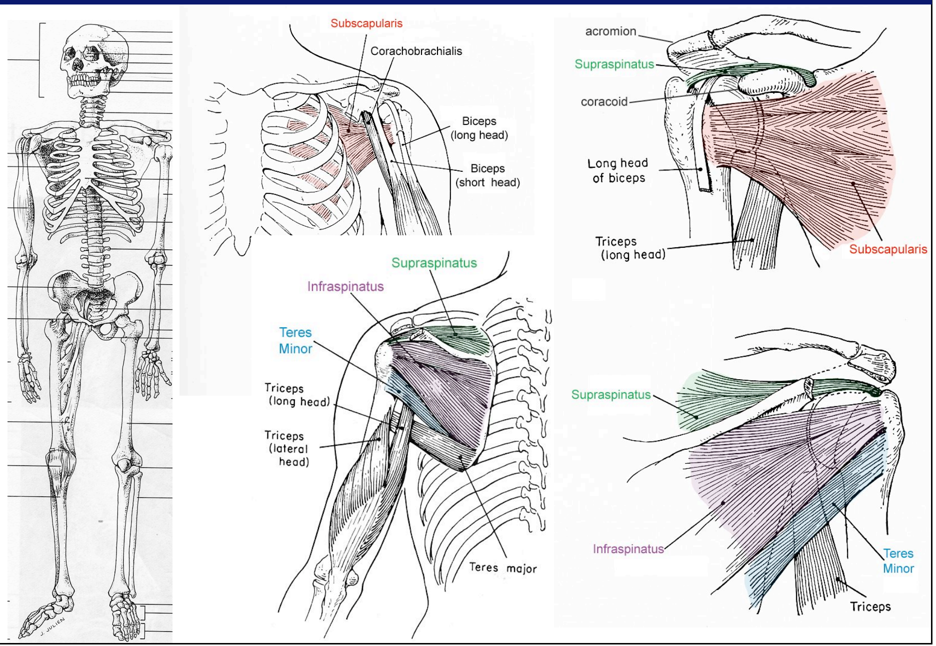


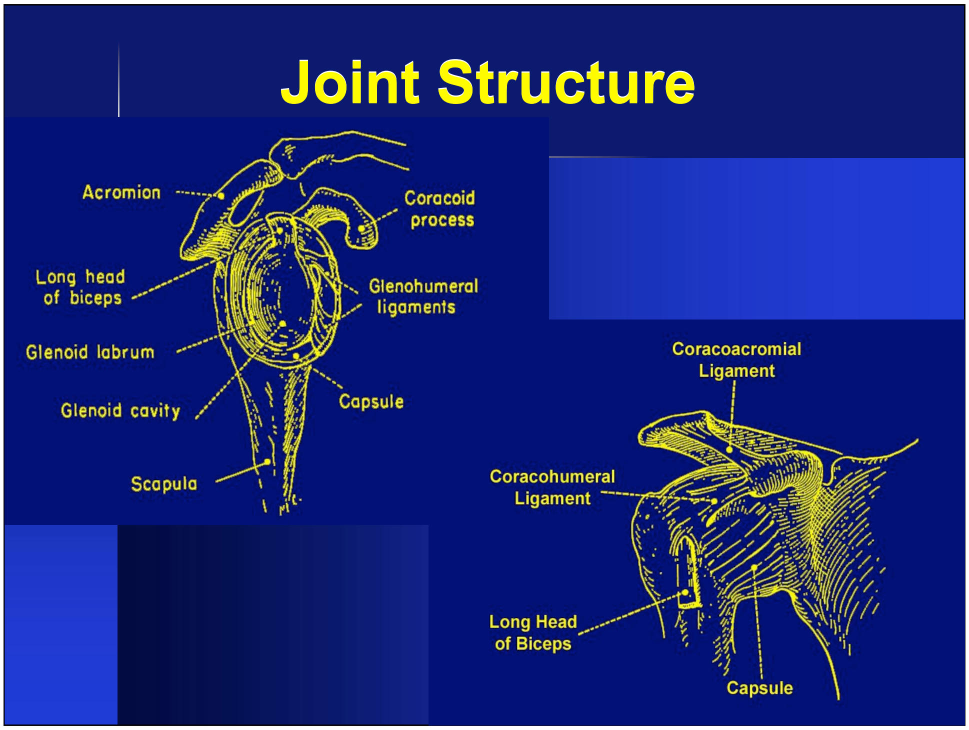
The structure of the shoulder complex makes it susceptible to injury during throwing, particularly when throwing in a fatigued state. This presentation covers mechanical factors related to the overhead throw, and touches on some implications for causes of chronic shoulder pain as well as suggested precautions.

Gross Structure



Review of Gross Structure (name bones & muscles)

- Bones: scapula; clavicle; humerus
- Joints: glenohumeral; scapulothoracic; acromioclavicular; sternoclavicular
- Rotator Cuff muscles provide dynamic stability to the joint via mainly compressive forces.



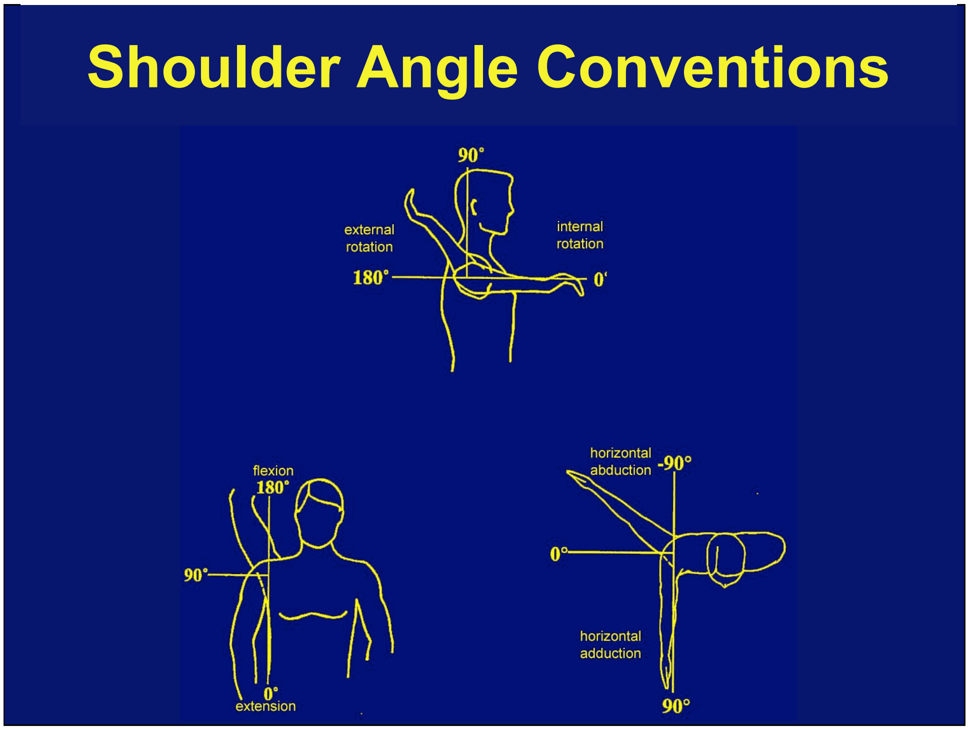
Glenohumeral Joint -- ball & socket configuration allows three-dimensional mobility

- shallowness of the glenoid fossa and large humeral head aid mobility at the expense of stability
- vacuum effect assisted by the glenoid labrum, balance of muscular forces & joint fluid provides stability
- surrounding joint capsule and ligaments provide static stability
- surrounding muscles provide dynamic stability

Acromioclavicular and Sternoclavicular Joints: stabilized primarily through ligaments

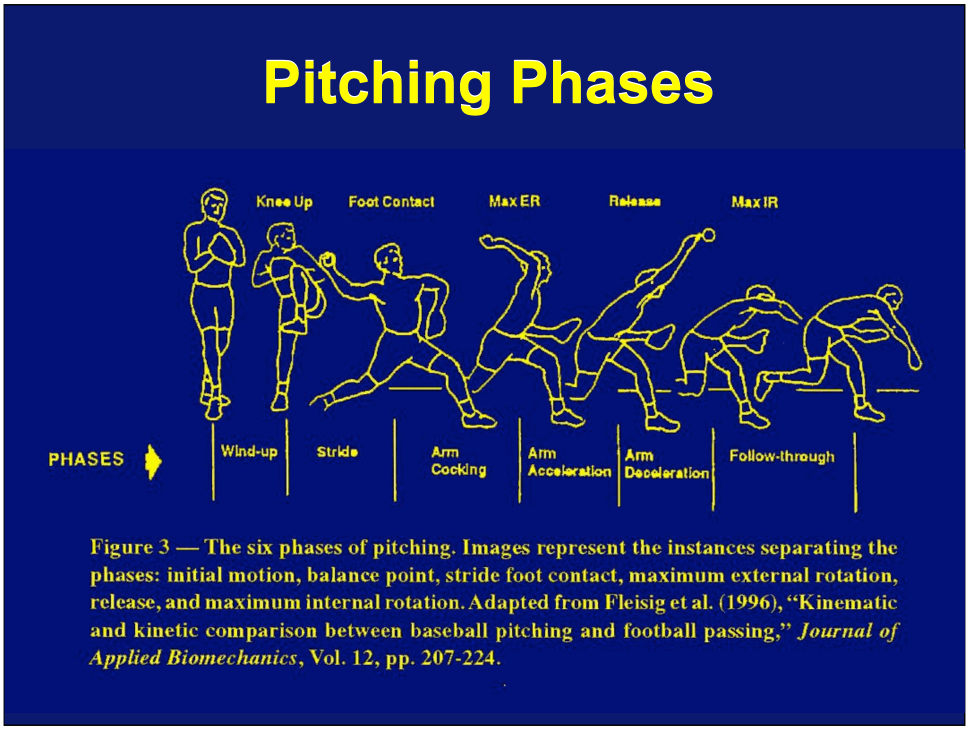
Acromial Arch (acromion and coracoacromial ligament): inhibits upward movement of the humeral head

Throwing issues, as we'll see later, arise due to instability of the glenohumeral joint



Some conventions for describing shoulder movements and position with influence on the throwing motion:

- Flexion / Extension
- Internal / External Rotation
- Horizontal Abduction/Adduction



Pitching Phases (from Stodden, et al, 2005).

o *Wind-up*: ends at knee up

o *Stride*: ends at foot contact

o *Arm Cocking*: ends at maximum external rotation

Critical instant - maximum internal Torque occurs during this phase

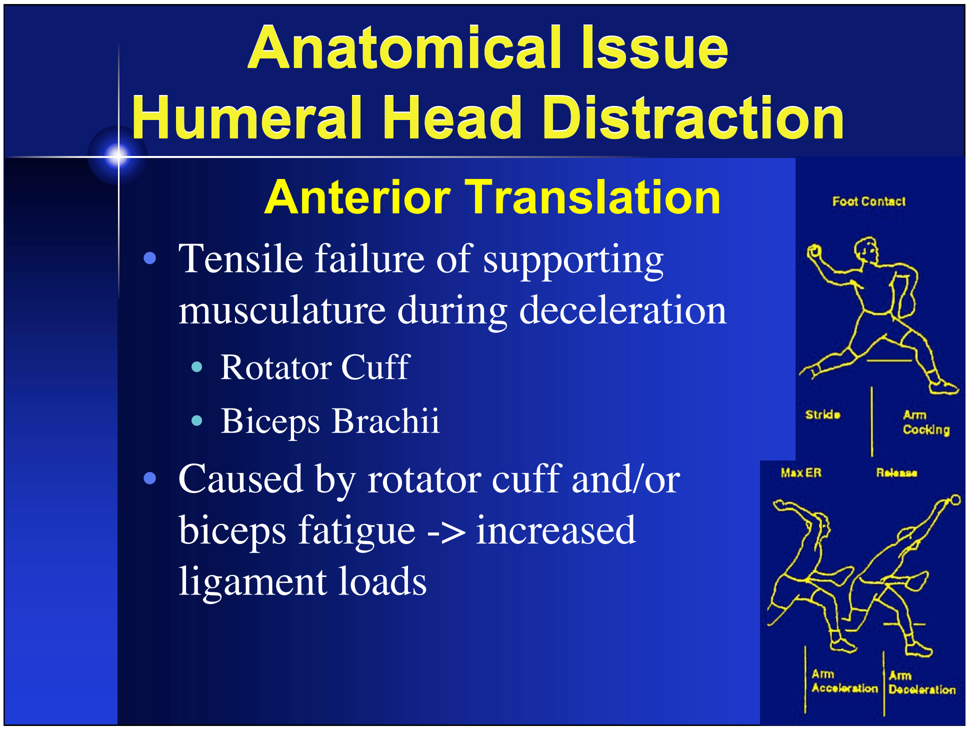
Max External Rotation 150º - 210º

o *Arm Acceleration*: ends after release

o *Arm Deceleration*: ends after maximum internal rotation

Critical instant - max compressive force

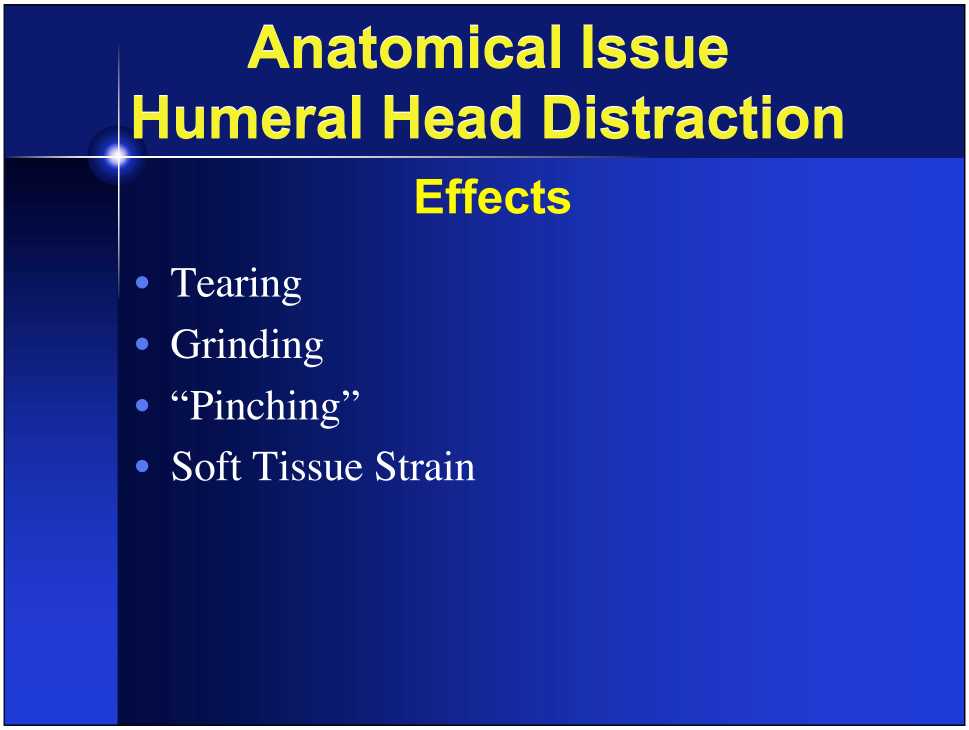
o *Follow-through*



Generally, most shoulder pain in pitchers and other overhand throwing athletes is related to humeral head distraction, usually anterior translation. Distraction can be attributed largely to tensile failure of the supporting musculature (rotator cuff - mid inferior area of supraspinatus most common - and biceps brachii).

This failure is caused by fatigue due to high loads. Excessive external rotation during cocking -> increased eccentric loads on rotator cuff -> fatigue -> increased demand on the **Inferior Glenohumeral ligament, the** primary constraint to external rotation in abduction. Rotator cuff compresses humeral head in cavity for additional support. As rotator cuff fatigues, it exerts less control, increasing ligament loads.

Role of biceps: provides elbow flexion torque and glenohumeral compression. Max elbow flexion torque must occur early enough before compression or it will be required to exert a higher maximum force. Biceps fatigue can strain the ligament structures.



Distraction Force > 100% body weight may put rotator cuff and labrum at risk

Repetitive Trauma -> chronic pain

- Tearing: compressive force from translation, joint laxity & high (380 N) anterior force during cocking.
- Grinding: rapid internal rotation with above.
- Labrum “trapped” between humeral head and glenoid rim (acute)
- Soft tissue strain: strain of gh joint restraints concurrent with humeral head subluxation

Kinematics and Kinetics
Two Critical Instants

Factors Relating to Shoulder Distraction

- Internal rotation torque during cocking
- Compressive force during deceleration

Internal rotation torque during cocking

- least stable in abduction combined with external rotation
- shoulder position @ max ext rotation ($184 \pm 14^\circ$): greater external rotation
- high peak external rotation & abduction torques

Compressive force during arm deceleration

- posterior & compressive forces resist distraction (biceps)
- horizontal abduction torque resists horizontal adduction
- external rotatory torque resists internal rotation

Changes in throwing mechanics during a game session (Barrentine et al)

- @ foot contact: $+5^\circ$ abduction; $+5^\circ$ horizontal adduction; $+8^\circ$ external rotation
- arm cocking and acceleration: -4° external rotation;
- @ release: -4° abduction

Applications

Max Throws/Game

AGE	MAX / GAME	GAMES / WK
8-10	52 ± 15	2 ± 0.6
11-12	68 ± 18	2 ± 0.5
13-14	76 ± 16	2 ± 0.4
15-16	91 ± 16	2 ± 0.4
17-18	106 ± 16	2 ± 0.6

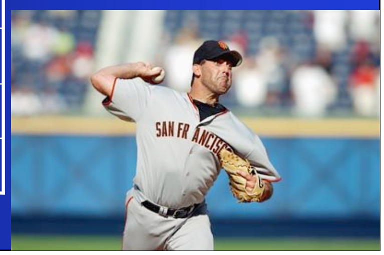
Recommended Rest for Min Throws

AGE	1 DAY REST	2 DAY REST	3 DAY REST	4 DAY REST
8-10	21 ± 18	34 ± 16	43 ± 16	51 ± 19
11-12	27 ± 20	35 ± 20	55 ± 23	58 ± 18
13-14	30 ± 22	36 ± 21	56 ± 20	70 ± 20
15-16	25 ± 20	38 ± 23	62 ± 23	77 ± 20
17-18	27 ± 22	45 ± 25	62 ± 21	89 ± 22

Applications

Recommended Ages for Learning Various Pitches

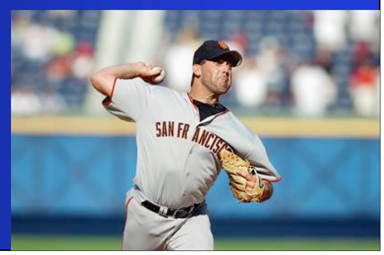
Pitch	Age
Fastball	8 ± 2
Change-Up	10 ± 3
Curve ball	14 ± 2
Knuckle ball	15 ± 3
Slider	16 ± 2
Fork ball	16 ± 2
Screw ball	17 ± 2



Applications

Cues

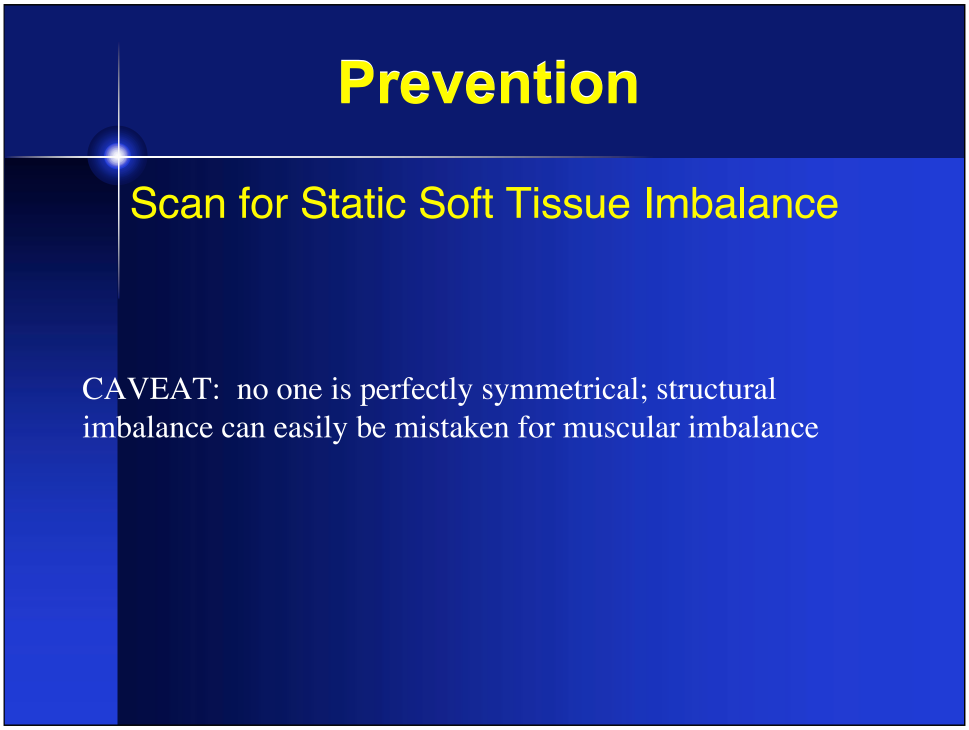
- Glenohumeral internal rotation deficit in those with impingement.
- Higher maximum external rotation associated with injury/pain,



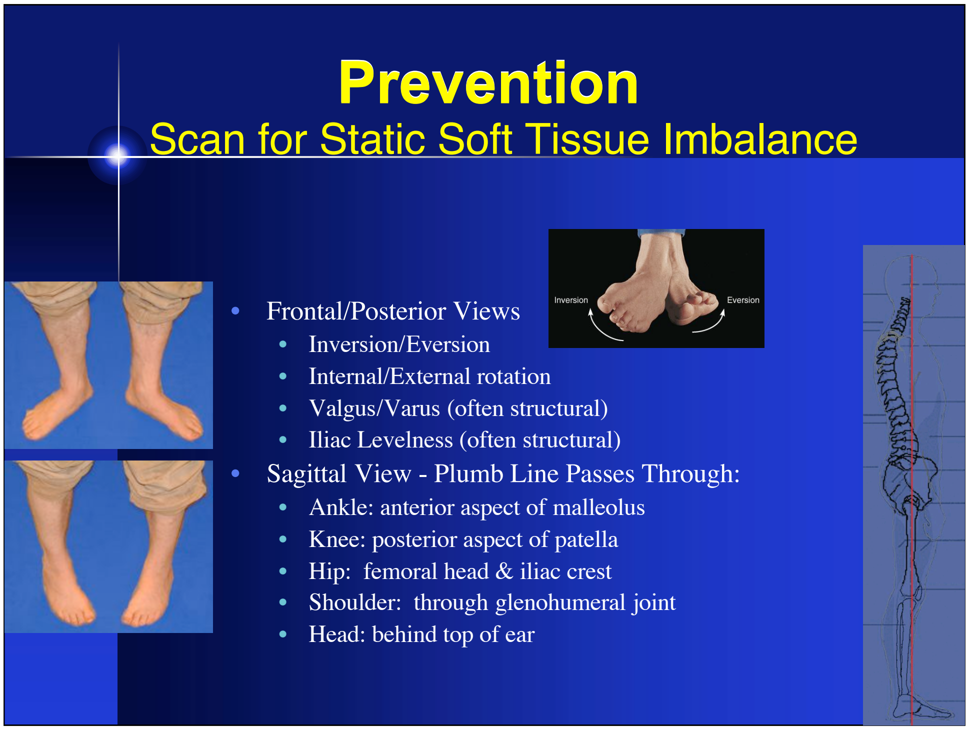
Internal rotation: throwing shoulder -8.5° in normal pitchers.

Specific Conditioning

- Shoulder exercises
-



Muscular imbalance can create uneven or unintended stress on articulations and bones. An appropriate conditioning program can be designed to correct it. If the individual doesn't respond to "fixes," the imbalance may be due to the formation of the body's bony structures. If so, it’s possible tampering with them could cause damage.



Name exercises for

- inversion/eversion
- internal/external rotation
- pelvic tilt downward/upward
- hyperkyphosis

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