Introduction to the Shoulder

EID 424
Bioengineering Applications in Sports Medicine
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Overview

- Bony anatomy
  - Glenohumeral joint
  - Acromioclavicular joint
- Muscles
- Shoulder stability
- Common pathologies

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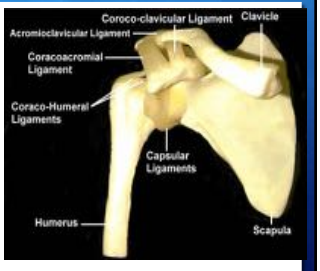
Bones

- Humerus
  - Upper part of arm
- Clavicle
  - Provides only attachment of shoulder/arm to rest of skeleton
- Scapula



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Scapula

- "Shoulder blade"
- Offset (~30°) from frontal plane
  - Scapular plane
- Much of shoulder pathology may be caused by abnormal scapular motion
- Three processes
  - Glenoid
  - Coracoid
  - Acromion

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Bony Anatomy

- Glenohumeral joint
  - "Shoulder joint"

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Glenohumeral Joint

- Greatest range of motion of all joints
  - Unconstrained ball-and-socket type joint
- Glenoid
  - Socket
  - Small
  - Shallow fossa
- Humerus
  - Ball
  - Large

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Glenohumeral Joint

- Little bony restraint
  - Emphasis on soft tissue
    - Joint capsule
    - Ligaments
    - Muscles
- Wide range of motion at expense of stability

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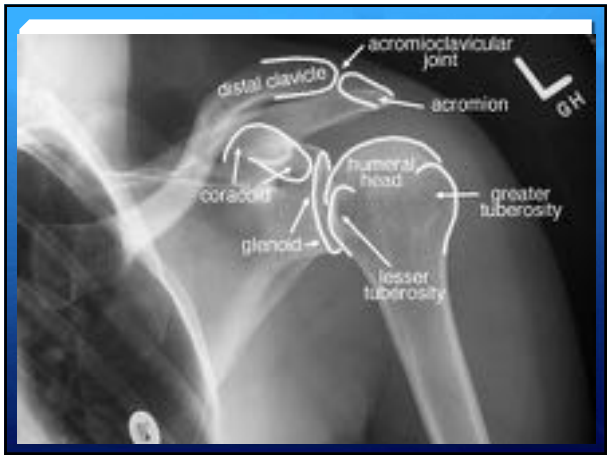

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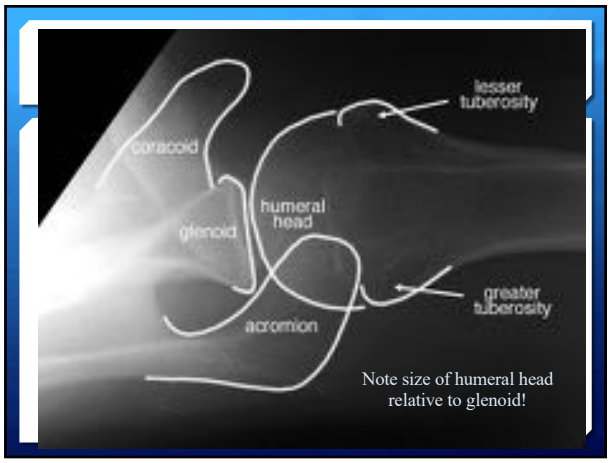

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Glenohumeral Static Stabilizers

- Joint capsule
- Labrum
- Ligaments

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Glenoid Labrum

- Fibrous ring
- Attaches to articular margin of glenoid
- Blood supply similar to meniscus
  - Mostly peripheral

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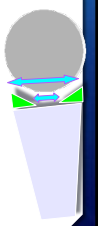
Glenoid Labrum

- Deepens glenoid fossa
  - Loss of labrum results in 50% loss in glenoid depth
- Increases glenohumeral contact area
- Again, similar to meniscus



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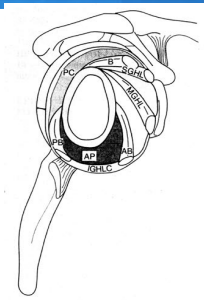
Glenohumeral Ligaments

- Glenoid to humerus
- "Capsular ligaments"
  - Thickenings of joint capsule
  - Superior glenohumeral ligament (SGHL)
  - Middle glenohumeral ligament (MGHL)
  - Inferior glenohumeral ligament complex (IGHL)
    - Anterior band
    - Posterior band
    - Axillary pouch



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Other Static Stabilizers

- Coracohumeral ligament
  - Connects coracoid process to humerus
- Rotator interval capsule
  - Triangular portion of capsule between supraspinatus and subscapularis muscle tendons

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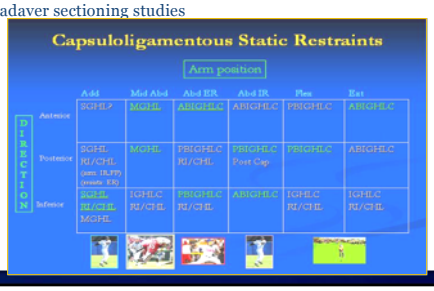
Static Stabilizers

- Roles complex
  - Depends on shoulder position, force direction
  - Cadaver sectioning studies



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Clavicle

- Small bone
- First to ossify
  - 5th week of gestation
- Only bony connection between shoulder complex and rest of skeleton
- Protects passage of lots of structures
  - Blood vessels
  - Nerves

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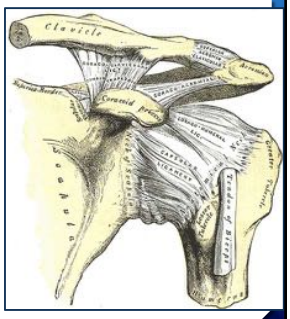
Acromioclavicular Joint

- AC joint
  - AC ligaments
    - Superior
    - Inferior
    - Anterior
    - Posterior
    - Prime stabilizer to AP translation of clavicle
  - Coracoacromial (CA) ligaments
    - Aren't they on the same bone?



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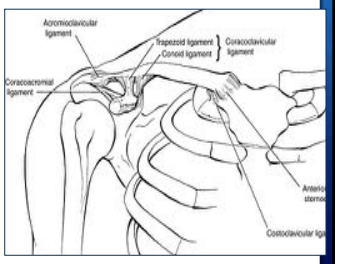
Acromioclavicular Joint

- AC joint
  - CC ligaments
    - Coracoclavicular
    - Helps couple glenohumeral abduction and flexion to scapular rotation
    - Trapezoid ligament
      - Prime restraint to AC compression
    - Conoid ligament
      - Prime restraint to superior translation



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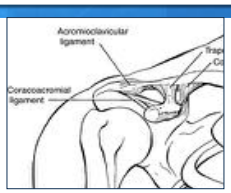
Coracoacromial Arch

- Consists of
  - Acromion
  - AC joint
  - Coracoid
  - CA ligament



- Limits space available for supraspinatus muscle
  - *Impingement*

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Muscles of the Shoulder Joint

I'll make you wish to hear more about the quadriceps…

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Lots of Muscles!

- Latissimus dorsi
  - Lats
- Trapezius
  - Upper
  - Middle
  - Lower
- Rhomboids
  - Major
  - Minor
- Teres major
- Pectoralis
  - Major
  - Minor
- Serratus anterior
- Levator scapulae
- Deltoids
  - Anterior
  - Posterior
  - Middle
- *Rotator cuff*

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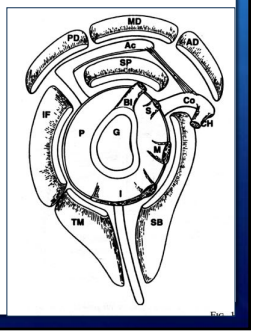
Static and Dynamic Stabilizers of GH Joint

- Static
  - Labrum
  - Capsule
  - Capsular ligaments
- Dynamic
  - Biceps tendon (long head)
  - Rotator cuff muscles



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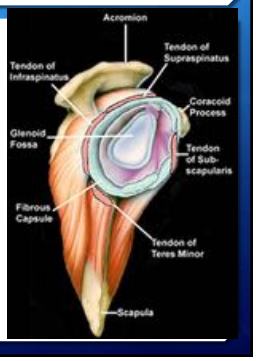
Rotator Cuff Muscles

- Comprised of:
  - Supraspinatus
  - Infraspinatus
  - Subscapularis
  - Teres Minor
- Primary dynamic stabilizers of GH joint
  - Provide force to compress humeral head into glenoid



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Rotator Cuff Muscle Functions

- Supraspinatus
  - Abducts humerus
  - Depresses humeral head
- Infraspinatus
  - Externally rotates and extends humerus
- Teres minor
  - Externally rotates and extends humerus
- Subscapularis
  - Internally rotates humerus

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Common Shoulder Disorders

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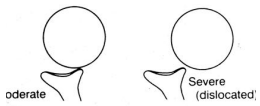
Shoulder Instability

- Pathologic excessive motion
  - Different from laxity
- Degree
  - Subluxation
  - Dislocation
- Frequency
  - Acute
  - Chronic
  - Recurrent
- Direction
  - Anterior
  - Posterior
  - Multidirectional
- Mechanism
  - Traumatic
  - Atraumatic
    - Rare
  - Microtrauma
    - Repetitive overhead motions



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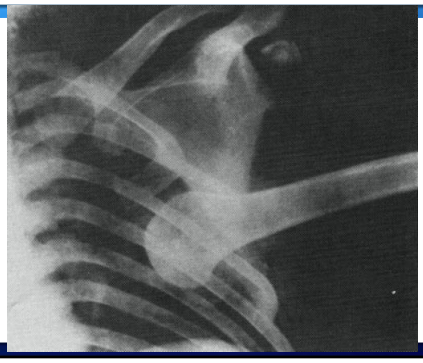
Shoulder Dislocation



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Shoulder Dislocation

- Most result of trauma
- Anterior dislocation most common
  - Arm is abducted and externally rotated
- Atraumatic rare
  - General ligamentous laxity
  - Voluntary dislocators/subluxators

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Shoulder Dislocation

- Repetitive microtrauma
  - Throwing and racket sports, swimming
  - Constant loading and stressing of capsule and ligaments in abduction and external rotation at a rate that exceeds tissue repair
  - Multidirectional instability
  - Role of muscle fatigue?
  - Often leads to impingement of rotator cuff muscles

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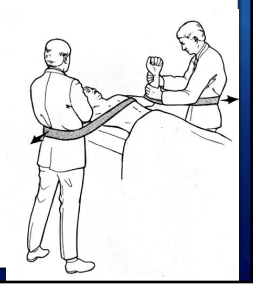
Reduction of Dislocation

- Often done on-field
- Anesthetic?
  - Intra-articular lidocaine injection



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Bankart Lesion

- IGHL C detached from glenoid rim
- Most commonly seen in anterior instability

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Classification of Instability (Historic)

- **TUBS** ["torn loose"]
  - **T**raumatic
  - **U**nidirectional instability
  - **B**ankart lesion
  - **S**urgery
- **AMBRI** ["born loose"]
  - **A**traumatic
  - **M**ultidirectional instability
  - **B**ilateral
  - **R**ehabilitation
  - **I**nferior capsular shift [surgery to tighten joint if rehab fails]

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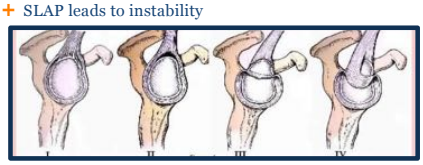
SLAP Lesion

- **S**uperior **L**abrum **A**nterior to **P**osterior lesion
- Common in throwing athletes
- Controversy
  - Instability leads to SLAP
  - SLAP leads to instability



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Non-Operative Treatment

- Immobilization
- Rehabilitation

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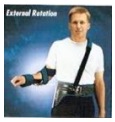
Immobilization

- Traditionally used to prevent ER and abduction
  - Usefulness dependent on sport
- Effectiveness for recurrent dislocators?
- Position?
  - Gunslinger brace! [brace in external rotation]



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Rehabilitation

- Restore range of motion
  - Decrease pain
  - Pendulum [Codman's] exercises
- Isometric strengthening
  - Resisted IR and adduction
- Rotator cuff strengthening
- Proprioception and neuromuscular control
- Training for functionally specific activities

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Surgical Treatment

- Open
  - Proven
  - Good results
    - Stable
  - Takedown subscap muscle
  - Motion loss
    - Unpredictable return to overhead sports
- Closed (arthroscopic)
  - Less stiffness
  - Better appearance
  - No subscap issues
  - Technique dependent
  - Greater recurrence
  - Long-term unknown

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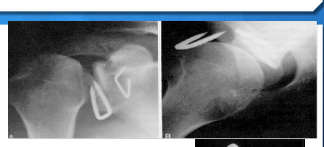
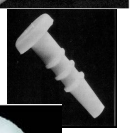
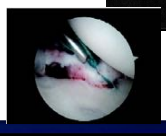
Operative Treatment



- Staples [no more]
- Bioabsorbable tacks
- Sutures, suture anchors
- Thermal shrinkage
  - Thermal capsulorrhaphy
  - Probably not a good idea

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Rotator Cuff Tears

- Small
  - < 1 cm
- Medium
  - 1-3 cm
- Large
  - 3-5 cm
- Massive
  - > 5 cm
- Often caused by impingement of supraspinatus

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Treatment of Rotator Cuff Tears

- Small, medium typically respond well to conservative treatment
  - Therapy
  - Cortisone injection?
- Large, massive typically require surgical repair
  - Open
  - Mini-open
  - Arthroscopic

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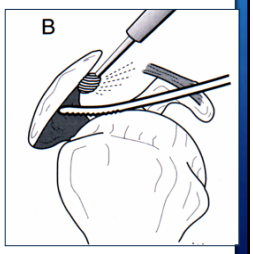
Rotator Cuff Tears

- Often caused by impingement of supraspinatus passing through coracoacromial arch
  - Repair and perform subacromial decompression



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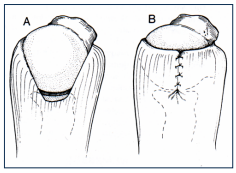
Rotator Cuff Repairs

- Important factors
  - Tear size
  - Tear location
  - Tissue quality
    - Muscle
    - Tendon
  - Repair as much as possible



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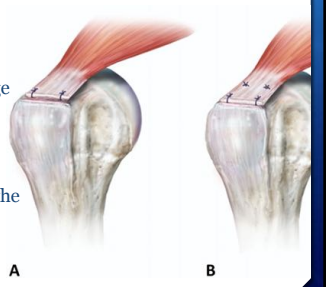
Current Controversy: Single- vs Double-Row Repair

- Traditionally, one row of stitches attached to anchors used to repair
- This only holds down the edge of the tendon
- Two rows should more accurately recreate the "footprint" of the tendon on the bone



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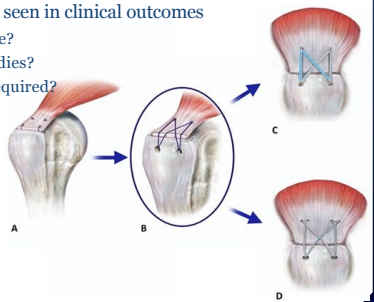
Current Controversy: Single- vs Double-Row Repair

- So far, no difference seen in clinical outcomes
  - Really no difference?
  - Underpowered studies?
  - Better technique required?
- Jury still out



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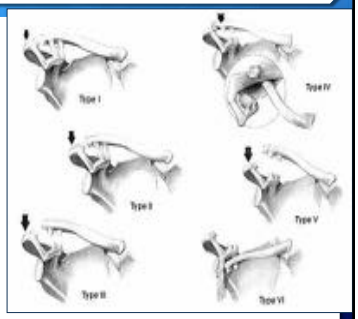
AC Joint Injuries

- Shoulder separation
- Injury mechanism
  - Direct trauma most common
    - Fall onto shoulder with adducted arm
    - Hockey player hitting boards



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AC Joint Injuries

- Type I
  - AC ligaments sprained
  - CC ligaments intact
- Type II
  - AC ligaments torn
  - CC ligaments sprained
- Type III
  - AC and CC ligaments torn
- Type IV, V, VI
  - Refinements described by Rockwood
- Type III
- Describe displacement of clavicle

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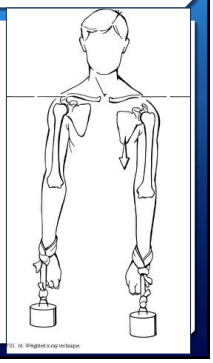
Visualizing AC Joint Injuries

- Stress views?
  - Anesthetic injected into joint
  - Hang weights from hands
  - No
    - Little info
    - Extra cost
    - Painful



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Primary AC Repairs

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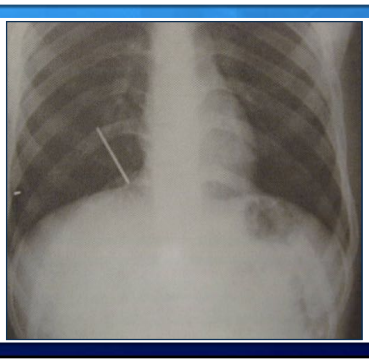
Complications of Hardware



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CC Ligament Reconstruction: Current Concept

- Weaver-Dunn reconstruction
  - CA ligament transfer
  - Single suture to hold things together
    - Weak, esp initially
- Tendon graft reconstruction
  - Use tendon graft
    - Semitendinosus
  - Some initial work done at Cooper (Lee et al., 2003)
    - Tensile strength of different grafts
    - Responses to cyclic loading

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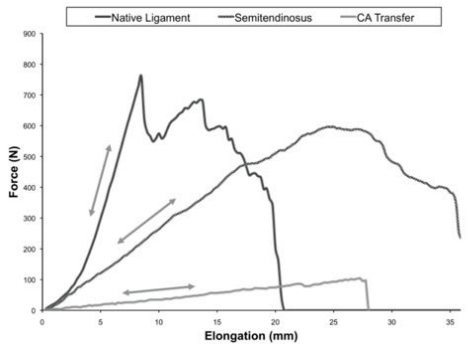
CC Ligament Reconstruction



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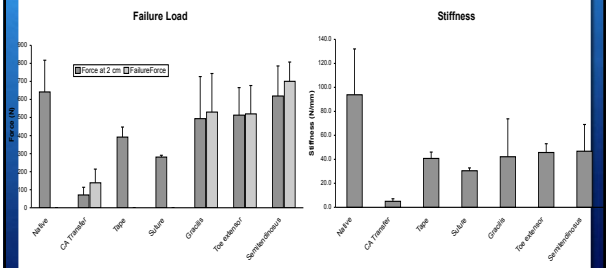
CC Ligament Reconstruction



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AC Ligament?

- Often left alone if torn
- Some advantage to shaving off part of the clavicle
  - If AC ligament torn, acromion and clavicle can rub against each other
  - Can cause arthritis

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Shoulder Injury Terminology

- GH joint
  - Shoulder dislocation
- AC joint
  - Shoulder separation

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What Makes (Made) Him So Good?

- Lots of external rotation range of motion
  - Also position of dislocation, microtrauma

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Issues for Pitchers

- Increased external rotation
- Decreased internal rotation
  - Hypertrophy of muscles to decelerate arm
  - Glenohumeral internal rotation deficit [GIRD]
  - Does not seem to relate to injury
- Total range of motion concept
  - Increased ext rot coupled with decreased int rot on dom side
  - "Normal" int/ext rot on non-dom side
  - Max external rotation to max internal rotation range should be similar between dom/non-dom sides

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What About Kids?

- Curveballs are fine
  - Twisting motion does not place extra stress on shoulder/elbow
  - Fastball associated with higher forces
- Pitch counts matter!
  - Limits and recommendations exist
  - The better kids play in multiple leagues
    - Pitch counts in each league independent
  - Live in warm weather = play in leagues year-round
    - No off-season for recovery

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