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Athletic Shoulder II

-Tennis Injury-

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◆ **Tennis : basic strokes**

- serve (overhead) / forehand drive / backhand stroke

◆ **Serve : wind-up**

- begins w/ standing w/ shoulders in line w/ intended direction of serve
  ends w/ ball release from left hand
- risk of injury is low

◆ **Serve : cocking(=preparatory phase)**

- -- sequence of extension, E/R & abduction
- -- posterior deltoid activity is reduced by a prominent backward lean of trunk → greater use of anterior Deltoid during abduction phase of cocking
- -- related to mechanisms involving power generation
- -- end-range eccentric contractions of internal rotators & horizontal adductors
- -- contractile injuries from eccentnic overload : Subscapularis, Latissimus dorsi, Pect major → static joint instability
- -- common compensation for ↓ in strength
  ± ROM at shoulder girdle→↑ amount of elbow flexion
- -- Triceps brachii : compensate for loss of power at shoulder
- -- high valgus force on medial elbow
- stretch-shortening cycle
  -- short bursts of end-range eccentric muscular contractions
  → followed quickly by full-range concentric contractions

◆ **Serve : acceleration**

- athletes, release of power

· begins w/ I/R of right arm
· ends at ball contact w/ racquet
→ powerful concentric contractions of
--internal rotators & horizontal adductors of GHJ
--concentric contractions of elbow extensors & wrist flexors
⇒ propel ball forward
· protecting joints : Biceps brachii & Rhomboids (working eccentrically)
· insufficient endurance of slow twitch stabilizing muscle → static stabilizers tend to elongate & stretch

◈ Serve : **follow-through**

· begins w/ ball contact & continuces until completion of stroke
· eccentric predominant muscle activity, occuring in U/ & L/E & trunk→ absorption of energy & deceleration
· strong posterior Deltoid, Infraspinatus & anterior Deltoid activity
· reduced participation of Pect major
· structures in posterior joint region : the most commonly affected
→ posterior RC & bicipital tendonitis from eccentric overload
· tightened posterior joint capsule → ↑ anterior & superior translation of HH on glenoid labrum during late cocking & acceleration stages : leading to 2° static joint instability & impingement SD

◈ Serve : **elbow & forearm**

· flexing to around 120° in cocking
· extending to around 15-20° at ball impact
· extension velocity : 900° per sec
· acceleration & deceleration of elbow
· forearm pronation

◈ **Forehand drive : cocking**

· backward stroke of shoulder extension & moderate abduction
· main Deltoid activity (posterior & middle heads)

◈ **Forehand drive : acceleration**

· rapid flexion (0.14 seconds)
· anterior & middle Deltoid, Peck major, Biceps & Triceps brachii (elbow stabilizer)

◈ **Forehand drive : follow-through**

· deceleration

inconsistent participation by Latissimus dorsi suggests deliberate I/R is meeded for ball spin & additional deceleration.

◆ **Ground strokes : elbow**

not have much motion

elbow flexor & extensor muscle load absorption

◆ **Power game : style**

· full western grip : more extreme positions of the racquet in the hand

· limitation of shoulder motion in favor of an "open" stance & "windshield wiper" stroke

-- more velocity of the ball

-- extra stress on the elbow & forearm

· the latest generation of racquets

-- top spin

-- large motions on wind-up & follow through

-- swinging hard on all shots

-- playing offensively

◆ **Racquet**

· head size : midsize or large size

-- create larger maximal hitting zones

· large racquet head

· higher resonance frequency of racquet → reduce arm vibration

· grip size : from tip of 3rd finger to distal palmar crease

-- too small : muscle fatigue from overuse

-- too big : less feel for & control over racquet

-- minimal effect on EMG activity

string tension : debate

-- slightly looser strings produce more velocity in the ball

◆ **Shoes**

· sole cushioning systems

· lacing pattern

-- shock absorption functions : not high

-- foot control : better maintained by flexible joints & muscular strength in legs

◈ Court surface :

clay courts	synthetic & hard courts
ball : slow down	speed up
longer matches : more strokes	shorter points
extra strain on arm & back	more impact forces on legs racquet & arm
extra running : more demands on legs	increased stress on legs

◈ Loads on anterior glenoid in throwing motion : 2 times BW

◈ Peak velocity in serve

- tennis racquet : 62-72 miles/hour
- ball : 83-125 miles/hour
- shoulder : I/R at 1140-1715°/sec

◈ Velocity in ground strokes

- in forehand : 52-56 miles/hour (ball : 80-85)
- in backhand : 40-47 miles/hour (ball : 65-70)

stroke	rotational velocity ♔ (°/second)	hand speeds at ball impact ♔ (miles/hr)	muscle activation (EMG analisis)
serve	1500	47	Subscapularis
forehand	387	37	Pect major
			Serratus anterior
backhand	895	33	middle Deltoid
			Supraspinatus
			Infraspinatus

♔ world-class tennis players

◈ These motions & forces are generated & controlled by coordinated muscle contraction. At the shoulder, the forces are the summation at the kinetic chain activity that starts w/ the ground reaction force in the legs & proceeds to the shoulder.

◈ At the shoulder, the forces are transmitted through a graded coordinated muscular firing pattern to the arm & then to the racquet.

◈ Muscular firing pattern : shoulder

- early scapular stabilization

- early acromial elevation
- rotator cuff firing
- anterior force generation
- posterior force regulation in follow through

◆ **The elbow, forearm & wrist must absorb most of the rotational torque transmitted from an off-center hit.**

◆ **Athletic fitness demands**

- speed / power / quickness

→accomplished through weight training, sprint/interval running, foot work, foot speed drills, plyometrics

◆ **Musculoskeletal base**

- if the musculoskeletal base is inadequate for the sports, overload injury, fatigue & decreased performance may well be the results.
- strength, flexibility, muscle balance & endurance

◆ **Sound stretching programs, the appropriate use of weight training & isokinetic training can reduce the risk of overuse injury & potentially improve performance.**

chronic injuries (63%)	acute injuries (37%)
rotator cuff(RC) tendoniti	
lateral epicondylitis	ankle sprain
chronic muscle strain	torn menisci
plantar fasciitis	Fx
stress Fx	

◆ **Possible mechanisms of injury**

- trauma
- overloading, overuse, muscle imbalance in shoulder girdle joints or muscles & proximal or distal to shoulder
- poor throwing technique
- compensatory changes in throwing technique

◆**Throwing athletes**

↑E/R, ↓I/R in abduction→ ↑in anterior capsular laxity

→ ↑translation of HH within glenoid fossa→ ↓ in static stability by capsule

lead to ↑reliance on RC musculature as a mean of providing GH stability

→ dynamic stability provided by RC is prone to fatigue

→ lead to abnormal mechanics & ↑ potential for injury

◈Tennis player ROM : dominant arm

- ER : increase or same
- IR : loss→ posterior capsule or RC tightness

- Ellenbecker et al -

- Kibler et al -

- Posterior capsule tightness could result in increased anterior translation.

- Harryman et al -

◈Tennis Injuries of the shoulder

overuse
muscular fatigue → injury to static shoulder stabilizers

↓

plastic deformation of static stabilizers → 2° impingement → ↑instability → RC tear

◈Common shoulder injuries

- impingement SD : RC tendonitis / tear / bursitis
- instability / labral tears /
- internal impingement syndrome bicipital tenosynovitis / S/L of long head of biceps tendon /
- thoracic outlet syndrome / os acromiale / winging scapula

◈Management

- early evaluation / stabilization / protection / early treatment

◈Rotator cuff (RC) tendonitis & tear

- one of the most common injury
- older athlete
- caused by damage directly to RC
- condition is usually functionally disabling
- conservative Tx
  -- decreased activity
  -- ROM exercises
  -- gradual muscle strengthening exercises
- even w/ early surgery, results are often disappointing, especially in the large tears.
- a good chance of returning to previous level of play : 19/23(83%)

- Bigliani et al -

Am J Sports Med, 1992

◆Instability of GHJ

· athlete under 35 years of age
-- result of deficits in muscular strength & balance of muscular inflexibility predispose to capsular & labral deficiencies
· subclinical adaptation
-- short arming the throw
-- alteration of arm position during throwing or lifting
-- muscle recruitment from anterior shoulder, forearm or trunk
· treatment is limited by anatomic instability

◆Internal impingement of RC

initial pain during late cocking & early acceleration phase of serving
RC tear located on articular surface of posterior supraspinatus &/or anterior infraspinatus & pathologic changes of posterosuperior glenoid labrum

◆Lateral epicondylitis

· a result of repetitive overload
· pathologic change in extensor tendon attachments around lateral epicondyle (esp. in ECRB)
· Sx : pain on resisted finger or wrist extension
resisted forearm supination
gripping objects
backhand stroke
· double-handed backhand :
more injury to extensor origin than to use of single handed backhand
- *Gerber, Krushell* -
- *Jobe et al* -
· subclinical adaptations : hitting "behind the body" , hitting w/ wrist movement, recruitment of triceps or alteration of position of elbow
· Tx : conservative Tx
-- decreasing activities to reduce stress / antiinflammatory medications
-- strengthening exercises : rubber tuning
-- counter force brace / local steroid injection
surgery : -- do not respond conservative Tx for 6-8 weeks
-- return to play average 3 months

◆ Medial epicondylitis (=medial tennis elbow)

- more commonly seen in advanced & competitive players
- pathology : repetitive tensile microtears
- pain : felt more on forehand stroke or serve
- mechanical factors :
  - -- excessive racquet velocity
  - -- exaggerated racquet position
  - -- desire to create heavy top spin
- tissue injury : valgus overload complex
  - -- forearm flexor mass, biceps & pronator
  - -- ±UCL
  - -- ulnar nerve
  - -- ±posterior medial olecranon
- subclinical adaptations
  - -- hitting "behind the body"
    - -- more overhead throwing motion
  - -- more wrist snap
  - -- more use of shoulder in throwing motion
- D/D : UCL inscufficiency / ulnar neuropathy
- Tx : conservative Tx

  surgery
  - -- excision of all degenerative tendon tissue
  - -- fasciotomy & debridement of damaged muscle
    - -- side-to-side or tendon-to-bone repair

◈ **Stress fractures**

ulnar : non dominant arm two-handed backhand

humerus / index metacarpal / distal radius / acromion

◈ **Nerve entrapment about elbow**

ulnar N / radial N (high radial N) /

posterior interosseous N / median N / long thoracic N