NC Academy of Family Physicians
Sports Medicine and the Active Patient

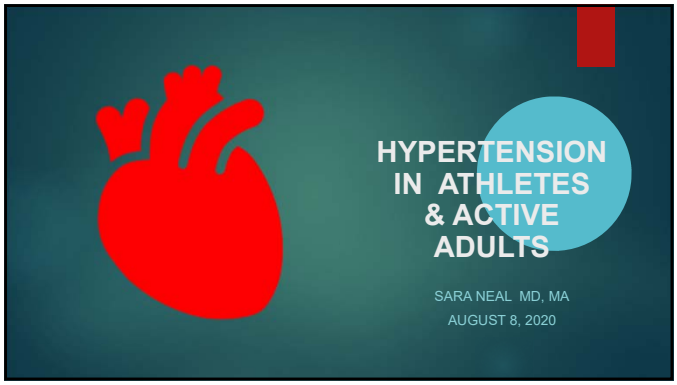
Saturday, August 8, 2020 | Half-Day Saturday Virtual CME Opportunity
Karl "Bert" Fields, MD, ABFM, CAQSM| Program Chair

7:00 am – 7:15 am	**Virtual Meeting Room Opens** Please check your email for your personal webinar link.	
7:15 am – 7:30 am	**Welcome & Introductions** David Rinehart, MD | NCAFP President Karl "Bert" Fields, MD, ABFM, CAQSM| Program Chair	
7:30 am – 8:00 am	**Hypertension in Athletes and Active Adults** Sara Neal, MD, MA, ABFM, CAQ	**.50 CME Credits**
8:00 am – 8:30 am	**The Active Adult with Osteoarthritis** Karl "Bert" Fields, MD, ABFM, CAQSM	**.50 CME Credits**
8:30 am – 9:00 am	**Concussion: Update on Evidence Base Medicine** Dominic McKinley, MD, CAQ	**.50 CME Credits**
9:00 am – 9:30 am	**Common Pediatric Sports Medicine Diagnoses** Ryan Draper, DO, ABFM, CAQSM	**.50 CME Credits**
9:30 am – 9:45 am	**Question & Answer Panel One** Sarah Neal MD | Bert Fields MD | Dominic McKinley MD| Ryan Draper DO	**.25 CME Credits**
9:45 am – 10:00 am	**Mid-Morning Break**	
10:00 am – 10:30 am	**Common Shoulder Problems in Family Medicine** Kevin Burroughs, MD, CAQ	**.50 CME Credits**
10:30 am – 11:00 am	**The "Sports" Elbow** Kevin Burroughs, MD, CAQ	**.50 CME Credits**
11:00 am – 11:30 am	**Common Hand and Finger Injuries** Ryan Draper, DO, ABFM, CAQSM	**.50 CME Credits**
11:30 am – 12:00 pm	**EBM Running Injury** Karl "Bert" Fields, MD, ABFM, CAQSM	**.50 CME Credits**
12:00 pm – 12:15 pm	**Question & Answer Panel Two** Kevin Burroughs MD | Ryan Draper DO | Bert Fields MD	**.25 CME Credits**
12:15 pm	**Adjourn**	

Conference Materials Website

www.ncafp.com/augustcme

NCAFP Help Desk - (910) 660-0949


HYPERTENSION IN ATHLETES & ACTIVE ADULTS
SARA NEAL MD, MA
AUGUST 8, 2020

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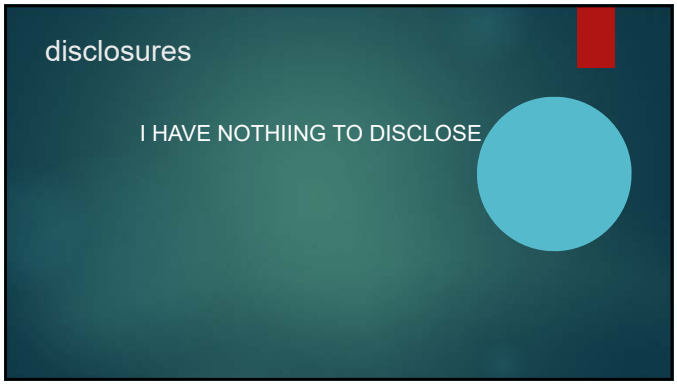
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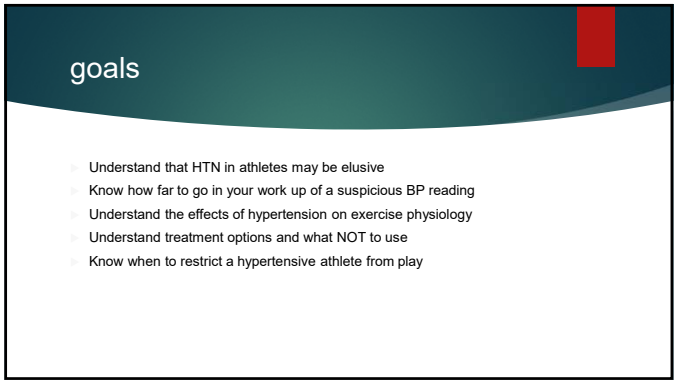
goals
Understand that HTN in athletes may be elusive
Know how far to go in your work up of a suspicious BP reading
Understand the effects of hypertension on exercise physiology
Understand treatment options and what NOT to use
Know when to restrict a hypertensive athlete from play

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CASE

- 28-year-old defensive lineman
- History of hypertension for 10 years
- BP well controlled last 3 years with use of diuretic

- Immediately after a game, he was noted to have:

Slurred speech

Inability to walk straight forward; he veered to the right when attempting to walk forward

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WORKUP

- CT head
- Coagulation panel including Antiphospholipid etc
- Sickle cell screen
- Carotid imaging
- Echocardiogram

- All normal except:
- Head CT showing small internal capsular infarct

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- Ischemic strokes common in the internal capsule (IC) area
- IC area has small diameter arteries
- CAUSES of these lacunar infarcts:
- Chronic HTN can cause thickening of vessel wall (*lipohyalinosis)*
- Embolism
- ASCVD of larger trunk vessels

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CASE

- Ultimately had full workup with MRI, MRA ECHO etc
- All negative
- Fortunately, full recovery

Risk for stroke thought to be long term effects of previously untreated hypertension *(lipohyalinosis)*

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HTN FACTS

- HTN most common CV disorder in USA and worldwide
- HTN also most common CV disorder in athletes *(Schleich)*

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PREVALENCE OF HTN IN USA

- Prevalence of HTN among US adults > 20 yoa is 32.6% *(NHANES 2012)*

AGE RANGE	PREVALENCE HTN
18-39	7.3%
40-59	32.4%
> 60	65.0%

- Projections show that by 2030, approximately 41.4% of US adults will have hypertension,
- This is an increase of 8.4% from 2012 NHANES estimates *(Heidenreich)*

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Intersection of MD with athlete

- THE
- PRE-PARTICIPATION
- EXAM

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PRE-PARTICIPATION EXAMINATION (PPE)

Blood pressure status for athletes is usually a **single reading** at PPE

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PRE-PARTICIPATION EXAMINATION (PPE)

Blood pressure status for athletes is usually a **single reading** at PPE

Elevated BP readings are the **most common abnormality** found at pre-participation exams *(Kouidi)*

Study of adolescent athletes:
80% of those w BP > 142/92 at PPE were found to eventually develop HTN *(Tanji)*

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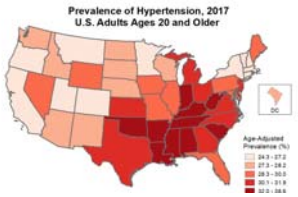
PRE-PARTICIPATION EXAMINATION

Likely to see more of this given adolescent obesity epidemic



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Study on adolescents in Mississippi

- 7700 student athletes ages 14-18
- Looked at obesity and hypertension
- 23% obese (BMI> 95%)
- 20% overweight (BMI >85%<95%)

Obese students were **2.4X** more likely to have elevated BP at pre-participation exam *(Stiefel)*

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DEFINITION HTN: ADULTS

JNC – 8 Classification of BP

Table 3. Classification of Blood Pressure in Adults (age ≥18 years)

Classification	Systolic Blood Pressure (mmHg)		Diastolic Blood Pressure (mmHg)
Normal	<120	AND	<80
Prehypertension	120-139	OR	80-89
Stage I HTN	140-159	OR	90-99
Stage 2 HTN	≥160	OR	≥100

- Also consider if there is presence of target organ damage (TOD) or not

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DEFINITION HTN: PEDIATRICS

Updated Definitions of BP Categories and Stages

For children aged 1-13 y	For children aged ≥ 13 y
Normal BP: < 90th percentile	Normal BP: < 120/< 80 mm Hg
Elevated BP: ≥ 90th percentile to < 95th percentile or 120/80 mm Hg to < 95th percentile (whichever is lower)	Elevated BP: 120/< 80 to 129/ < 80 mm Hg
Stage 1 HTN: ≥ 95th percentile to < 95th percentile + 12 mm Hg, or 130/80 to 139/89 mm Hg (whichever is lower)	Stage 1 HTN: 130/80 to 139/89 mm Hg
Stage 2 HTN: ≥ 95th percentile + 12 mm Hg, or ≥ 140/90 mm Hg (whichever is lower)	Stage 2 HTN: ≥ 140/90 mm Hg

Children < 13 yoa: BP is rated against demographic norms

does it exceed 90%?

95%?

99%?

Children > 13 similar numbers to adults

secondary hypertension was previously more common in children

primary hypertension now accounts for most cases of childhood hypertension *(Kapur)*

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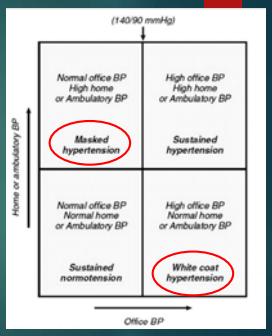
MASKED HTN & WHITE COAT HTN (WCH)

- Masked hypertension was defined as an office BP <140/90 mmHg but an ABP average ≥135/85 mmHg
- Ambulatory BP monitor considered gold standard evaluation for suspected WCH, but …
- Home BP with appropriate cuff, training and done 2 or more times a day has been shown to be sufficient to rule out white coat HTN *(Anderson)*



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MASKED HTN

- May be particularly important in the athlete
- Small study in Norwegian "football" players who were selected due to elevated BP at PPE
- Set up for Ambulatory BP
- Measured against control group, age matched, optimal BP readings
- 58% of players with elevated initial BP readings had sustained HTN
- 11% had WCH
- More than one-third of the control group had masked hypertension during daytime
- Additionally, these groups had a reduced nocturnal dip in BP, potentially indicating increased nocturnal sympathetic activity

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HOW FAR DO YOU GO WITH WORK-UP?

- An abnormal blood pressure reading should be followed up
- Recheck at same office visit
- Check in other arm
- Consider outpatient records
- Consider family history
- Repeat home blood pressures.
- Is ambulatory blood pressure monitoring an option?
- If blood pressures remain high, consider creatinine, ECHO, referral.

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PHYSIOLOGY: EXERCISE IN NORMAL vs HTN

HTN patients have greater increase SBP, DBP, MAP,HR & sympathetic activity in both dynamic and static exercise

DYNAMIC EXERCISE	NORMAL	HTN
SBP	↑	↑↑
DBP	→↑	↑
MAP	→↑	↑↑
HR	↑	↑↑
SYMPATHETIC EFFERENT ACTIVITY	↑	↑↑

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EXERCISE PHYSIOLOGY IN ATHLETES WITH HTN

- A disproportionate response to exercise is seen in athletes with HTN or pre-HTN
- These individuals have an inverse, independent, and graded association between exercise capacity and their mortality risk

- a cohort of 4631 hypertensive veterans with multiple cardiovascular risk factors
- all successfully completed a graded exercise test
- mortality risk was 13% lower for every 1-MET increase in exercise capacity they achieved. *(Myers)*

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EXERCISE AS TREATMENT

- In hypertensive individuals, habitual physical activity lowers BP and the risk of mortality, independent of other risk factors.
- increased cardiorespiratory fitness attenuates the 24-hour BP and the BP response to exercise or physical exertion, thereby lowering the risk for LVH. *(Kokkinos)*

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TREATMENT OPTIONS

LIFESTYLE MODIFICATIONS (LSM)

Individual modifications may only drop BP a little, but combinations of changes may make significant difference

LSM and change in SBP mm Hg

- Recent tobacco use 10-12
- Oral contraceptives 8-15
- High sodium intake 2-14
- Recent alcohol intake 2-4
- Cocaine 8-?
- Anabolic steroids 9-10
- NSAIDS 2-4
- Energy drinks 2-8

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TREATMENT OPTIONS: BENEFIT OF EXERCISE ON BLOOD PRESSURE

- Regular aerobic (dynamic) exercise can reduce BP in hypertensive and in normotensive
- Systolic drop 4-9 mm
- Diastolic drop 3-6 mm
- Static exercise: capable of lowering resting BP in hypertensive and normotensive
- a recent meta-analysis, static exercise was shown to reduce systolic 10.9 mm Hg and diastolic by 6.2 mm Hg,

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TREATMENT OPTIONS: MEDICATIONS

ANTIHYPERTENSIVE TEATMENT OPTIONS BY CLASS

- ACE inhibitors
- Alpha blockers/Alpha agonists
- Angiotensin receptor blockers
- Beta blockers
- Calcium channel blockers
- Direct Renin inhibitors
- Diuretics
- Vasodilators

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TREATMENT OPTIONS: MEDICATIONS

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TREATMENT OPTIONS: MEDICATIONS

ANTIHYPERTENSIVE TEATMENT OPTIONS BY CLASS

- **ACE inhibitors**
- **Angiotensin receptor blockers**
- **Calcium channel blockers**

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TREATMENT OPTIONS: ACE & ARB

- ACE & ARB shown to have little or no effect on exercise capacity
  (Carre, D'Esta, Barrow)
  - Evaluate electrolytes and creatinine

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TREATMENT OPTIONS: ACE & ARB

- ACE & ARB shown to have little or no effect on exercise capacity
  (Carre, D'Esta, Barrow)

HOWEVER …

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TREATMENT OPTIONS: ACE & ARB

- **Contraindicated in women of child-bearing** age (fetal abnormalities)
- Risk of **angioedema**

5X in African American *(Brown)*

Increased in Latino *(Kaplan)*

10% risk of angioedema with ARB if it occurred with ACE *(Beavers)*

- **Cough** (less but still possible with ARB; up to 29% who have cough with ACE will have cough with ARB) (Product)

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TREATMENT OPTIONS: CALCIUM CHANNEL BLOCKERS

DIHYDROPYRIDINES

VS

NON-DIHYDROPYRIDINES

Memory trick: HYDRATION is good for athletes... Therefore diHYDROpyridines are good for athletes

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TREATMENT OPTIONS: CALCIUM CHANNEL BLOCKERS

NON-DIHYDROPRIDINES

- VERAPAMIL
- DILTIAZEM

- Less vasodilation
- Can cause reductions in heart rate and contractility due to effects on SA & AV nodes
- Verapamil most pronounced negative inotropic effect

DIHYDROPYRIDINES

- Nifedipine
- Felodipine
- Amlodipine
- Nicardipine

- More vascular selectivity and fewer cardiac effects
- Do not suppress nodes automaticity (rate) or conduction (contractility)

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TREATMENT OPTIONS: CALCIUM CHANNEL BLOCKERS

- CCB may be especially helpful in African American athletes as CCB decrease vascular resistance *(important component of pathogenesis HTN in AA)*
- Non-dihydropyridines (Verapamil and Diltiazem) can have effect on maximum heart rate
- Dihydropyridines can cause small decrease in VO2 max.
- For most, these are usually thought to be negligible effects

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TREATMENT OPTIONS: CALCIUM CHANNEL BLOCKERS

- In theory, CCB can increase risk of heat –related illness.
- Theoretical mechanism : as they vasodilate, hypotension and interference with thermoregulation
- Dihydropyridines usually well tolerated except for dose dependent edema (10%)
- No specific lab monitoring necessary
- **OK for women of child- bearing age**

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TREATMENT OPTIONS: WHAT ***NOT*** TO USE

(and reasons)

- Diuretics: intravascular volume depletion, electrolyte disturbance; can decrease threshold for heat illness. Cramps.
- Thiazides especially can act as masking agents for anabolic steroids
- Beta blockers are banned for sports requiring fine motor movements:

Darts, Archery, Billiards, Golf, Biathlon, Riflery/shooting

- Beta blockers also banned for:

Underwater sports, Automobile racing, Skiing, Snowboarding

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WHEN TO RESTRICT FROM PLAY

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WHO CAN PLAY?

PREHYPERTENSION
- No restrictions
- Need appropriate follow-up

STAGE 1 HTN WITH NO TARGET ORGAN DAMAGE
- No restrictions
- Treat and monitor every 2-4 months
- See how training is affecting BP

STAGE 1 HYPERTENSION WITH TARGET ORGAN DAMAGE
- Play is RESTRICTED until BP target of <140/90 is achieved

STAGE 2 HTN (> 160/100)
- RESTRICTED until BP target of <140/90 is achieved
- Especially true in sports with intense dynamic and static components (boxing, triathlon, speed skating, rowing)

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WHO CAN PLAY? (PEDS)

PRE-HYPERTENSION
- No restrictions on play but…
- Follow-up every 6 months

STAGE 1 (>95%) NO TARGET ORGAN DAMAGE (TOD)
- No restrictions on play
- Follow-up every 1-2 weeks

STAGE 1 WITH TOD *OR* STAGE 2 HTN
- RESTRICT from sport
- Refer to pediatric HTN specialist

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RISKS OF OLDER ATHLETES WITH HTN

- Athletes >35 have increased risk for CAD and may need additional work up. Consider ECHO and exercise tolerance testing
- Systolic >225-240 warrants further attention
- Rise in diastolic BP during exercise may indicate elevated systemic vascular resistance
- Failure of BP to fall by 3 mins post ETT – consider CAD?

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SUMMARY

- HTN most common CV disorder in athletes
- The overall risk of CV disease cannot be dismissed due to the thought that routine physical activity may be cardioprotective.
- Do not neglect full work up for any elevated blood pressure
- Control BP without affecting exercise capacity, without lowering heat illness threshold, without using banned substance
- Restrict play until blood pressure is controlled in any patient with stage 2 hypertension
- Restrict play in any patient with target organ damage until further evaluation and treatment

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The Active Adult with OSTEOARTHRITIS

Karl B. Fields, MD
Professor of Family Medicine and Sport Medicine UNC
Cone Health Sports Medicine Fellowship
Greensboro AHEC
2020

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Osteoarthritis

The most common arthritis worldwide affecting a majority of persons 65 and over

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Common symptoms of OA

- Stiffness and decreased joint motion
- Pain – progresses through stages
- Swelling
- Joint deformity
- Instability

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Generalized OA

- Involvement of hands with Heberden and Bouchard nodes
  - Multiple Heberden nodes is key marker
  - Onset usually in middle age
- Involvement of spinal joints
- Involvement of 2 other joints
- Not likely a specific syndrome so much as a genetic subsceptibility to OA

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Osteoarthritis Changes

- Process of continual destruction and repair
- Subchondral bone becomes thickened, sclerotic and eburnation occurs - pain from repetitive microfractures
- Subchondral cysts
- Osteophytes

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Locations of Osteoarthritis

- Hip
- Knee
- Cervical and lumbar spine
- CMC, DIP, PIP and first MCP joint of hands
- Foot and Ankle

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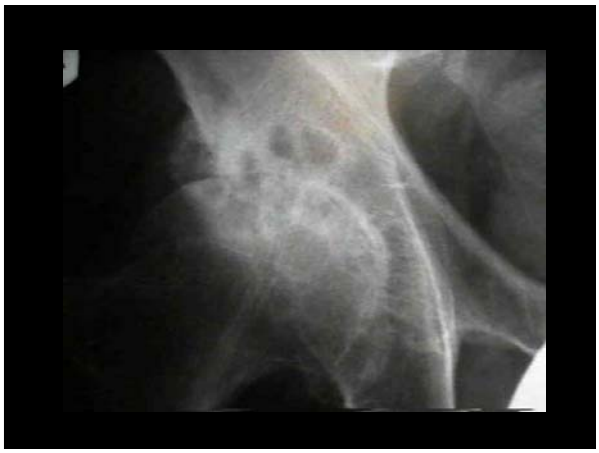

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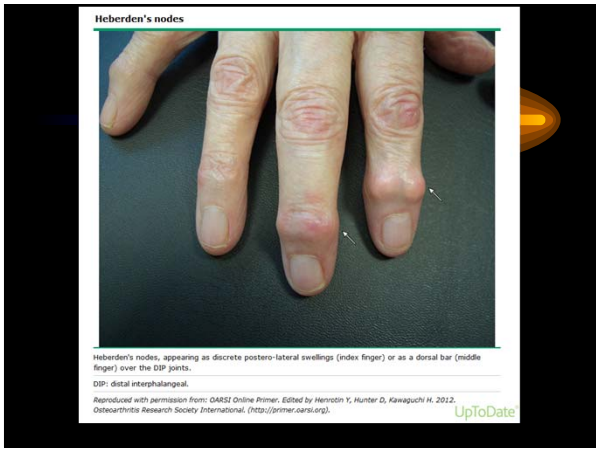
Heberden's nodes
Heberden's nodes, appearing as discrete postero-lateral swellings (index finger) or as a dorsal bar (middle finger) over the DIP joints.
DIP: distal interphalangeal.
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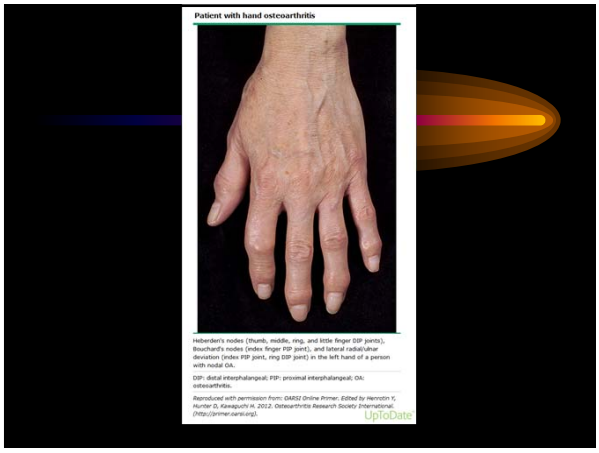
Patient with hand osteoarthritis
Heberden's nodes (thumb, middle, ring, and little finger DIP joints), Bouchard's nodes (index finger PIP joint), and lateral radial/ulnar deviation (index PIP joint, ring DIP joint) in the left hand of a person with nodal OA.
DIP: distal interphalangeal; PIP: proximal interphalangeal; OA: osteoarthritis.
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UpToDate

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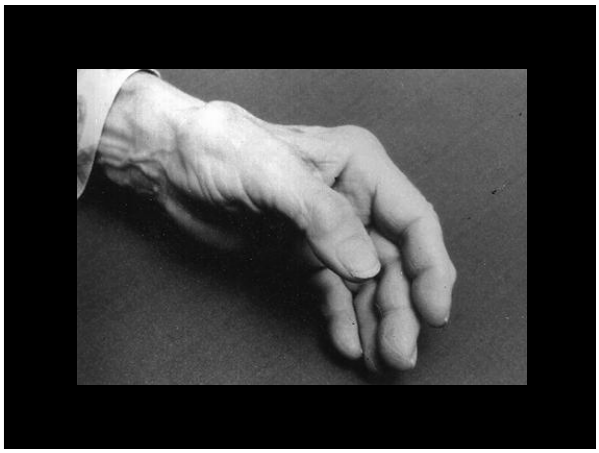

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Diagnosis of OA

- Physical exam and XR are typically adequate
- MRI, CT and US useful in specific cases
- US and MR have shown that CPPD may complicate 30% of cases increasing to 60% in older patients
- CPPD crystals can create more inflammatory and pain issues

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Treating the Patient with OA

- Rx is oriented toward maintaining function
- Reduction of pain
- Limiting ongoing injury
- Decreasing risk of complications such as surgical intervention or permanent joint damage

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Nonpharmacologic Approaches to RX

- Emphasize exercise to maintain aerobic fitness
- Decrease stress of ADLs
- Weight loss when indicated
- Range of motion
- Improve strength

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Changing Paradigm of OA and Exercise

- Old Paradigm: joint is damaged so maximal rest and limited stress is best strategy
- New Paradigm is POLICE
  - Protection
  - Optimal Loading
  - Ice
  - Compression
  - Elevation

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Exercise as Therapy for OA

- Beneficial effect in OA of knee documented in 17 studies to reduce pain and improve function.
- Guidelines for optimal exercise type and dose are lacking but both biking and water exercise were very effective in Knee OA
- Trend to allow a mix of weight bearing – walking or hiking, strength work, Pilates or yoga, biking or swimming
- Alternate weight bearing and non WB days

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Does Exercise Cause OA?

- Studies of runners suggest that risk is actually decreased
- Studies linking exercise to OA usually show that injury was actually the key factor
- Occupational studies probably demonstrate the same confounder

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Jama 2020: Risks for Knee OA

- Large population study looked at activity levels and knee OA – 10 year f/u Xrays
- All subjects had mild symptoms and high function
- Low to moderate physical activity. OR 0.69
- Any vigorous activity OR 0.75
- Long term extensive sitting OR 1.0

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Jama 2020: physical activity and knee OA

- 49.7% failed to perform any strenuous P.A. in 8 years
- 42.5% reported persistent moderate-to-high frequency of extensive sitting.
- Specific factors limit physical activity
  - Older age
  - higher BMI
  - more severe knee pain
  - non–college-graduate education level
  - weaker quadriceps
  - depression

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OARSI guidelines for Medical treatment

- Topical non-steroidal NSAIDs were strongly recommended for individuals with Knee OA (Level 1A).
- OA and GI symptoms: COX-2 inhibitors were Level 1B and NSAIDs with proton pump inhibitors Level 2.
- OA and CVD or frailty: oral NSAIDs not recommended. Intra-articular (IA) corticosteroids, IA
- OA and CVD: hyaluronic acid, and aquatic exercise were Level 1B/Level 2 treatments for Knee OA, but not hip or other areas.

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NSAIDS

- Used at both analgesic and therapeutic doses for OA – trend is for use minimum amount required
- Synovitis is rare so most patients do not require therapeutic dosing or continuous therapy
- Patients respond differently to various classes so change of drug should switch class
- Major drawback is the GI toxicity of all products and risk in patients with CVD or renal disease

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Placebo, Tylenol, Opioids

- Acetaminophen/Paracetamol (APAP) was conditionally not recommended (Level 4A and 4B),
- use of oral and transdermal opioids was strongly not recommended
- Placebo response benefited 60% of patients

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Duloxetine

- Pain relief from central nocioceptive pathways by selective inhibition of serotonin and norepinephrine reuptake
- Pain relief demonstrated in RCTs with RR 1.49 and 1.69 of 30 to 50% pain reduction
- Start with 30 mg but effective at 60 to 120 mg per day
- Nausea in 15 %, fatigue , dizziness, dry mouth

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Tramadol for OA

- Downgraded benefit for pain to questionable clinical benefit *Cochrane 2019*
- Up to 50% more patients do experience a 20% or greater improvement than placebo
- Still only 20% of patients have strong response
- Side-effects led to RR of 2.6 of drop out

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Corticosteroid Injection

- Studies suggest pain relief from 1 to 6 weeks with decline to no benefit by 13 weeks.
- NNT 8 with either 40 or 80 of triamcinolone or methylprednisolone
- By 6 months no difference shown in placebo-controlled trials
- Risk and side-effects minimal
- Long term PT and exercise programs provided as much pain relief

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Hyaluranon – No longer recommended by AAOS

- Hyaluranon showed minimal benefit for pain vs. placebo that did not clearly meet clinically important difference
- Hyaluranon vs. CSI no clear benefit
- Side-effects of flares and wallet damage

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Platelet Rich Plasma

- Meta-analysis of 10 trials showed significant benefit in pain reduction
- PRP outperformed placebo
- PRP outperformed Hyaluranon
- Trials had high risk of bias and unclear how many injections needed
- No long term or outcome-based EBM yet
- Relatively expensive

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Supplements – limited EBM

- Most supplements show a lack of clinically important benefit
  - glucosamine, chondroitin,
  - vitamin D, diacerein, avocado soybean unsaponifiables (ASU),
  - fish oil
- curcumin (active ingredient of turmeric) small trials show benefit and no significant side-effects
- Boswellia serrata small trials with benefit and no significant side-effects

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Activity After Knee Arthroplasty

- Diduch: 88 pts/ 114 total knees/ mean age 51
- 86 improved activity/ 24% to vigorous sport
- Bradbury: 159 pts/ 208 knees
- 65% returned to sports activity
- Bowling 91%/ golf 57%/ tennis 20%

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Summary OA

- OA affects a majority of people sometime in life
- Exercise, weight loss and overall conditioning provide the cornerstone for successful disease control
- Medical options offer relief of pain
- Tylenol and Hyaluranon have lost favor
- TKR and THR returns older people to sport

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Concussion: Update on Evidence Base Medicine

Dominic McKinley, MD, CAQ

August 8, 2020

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Learning Objectives

- To be able to diagnose a concussion
- To be able to manage a concussion based on evidence based medicine
- To be able to understand the different subsets of concussions

2

What is a Concussion?

mild Traumtic Brain Injury (mTBI)

3

Mild Traumatic Brain Injury (mTBI) Criteria

- Glasgow Coma Scale (GCS) score: 13-15
  - Measured 30 min after injury (or upon presentation)
- LOC < 30 min
- Post traumatic amnesia < 24 hrs
- Transient neurological abnormalities after sustaining brain trauma
  - American Congress of Rehabilitation Medicine (ACRM). Definition of mild traumatic brain injury. *J Head Trauma Rehabil* (1993) 8:86–7.

4

Concussion (mTBI) Definition

- "...is a traumatic brain injury induced by biomechanical forces..."
  - CISG Berlin 5th ed 2017
- "...a traumatic physiological brain injury..."
  - Leddy, J et al., Exercise is Medicine for Concussion. *Current Sports Med Reports.* 2018; 17:262-270
- "...a heterogeneous mild traumatic brain injury (mTBI)characterized by a variety of symptoms, clinical presentations, and recovery trajectories..."
  - Lumba-Brown A, Teramoto M, Bloom OJ *et al.* Concussion guidelines step 2: evidence for subtype classification. *Neurosurgery* nyz332 (2019)
- "...acute brain injury resulting from mechanical energy to the head from external physical forces."
  - American Congress of Rehabilitation Medicine (ACRM)

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Mechanism of Injury

Contact Forces

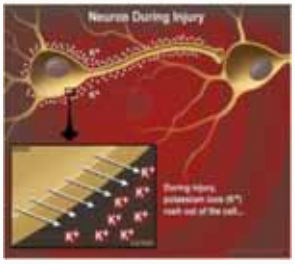
- Direct blow

Inertial Forces

- Indirect blow
- Rotational forces
  - Damages deep white matter

6

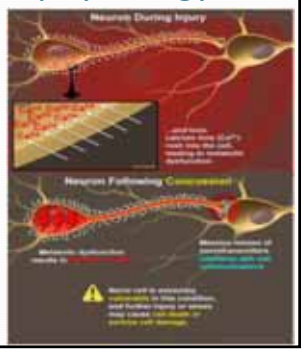
Concussion Pathophysiology



7

Concussion Pathophysiology

- Vestibular Impact:
  - Complex central system of small sensory inner ear organs, brain stem connections, cerebellum, cerebral cortex, ocular system , thalamus and muscles
  - Alters info related to head movement and position to maintain visual and balance control in time and space



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Epidemiology

- High risk sports:
  - Football
  - Hockey
  - Lacrosse
  - Soccer
  - Cheerleading
  - Boxing

9

Epidemiology

- Athletes likely to sustain multiple concussions in their career
  - Kobeissy FH, editor. Brain Neurotrauma: Molecular, Neuropsychological, and Rehabilitation Aspects. Boca Raton (FL): CRC Press/Taylor & Francis; 2015.
- Gender difference
  - Kobeissy FH, editor. Brain Neurotrauma: Molecular, Neuropsychological, and Rehabilitation Aspects. Boca Raton (FL): CRC Press/Taylor & Francis; 2015.
  - Females are likely to take longer to recover and more likely to have sxs lasting more than 1 month
    - Iverson GL, Gardner AJ, Terry DP, et al. Predictors of clinical recovery from concussion: a systematic review. Br J SportsMed. 2017;51:941–948.
  - Females may be at higher risk of a neck injury associated with a concussion in sports with similar rules as men
    - Sutton M, et al JOURNAL OF WOMEN'S HEALTH 2019 DOI: 10.1089/jwh.2018.7282

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Differential Diagnosis

- Cerebral hematoma
- Skull fracture
- Drug induced
- Seizure
- Cerebral edema

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How to Diagnose A Sport Related Concussion (SRC):

mild Traumtic Brain Injury (mTBI)

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Preseason Screening

- "Best Practice" per NCAA
  - Symptom check list
  - Cognitive Eval
  - Balance assessment
  - Standard Concussion Assessment Tool 5th Ed. (SCAT – 5)
- Computerized Neuropsychological Test
  - Immediate Postconcussion Assessment and Cognitive Testing (ImPact)
  - Cogsport
  - Central Nervous System Vital Signs
  - Automated Neuropsychological Assessment Metrics

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Transient Neurological Symptoms

- Symptoms occur with 1st 30 min to 4 hrs post injury
- Headache – most common
- Dizziness
  - Predictor of protracted recovery (> 21 dys)
- Nausea
- Vomiting
- LOC
- Slurred speech
- Decrease concentration
- Dazed
- Visual impairment
- Fatigue
- Foggy feeling
- Tinnitus
- Confusion
- Memory deficits
- Not feeling right
- Phonophobia
- Photophobia
- Mood changes

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Neurobehavioral Symptoms

Somatic

- Physical changes:
  - Headache*
  - Nausea/vomiting
  - Dizziness
  - Fatigue
  - Sleep disturbance

Neuropsychiatric

- Cognitive deficits
  - Attention
  - Memory
  - Executive function
  - Depression
- Behavorial
  - Personality change
  - Depression
  - Anxiety

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On-Field Assessment

- Initial observation of the athlete
- Basic Life Support protocol
- Do not move the athlete unless cleared to do so and triage plan in place
- Clear the cervical spine with questions and exam
- Eval for red flags
- Maddocks Questions – place/time/memory assessment – *Clin J Sport Med 1995*
- Glasgow Coma Scale (GCS)
- Neuro exam
- Do not remove any equipment unless trained and for airway management
- If no medical personnel immediately available, the athlete should be taken to a medical facility for urgent evaluation

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Red Flags:

- Neck pain/tenderness - midline
- Double vision
- Weakness/tingling in extremities
- Severe or increasing headache
- Seizure or convulsion
- LOC
- Deteriorating cognitive function
- Vomiting
- Increasing restlessness, agitation or combativeness

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Off-Field Assessment

- Includes: Sideline, emergency care facility or office settings
  - Standard Concussion Assessment Tool 5th Ed. (SCAT – 5)
  - Computerized Testing
  - Return to learning status
- Avoid oral NSAIDS until fully medically evaluated
- Monitor close over 24 – 48 hrs for deterioration

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Initial Concussion Screening

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Initial Concussion Screening

- SCAT 5
- Vestibular/Ocular Motor Screening (VOMS)
- Balance Error Scoring System (BESS)

20

Sport Concussion Assessment Tool -5th Edition (SCAT5)

- Standardized tool for concussion assessment for licensed healthcare professionals produced by the Concussion in Sport Group (CISG) in Berlin 2017
  - Concussion Recognition Tool 5 (CRT5) used for nonhealthcare individuals
- For ages 13 y.o. and older
- ***Not used as a stand*** *alone method to diagnose a concussion, measure recovery or make decisions about about RTP*
  - Davis GA, et al Br J Sports Med 2017

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SCAT 5

- Step 1: Athlete background
- Step 2: Symptom evaluation (22 sxs with 0-6 severity rating with max score 132)
- Step 3: Cognitive screening (orientation, immediate memory, concentration)
- Step 4: Neurological screen (includes mBESS)
- Step 5: Delayed recall
- Step 6: Decision and score total

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Child SCAT 5

- Eval ages 5 – 12
- Step 2 includes a child's report and **a parent's report** of sxs (each with 21 sxs with severety grade 0 - 3 totaling 63 points)
- Step 4 neurologic screen
  - the single leg stance for 10 – 12 y.o. only
  - If child cannot read, they can be asked to describe what they see in a picture

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Vestibular/Ocular Motor Screening (VOMS)

- 5 – 10 minute symptom based set of screening tools to identify vestibular and ocular motor impairments
- Includes 5 domains:
  - Smooth pursuit
  - Horizontal and vertical saccades
  - Near point convergence (NPC) distance
  - Horizontal and vertical vestibular-oculomotor reflex (VOR)
  - Visual motion sensitivity (VMS)
- Retrospective chart review cohort study; level of evidence 2
  - 167 pediatric pts (11 – 19 y.o.)
  - Poor scores on any domains except NPC and ACCOM may predict prolong recovery
    - Anzalone AJ, et al. *Am J Sports Med*. 2017
- Vestibular and oculomotor sxs early in concussion may signal a prolonged recovery
    - Konto AP, et al 2017

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VOMS

- 2014 cross-sectional study, level of evidence 2
  - Showed internal consistency and sensitivity in identifying a concussion on screening
  - 64 sport related concussed pt (13.9 ± 2.5 y.o.) vs 78 controls VOMS assess 5 domains and Post-Concussion Symptom Scale (PCSS)
  - 61% sxs provocation with 1 VOMS test
  - VOMS correlated to PCSS score
  - VOR and VMS most predictive of concussed group (odds ration {OR}, 3.89; *P* <.001 for VOR and OR 3.37; *P* <.01 for VMS group)
  - NPC distance ≥ 5 cm and any VOMS item symptom score ≥ 2 increased probability of correctly identifying concussed pt 38% and 50%, respectively
    - Mucha et al. Am J Sports Med. 2014 October ; 42(10): 2479–2486. doi:10.1177/0363546514543775.

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Balance Error Scoring System (BESS)

- Quantitative measurement of postural instability to assess concussed athletes developed 1999
  - Riemann and Guskiewicz Journal of Athletic Training 2000;35(1):19-25
- Assesses vestibulospinal aspect of the vestibular system
- Consists of 6 stance conditions, each 20 seconds
  - Double leg
  - Single leg
  - Tandem
- Nondominant leg used
- Eyes closed
- Performed on both normal and medium density foam surface
- Errors:
  - Inability to maintain stance
  - Eye opening
  - Hip flexion or abduction > 30°
  - Lifting foot (toes/heels)
- Max 60 error points

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Modify BESS (M-BESS)

- Assesses balance only on firm surface
- Excellent for sideline assessment
- Max score of 30 points (10 pts for each stance)

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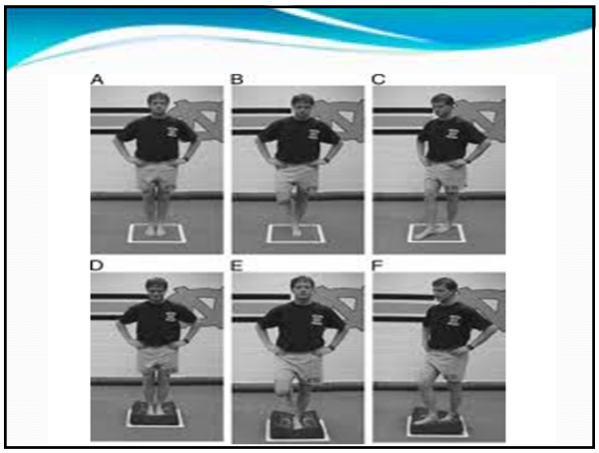

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Concussion Subtypes

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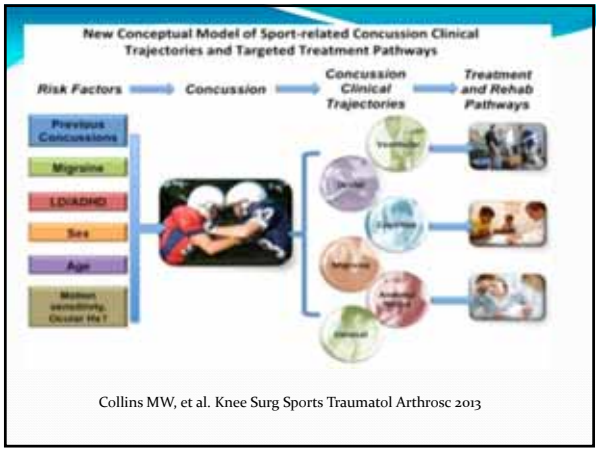

Collins MW, et al. Knee Surg Sports Traumatol Arthrosc 2013

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Sports Related Concussions Subtypes

- Vestibular-spinal (postural/balance)
- Oculomotor (visual stability)
- Cognitive-fatigue
- Anxiety-mood
- Post-traumatic headache/migraine
- Can occur concomitantly or independent – not mutually exclusive
- Subtype predominance may change
- Associated conditions:
  - Cervical strain
  - Sleep disturbance
- Treatment specific

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Headache/Migraine Subtype

- Most prevalent (0.52; 95% CI=0.37, 0.67)
  - Lumba-Brown, et al 2020
- Can involve different types of headaches with migraine
- Can worsen preexisting headache frequency and severity
- Consideration being considered for refine classification within subtype – i.e. migraine vs nonmigraine subtype
- Nausea
- Vomiting
- Light, sound and smell sensitivity

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Vestibular Subtype

- Complex central system of small sensory inner ear organs, brain stem connections, cerebellum, cerebral cortex, ocular system , thalamus and muscles
- Provides info related to head movement and position to maintain visual and balance control in time and space
- Sxs highly prevalent in concussions
  - 23% - 81% dizziness first days of injury
    - *JNPT* 2010;34: 87–93
  - Highly prevalent in pediatric group
- Includes: vestibul-ocular (VOR and VMS), vestibulo-spinal(balance) and gait dysfunction
- Dizziness
- Fogginess
- Lightheadedness
- Nausea
- Vertigo
- Disequilibrium
- Impaired balance
- Associated with:
  - Diminished verbal memory
  - Diminished processing speed
  - Diminished reaction time

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Oculo-motor (Visual) Subtype

- Up to 45% of SRC athletes may experience convergence insufficiency (CI)
  - Konto AP, et al 2017
- CI may be associated with increased cognitive impairment and prolong recovery
  - Pearce KL, et al 2015
- Can lead to impaired academic performance
- Blurred vision
- Diplopia
- Difficulty reading
- Eyestrain (asthenopia)
- Photophobia
- Headache
- Dizziness
- Poor vision concentration
- Nausea

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Anxiety-Mood Subtype

- Pre existing conditions may predispose/contribute to this subtype
- Aggravated by social isolation and decrease physical activity
- May occur in 1/3 of adults and children within 3 days post concussion
  - Lumba-Brown, et al 2020
- Increased:
  - Anxiety/nervousness
  - Feeling more emotional
  - Hypervigilance
  - Ruminative thoughts
  - Feelings of being overwhelmed
  - Depressed mood/sadness
  - Anger
  - Hostility/irritability
  - Loss of energy
  - Fatigue
  - Feeling of hopelessness

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Cognitive-Fatigue Subtype

- Deficits in testing
- Can have exacerbation of preexisting of cognitive dysfunction
- Impaired:
  - Attention
  - Reaction time
  - Speed of processing/performance
  - Working memory
  - New learning
  - Memory storage and retrieval (amnesia)
  - Organization of thoughts

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Concussion-Associated Conditions

Cervical Strain

- Share common MOI to concussion
- Occipital headache
- Neck stiffness, weakness
- Occurs with other concussion sxs
- Injury to the neck can affect vestibular pathways to the brain

Sleep Disturbance

- Difficulty initiating and/or maintaining quality sleep
- Does not occur in isolation of other concussion sxs
- May affect recovery
- Can lead to fatigue, daytime drowsiness and tiredness

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Neuroimaging

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Neuroimaging

- Reserved for deteriorating neurological sxs or another diagnosis being considered, GSC < 13
- Non – contrast CT
  - Test of choice for acute eval to assess for intracranial bleed or fracture
- Magnetic Resonance Imaging
  - Usually reserve for persisting postconcussion sxs

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Evidence-Based Treatment Options

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Evidence-Based Treatment Options

- Vestibular and Visual Rehab
- Exercise
  - Exertional assessments using self reported sxs, HR and BP measures
  - Emerging evidence suggests safe and effective in treatment
- Physical Therapy:
  - Manual Therapy
  - Neck Rehab
  - Active Rehabilitation
    - *J Orthop Sports Phys Ther. 2020;50(4):CPG1-CPG73. doi:10.2519/jospt.2020.0301*
- Pharmacological Treatment
- Diet/Nutrition
- Education and Reassurance

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Vestibular and Visual Rehab

- There has been increasing interest in the use of vestibular rehabilitation for the treatment or management of patients with vestibular dysfunction
  - Chang 2008; Giray 2009; Hoffer 2011
- The original protocols by Cooksey and Cawthorne used group activities in a hierarchy of difficulty to challenge the central nervous system
  - (Cooksey 1946)

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Vestibular and Visual Rehab

- Addresses dizziness and visual/gaze dysfunction leading to trouble with postural stability, memory and concentration
- Step wise progression of provocative stimuli in an expose-recover manner to restore normal function of balance and vision
- Involves challenging the visual, somatosensory and vestibular systems
- *Vestibular rehabilitation should be considered in the management of individuals post concussion who have dizziness, gait and balance dysfunction that do not resolve with rest.*
  - Alsalaheen BA, et al. Bestibular Rehabilitaion for Dizziness and Balance Disorders After Concussion. *JNPT* 2010;34: 87–93. DOI: 10.1097/NPT.0b013e318dde568.

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Vestibular and Visual Rehab

Postconcussion Complaints

- Benign Paroxysmal Positional Vertigo (BPPV)
- Vestibulo-ocular reflex (VOR) impairment
- Visual motor sensitivity
- Balance impairment
- Cervicogenic dizziness
- Exercise induced dizziness

Rehab Intervention

- **BPPV:** Dix-Hallpike/Roll test
- **VOR:** Adaptation exercises
- **Visual motor sensitivity:** gradual and systemic exposure to provocative stimuli focused on graded exercises for visual, somatosensory and vestibular rehab
- **Cervicogenic dizziness:** treat underlying muscle injury
- **Exercise induced dizziness:** treatment controversial

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Ocular Therapy for mTBI

- Goal:
  - Non-surgical therapy for ocular muscle dysfunction
  - Can improve reading function
- Addresses convergence insufficiency, accommodative insufficiency, impaired version movements and minor ocular misalignments
- Involves use of eye patches, penlights, mirrors, lenses, prisms alternating monocular and binocular actions
- Limited empirical data for support of VT
  - 2011 Cochran review, Scheiman 2011a and 2011b
  - Ciuffreda, et al 2008
  - Thiagarajan, et al 2014
- Home software programs can be purchased

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Exercise

- Rest, rest and more rest…Oh Wait!…Exercise!
  - "Rest is Best" concept
    - "The concept of physical and cognitive rest as the cornerstone of concussion management was developed…by the International Concussion in Sport Group…"
      - Broglio, SP, et al. *Clin Sports Med.* 2015 April ; 34(2): 213–231. doi:10.1016/j.csm.2014.12.005.
    - Related to vulnerable period early after a concussion, but extended to postconcussive period as well
    - Insufficient evidence that rest promotes recovery
      - CISG-5 2017
- Oh Wait!…Exercise!
  - RTC trial showed strict rest beyond 2 days prolonged recovery
    - Kozlowski KF, Graham J, Leddy JJ, et al. Exercise intolerance in individuals with postconcussion syndrome. *J Athl. Train.* 2013; 48; 48:627-35
  - Reduced physical activity is detrimental to the athletes mental health
    - Thomas DG, et al. 2015

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What Constitutes Rest?

- Based on expert consensus
  - 24 – 72 hrs
- No agreement/No prospective RTC trials
- "Shut down" or "Dark Closet"
  - Restriction from all physical and cognitive activity until symptoms resolve

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Exercise

- What is the proper dose of "prescribed exercise" and type of exercise for each individual?
  - Subthreshold aerobic exercise
    - Leddy JJ, Kozlowski K, Donnelly JP, et al 2010
  - Unforced, voluntary exercise vs forced exercise
    - Influence on brain-derived neurotrophic factor (BDNF) levels
      - Griesbach GS, et al 2014; Griesbach GS, et al 2012

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Exercise

- The Buffalo Concussion Treadmill Test (BCTT)
  - "*A systematic and reliable method to determine the symptom-exacerbation exercise threshold in concussed patients*"
    - Leddy JJ, Baker JG, Kozlowski K, et al. Reliability of a graded exercise test for assessing recovery from concussion. Clin. J. Sport Med. 2011; 21:89-94. Epub 2011/03/02. doi: 10.1097/JSM.0b013e318dc721 00042752-201103000-00003 [pii]. PubMed PMID: 21358497.36.
  - Gives specific goals to achieve without focus on speed to recovery
  - Does not increase sxs the day post test or delay recovery when stop criteria are followed
- The Buffalo Concussion Bike Test (BCBT)
  - Based on stationary bike resistance required to achieve an equivalent VO_2 for each treadmill stage

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Exercise

- BCTT/BCBT exercise prescription:
  - Submaximal symptom exacerbation threshold determined
  - Prescribed exercise starts with bike for 1 week, treadmill for 20 min/dy 6-7 dys/wk at 80-90% of threshold HR
  - Exercised stopped at first sign of sxs exacerbation based on 2 pt increase from preexercise baseline
  - Recovery goal reached at ≥80% of max. HR for 20 min multiple days without sxs aggravation

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Manual Therapy and Neck Rehab

- Concussion injuries are associated with neck strains("whiplash")
  - Canadian study suggest 100% of the time
  - Cross over sxs between concussion and neck strain
  - Atlanto-occipital joint dysfunction can cause headache and neurological symptoms
- 70-120 G's($9.8 m/s^2$) vs 4.5G's
- 2nd CISG Consensus Statement
- Incooperating neck rehab with VRT has been shown that pts do better within 8 weeks of treatment
  - Diaz DS. Management of athletes with postconcussion syndrome. Semin Speech Lang. 2014;35(3):204–210.

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Pharmacology Treatment

- OTC meds most common for nonspecific treatment
- For prolong symptoms meds usually started about day 10
  - Giza, et al. Neurology, 2013
- No FDA-approved med for sport related concussion
- Most athletes recover from concussions, therefore need to weigh risk vs benefits with pharmacological treatment

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Specific Pharmacologic Treatment

- Tricyclic antidepressant
  - Amitriptyline
  - Treat anxiety/mood subtype
- Selective Serotonin Reuptake Inhibitors (SSRI)
- Selective Norepinephrine Reuptake Inhibitors (SNRI)
- Benzodiazepines
  - Klonopine
  - Vestibular-related anxiety

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Specific Pharmacologic Treatment

- Nonspecific dopamine agonists
  - Neurostimulants have helped to resolve TBI-induced cognitive-fatigue deficits
    - Methylphenidate
      - Newsome et al., 2009; Wagner et al., 2007
    - Amantadine
      - Neurostimulant
        - Dixon et al., 1999; Meythaler et al., 2002; Reddy et al., 2013
      - Facilitates dopamine release and inhibits reuptake
    - Atomoxetine

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Specific Pharmacologic Treatment

- Post traumatic Migraine treatment
  - Anecdotal evidence, no empirical studies
    - Tricyclics
    - SSRI
    - Anticonvulsants
    - Beta blockers
    - Triptans
- Sleep disturbance treatment
  - Melatonin
  - Ambien
  - Lunesta
  - Amitriptyline
  - trazodone

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Other Non-Pharmacologic Treatment

- May be beneficial
  - Biofeedback
  - Cognitive Behavioral Therapy

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Diet/Nutrition

- Focus on anti-inflammatory properties of nutritional substances
- Avoid proinflammatory foods?
- Supplements:
  - Omega 3
  - Creatine
  - Curcumin
  - Magnesium glycinate
  - Melatonin
  - Vitamin B
  - Ketogenic diets

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Mental Health Intervention

- Sport and exercise in general are protective
- Subacute headache and depression risk factors for > 1 month to recovery
- "…Ultimately, removing an athlete from sport may increase the risk for depression and other concussion-like symptoms to develop…"
  - Broglio et al. Page 3 *Clin Sports Med*. Author manuscript; available in PMC 2016 April 01.
- Requires multifactorial assessment and approach to treatment

58

Helmets

- Designed to prevent skull trauma and intracranial bleeding
- Some newer helmets designed to absorb more force at impact
- Sensor systems
  - Measure linear and angular force
  - Limited as force causing concussion is inconsistent amongst athletes

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Biomarkers

- Level of evidence is low for using fluid (blood, cerebrospinal fluid, saliva) biomarkers
- Brain trauma biomarkers
  - FDA approved for cerebral bleeds and brain structural damage
    - Gilal fibrillary acidic protein
    - Ubiquitin carboxy-terminal hydrolase L1 (UCHL1)

60

Return to Play

Can I Play?

61

RTP criteria

- Return to learn fully implemented
- Symptom scores, at rest and with match-intensity exercise have returned to baseline levels
  - State mandated RTP protocol *successfully* completed and signed by authorized medical personnel
- Neurological examination including balance testing are normal
- Cognitive testing (computerized and/or pencil-paper) has returned to baseline or age-appropriate norms
  - Patricios IS, et al. *Br J Sports Med* 2018

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Conclusions and Recommendations

- Initial Concussion Screening:
  - SCAT 5
  - VOMS
  - mBESS
- Educate regarding expected course leading to RTP
- Determine concussion subtype and associated conditions and implement appropriate treatment intervention
- Assess for anxiety, mood, and sleep disturbances in acute setting and recommend appropriate treatment
- Implement vestibular and ocular rehab
- Determine self-directed exercise threshold and progress as tolerated after 24 – 48 hrs of rest

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COMMON PEDIATRIC SPORTS MEDICINE DIAGNOSES

NCAFP Sports Medicine for the Active Patient
August 8, 2020

Ryan Draper, D.O, ABFM, CAQSM
Program Director
Cone Health Sports Medicine Fellowship
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1

Disclosures

- Neither I, nor my family, have any disclosures as it pertains to this lecture

2

- A big Thank You to Drs. Caroline Iskander and Tiffany St. Claire!!

3

Objectives

- Discuss some of the most common overuse pediatric sports injuries
- Learn how to identify some of the most common pediatric fracture patterns
- Discuss pediatric hip conditions (both sports and non-sports related)

4

5

Little League Elbow (Medial Epicondyle Apophysitis)

- Due to high Valgus stress
- Repetitive motion leads to injury to the apophysis in the skeletally immature
- Tend to occur in younger children
  - present with more insidious onset than an avulsion fracture (seen in older children, high school)

6

Medial Epicondyle Apophysitis

- Physical exam:
  - Neurological exam to assess for ulnar nerve involvement
  - Assess stability of elbow
    - May have dislocated and spontaneously reduced as youths have less inherent stability
  - Valgus with 25 degrees of flexion
  - *looking for pain or laxity*

7

8

9

Nursemaids elbow

10

Supracondylar Fractures

- Usually the result of falling onto an outstretched hand (FOOSH) with elbow in extension
- Will usually present with a large elbow effusion
- Can result in injury to the brachial artery, radial nerve, median nerve, or ulnar nerve
- Can also be associated with Volkman's Ischemia (induration of forearm flexors and pain on passive finger extension)

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12

Salter Harris Fracture Classification

13

14

15

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Spondylolysis

- Most frequent identifiable source of back pain in pediatric athletes
- Incidence is 6% by end of childhood
- Chronic back pain if not managed appropriately

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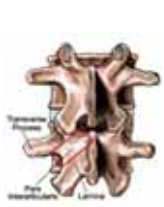
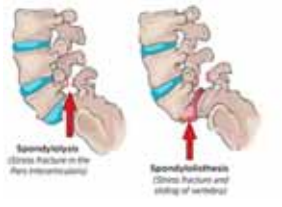
Spondylolysis/Spondylolisthesis

Fatigue fracture of the lumbar pars interarticularis.





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Spondylolysis

- L5 85-95% of the time
- Bilateral ---> spondylolisthesis
- Extreme spinal motion: dancers, gymnast, skaters, lineman, divers, wrestlers
- Commonly occurs during adolescent growth spurt (increase in lordosis leading to greater compressive forces on posterior spine)

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Spondylolysis: History

- Usually insidious but can be acute
- Pain especially worse with extension
- Spondylolisthesis: may present with radicular pain, weakness

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Spondylolysis: Exam

- Pain with deep palpation
- Stork Test - pain on weight bearing side
- Manual resistance to back extension while lying prone with forearms propped
- Hamstring tightness

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Diagnosis

- Can me made clinically
- If pain for more than 3-4 weeks despite rest, lumbar XR (AP and lateral)
- If XR negative and still high suspicion, MRI

23

Management

- Relative rest until pain subsides
  - length depends on symptoms and activities
  - average length is 90 days
- PT once pain subsides
- Gradual return to play

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Pediatric Hip

- Slipped capital femoral epiphysis (SCFE)
- Legg-Calve-Perthes disease
- Hip apophysitis
- Hip avulsion fractures

25

Slipped Capital Femoral Epiphysis

- Salter Harris type I fracture
- Results in slippage of metaphysis and femoral neck
- Most common hip disorder in adolescents
- Obese, 10yo AAM with insidious onset of hip, thigh, or knee pain
- Often bilateral
- PE will show limited hip ROM and reproducible pain
- Will walk with a limp and externally rotated foot
- This is an orthopedic emergency
- Treatment is surgical pinning

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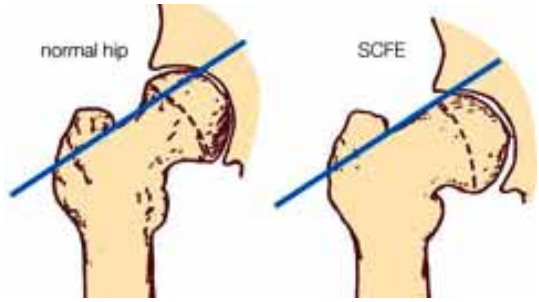

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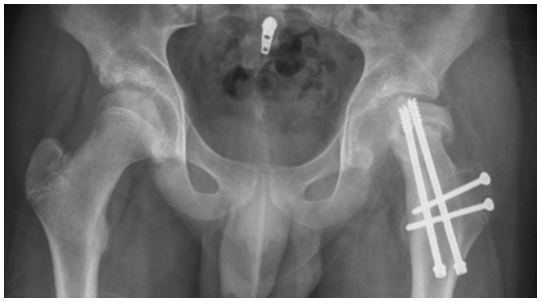

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Legg-Calve-Perthes Disease

- Boys age 4-8
- Painful limp
- Limited ROM
- Refer to orthopedic surgery

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Pelvic Apophysitis/Avulsion Fractures

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- Apophysitis treated with rest
- Avulsions <3mm heal well with conservative treatment
- Avulsions >5mm may need sugery

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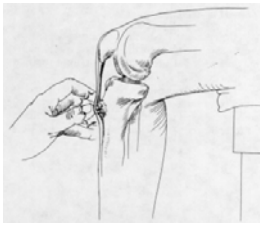
34

Osgood-Schlatter Disease

- Most common traction apophysitis
- Incidence greatest at time of growth spurt (boys 13-14yo, girls 10-11yo)
- *Sxs*: achy pain over tib. tubercle
- *Exam*: tenderness over tib. tubercle
- *X-rays*: none, clinical dx
- *Treatment*: relative rest 2-3 wks, icing, knee sleeve for comfort, use NSAIDS only for pain control

35



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Sinding-Larsen-Johansson Syndrome

- Overuse traction apophysitis at inferior pole of patella
- Most common in 10-14 yo
- *Sxs*: may be traumatically induced, pain worse w/ jumping or running
- *Exam*: tenderness over inf. patella
- *X-rays*: ? elongation of distal patella
- *Treatment*: usually self-limited, same as Osgood-Schlatter

37

Ankle sprain vs Ankle fracture

38

Sever Disease (Calcaneal Apophysitis)

- Pain at the insertion of achilles on the calcaneus, or medial/lateral aspect of calcaneal body
- Associated with growth spurts: age 8-12 yr
- Common in gymnastics, soccer
- Sxs: insidious, pain with activity
- Dx: point tenderness over apophysis, calcaneal compression test
- Rx: ice, heel cups, can take months to resolve

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Calcaneal Apophysitis

40

Iselin's Disease

Apophysitis of insertion site of peroneus brevis tendon on lateral aspect of the base of the fifth metatarsal

- Children (8-13 yo) during rapid periods of growth
- Traction of peroneus brevis tendon at attachment site
- Common in sports involving inversion: soccer, gymnastics, basketball, dancing

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Iselin's Disease: Presentation & Exam

- Pain and swelling over area without hx of trauma
- Pain during activity, usually goes away at rest
- Exam:
  - TTP over 5th metarsal, +/- redness, swelling
  - may limp or walk on inside of foot
  - pain with resisted eversion, extreme plantar flexion

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Iselin's Disease

Imaging (not required):
- Xray: Widening of apophysis on the inferior lateral base of the 5th MT

Treatment:
- Rest, ice, NSAIDs
- Stretch calves
- Insert in shoe may help

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Freiberg's Disease

44

Kohlers Disease

45

In Summary…

- Many pediatric injuries are the result of overuse and can be successfully treated with rest and a gradual return to sport
- Pediatric fractures should be identified early for optimal treatment outcomes
- SCFE is often missed early on and should be high on your index of suspicion for a limping child

46

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Common Shoulder Problems in Family Medicine

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1

Disclosures

- **Neither I, Kevin E. Burroughs, nor any family member(s), have any relevant financial relationships to be discussed, directly or indirectly, referred to or illustrated with or without recognition within the presentation.**

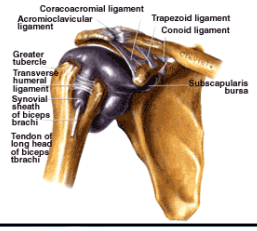
2

Goals/Objectives

- Review basic shoulder anatomy
- Review shoulder examination techniques
- Discuss evaluation and treatment of common shoulder problems encountered in a primary care clinic

3

Tendons and Ligaments of the Shoulder (Anterior View)



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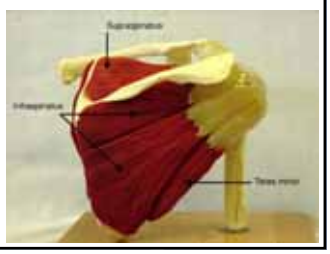
View of Rotator Cuff



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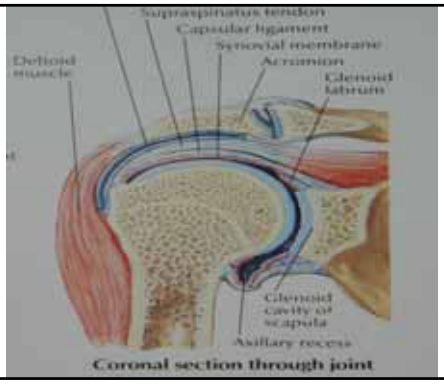

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Functional Anatomy

- 3 bones: clavicle, scapula, humerus
- 4 "joints" comprise the shoulder
  - Sternoclavicular
  - Acromioclavicular
  - Glenohumeral
  - Scapulothoracic (actually an articulation not joint)
- Ranges of motion
  - Abd- 180*, Add- 45*, Flex- 90*, Ext- 45*
  - Int Rotation- 55*, Ext Rotation- 40-45*

7

Pain in the shoulder

- Aside from the shoulder itself, referred pain comes from:
  - Hand (i.e. carpal tunnel)
  - Neck (i.e. cervical radiculopathy)
  - Chest (i.e. cardiac pain, esp left shoulder)
  - Abdomen [i.e. diaphragmatic irritation (gall bladder to right scapula)]
- Onset of pain may be clue also
  - At night, esp lying on side - RC
  - With overhead motions - impingement

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Shoulder-Physical Examination

- Check the neck first (Spurling's)
- Palpation
  - Bony aspects
  - Biceps tendon (long and short heads)
  - Note crepitation
  - In extension anterolateral subacromial space for bursa

9

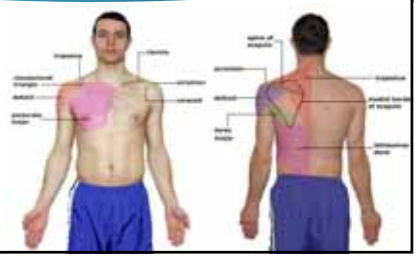
Bony Palpation

- Easiest to start at the sternoclavicular joint
- Work distally along the clavicle to AC
- Just inferior and medial is coracoid process
- From acromion, inferior is lesser tuberosity
  - Biceps groove is just lateral (int rotate arm)
  - Inferior, shoulder extended subacromial bursa
- Spine of scapula points to T-3, inferior T-7

10

Shoulder-Physical Examination

- Inspection
  - Note obvious deformity, asymmetry
  - Muscle atrophy (deltoid, supra and infraspinatus)
  - Skin
    - swelling, ecchymosis, venous distension



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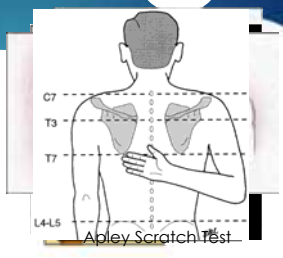
Range of Motion

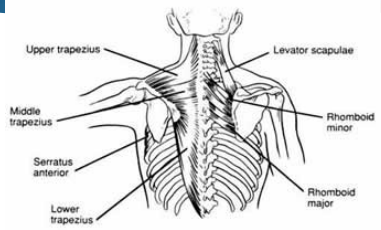
- Forward flexion:
  - 160 – 180°
- Extension:
  - 40 - 60°
- Abduction:
  - 180◦
- Adduction:
  - 45 °
- Internal rotation:



Apley Scratch Test

12

Scapular Actors



www.aaos.org and Arthroscopy: The Journal of Arthroscopic and Related Surgery, Vol 19, No 6 (July-August), 2003: pp 641-661 641

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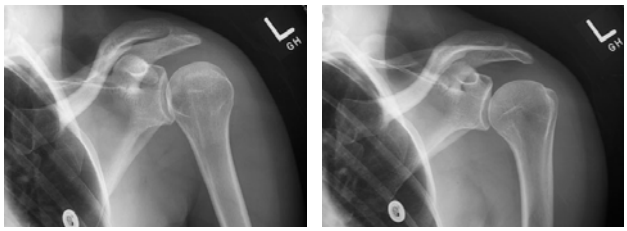
Radiology of the Shoulder - AP



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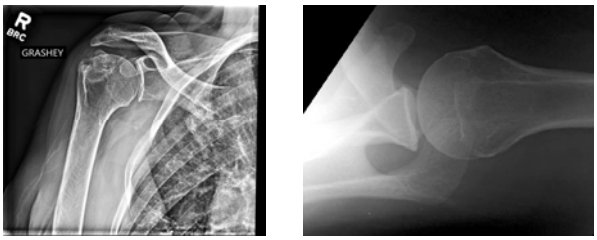
Radiology of the Shoulder



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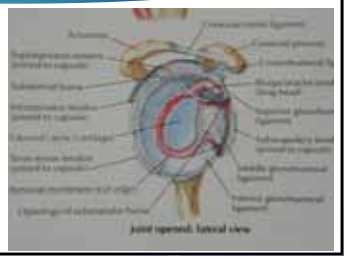
Radiology of the Shoulder



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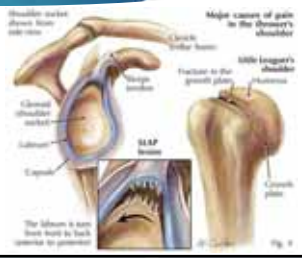
Shoulder Injuries

- Rotator cuff
- Instability
- Labral pathology
- Little Leaguer's shoulder



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Rotator Cuff Injuries - Evaluation

- History
  - Specific injury or insidious onset?
  - Pain during cocking usually impingement
  - Pain during deceleration commonly tensile failure
- Physical exam
  - AROM/PROM
  - Glenohumeral translation
  - Apprehension/relocation tests
  - ↓ strength due to pain, inhibition, fatigue – rarely full-thickness tear

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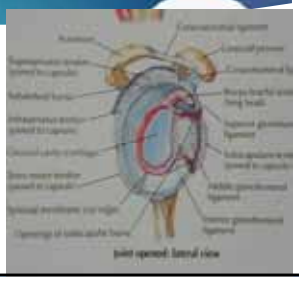
Rotator Cuff

- Mnemonic (anterior to posterior) Sub Sit
  - **Sub** scapularis
  - **S** upraspinatus
  - **I** nfraspinatus
  - **T** eres minor



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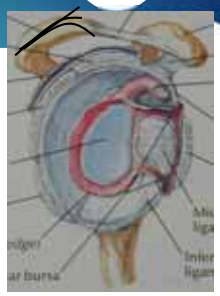
"Impingement"

- Structural or Mechanical
- Shape of the acromion
  - Anatomic variant
  - Degenerative change
  - AC arthropathy



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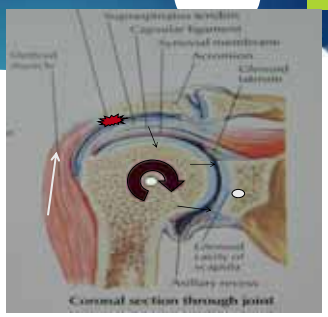
"Impingement"

- Dynamic
  - Affects on rotator cuff allow superior migration
    - RC tear
    - RC tendinitis
    - RC weakness
    - Instability
  - Esp. in <30-35 yo



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Shoulder

- Hawkin's sign
  - Arm passive abduction to 90*, forward flex 30* with thumbs pointing down, internal rotation
- Neer's Impingement sign
  - Arm to full forward elevation, pain 160-180*
  - Positive Neer test if pain relieved by injection
- Speed's test
  - 90* arm forward flexion, palm up, bicep pain
- Yergason's test
  - 0* adduction, elbow flexed. Pt. tries to flex elbow and supinate vs. resistance. Pain biceps

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Rotator Cuff Testing

- EMG study by Kelly et al showed the best positioning to test each of the rotator cuff muscles
- Supraspinatus-
  - "full can", pain with "empty can"
- Infrapinatus-
  - External rotation from -45 degrees
- Subscapularis
  - "Push Off" start with hand in small of back

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Rotator Cuff Injuries - Evaluation

- Radiology
  - Plain films:
    - AP
    - Grashey if concern for OA
    - Outlet
  - MR
  - Ultrasound

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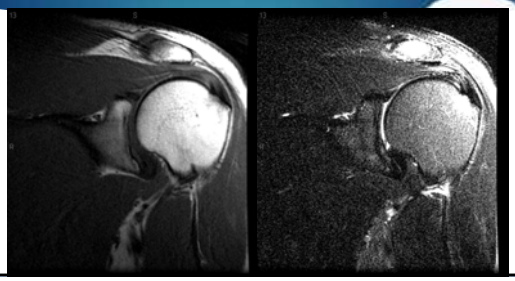
Rotator Cuff Tendinitis



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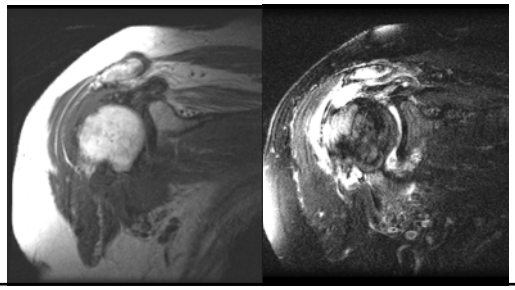
Rotator Cuff Tear with Retraction



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Rotator Cuff Injuries - Treatment

- Rest
- Rehab
  - Restore ROM
  - Strengthen cuff and scapular stabilizers
  - Maintain conditioning
  - Throwing program
- Anti-inflammatories
- Surgery

27

Posterior Capsule Stretch

- Contractures of the posterior structures, pectoralis minor, and short head of the biceps can contribute to glenohumeral internal rotation deficit and increased anterior

28

Labral Pathology

- Repetitive microtrauma results in fraying or tearing
- Disruption of biceps anchor causes pain and anterior-inferior translation of humeral head when completely detached
- Can occur alone, or with instability or cuff pathology

29

O'Brien's Active Compression Test

- Labral, AC, or biceps pathology
- Arm flexed to 90°
- Arm cross-arm adducted 10-15°
- Elbow extended
- Max pronation
- Resist downward force
- Positive test if painful
- Beware location of pain
  - AC

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Shoulder – Labrum Tests

- Other Tests Described
- Biceps Load
  - Abducted arm in 90/90 position, resisted biceps curl
- Crank
  - Axial load with circumduction

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Little Leaguer's Shoulder

- Prox. humerus physeal fxs in Little League players were 1st described by Dotter
- Joint capsule/ligaments ≅ 2-5x stronger than physis
- Present with dull ache and can't throw
- 12-15 greatest risk may not completely fuse 'til 20-22
- Pain due to stress fx at the

32

Little Leaguer's Shoulder

- Mechanism
  - Appears to be caused by rotational stress applied to proximal humeral physis during act of throwing
  - Overuse inflammation of proximal humeral physis vs. stress fracture of physis
  - During throwing, shoulder is forcibly internally rotated and adducted from an externally rotated abducted position

33

Little Leaguer's Shoulder

- Radiology
  - Widening of the proximal humeral physis
  - Easily seen on bilateral AP internal and external rotation x-rays
  - Associated findings
    - Demineralization
    - Sclerosis
    - Fragmentation of lateral aspect of proximal humeral metaphysis

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37

Risk Factors for Injury of Throwing Athletes

Pitching while fatigued	**Throwing too many endings over the course of the year**
Not taking enough time off from baseball every year	**Throwing too many pitches and not getting enough rest**
Pitching on consecutive days	**Excessive throwing when not pitching**
Playing on multiple teams at the same time	**Pitching with injuries to other body regions**
Not following proper strength and conditioning routines	**Not following safe practices while it showed cases**
Throwing curveballs and sliders at a young age	**Radar going use**

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MLB Smart Pitch Count Limits/Rest

Age	Daily Max (Pitches in Game)	0 Days Rest	1 Days Rest	2 Days Rest	3 Days Rest	4 Days Rest	5 Days Rest
7-8	50	1-20	21-35	36-50	N/A	N/A	N/A
9-10	75	1-20	21-35	36-50	51-65	66+	N/A
11-12	85	1-20	21-35	36-50	51-65	66+	N/A
13-14	95	1-20	21-35	36-50	51-65	66+	N/A
15-16	95	1-30	31-45	46-60	61-75	76+	N/A
17-18	105	1-30	31-45	46-60	61-80	81+	N/A
19-22	120	1-30	31-45	46-60	61-80	81-105	106+

- Key to limit workload of pitchers to limit pitching with fatigue.
- Research has shown that pitch counts are the most accurate and effective means of doing so.
- These are the rest recommendations.

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MLB Pitch Smart

- A series of practical, age-appropriate guidelines to help parents, players and coaches avoid overuse injuries and foster long, healthy careers for young pitchers
- **www.mlb.compitch-smart**

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Instability

- Stability relies on ligaments and rotator cuff action
- Inferior glenohumeral ligament
  - Maximally stretched in external rotation
  - Chronic stretching can cause functional incompetence
  - Causes rotator cuff to work harder – can fatigue or tear

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Shoulder Instability- Anterior

- Differentiate Laxity vs Instability
- Traumatic or atraumatic
  - History is key here
- Risk: repetitive overhead, "Gumby" types
- Symptoms: subluxation, "Dead Arm", ache
- Ask to put in position occurs most
  - Abduction, external rotation (Apprehension)
- AMBRI vs TUBS

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Shoulder Dislocations

- AMBRII
  - Atraumatic
  - Multi-directional
  - Bilateral
  - Rehabilitation
  - Inferior Capsular Shift
  - Interval lesion
- TUBS
  - Traumatic
  - Unidirectional
  - Bankart
  - Surgery

Thomas & Matsen JBJS 71A, 1989

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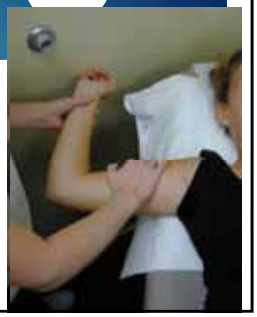
Shoulder - Instability

- Apprehension test ("Bye-Bye" test)
  - 90 abduct, external rotation, watch for giveway
- Relocation test
  - Pt. supine, apprehension or pain with anterior force that improves with posterior directed force



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Sulcus Sign/Test

- Seated, grab elbow, pull inferiorly.
- Observe below acromion for dimple looking for >1cm

45

Instability - Treatment

- Rest
- Rehab
  - As above, with stretching posterior capsule
- Surgical stabilization
  - EUA to determine direction & degree of laxity
  - Correct laxity without compromising motion
  - Subtle laxity → thermal capsulorrhaphy
  - Gross laxity → capsular shift

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Acute Anterior Dislocation

- Present with pain, arm folded across chest
- Loss of deltoid contour, prominent anterior lump
- Must do neurovascular exam
- Best if can X-ray before reduction, but in most cases one attempt at reduction can be performed
- Several techniques

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Anterior Dislocation

- After reduction, hold in internal rotation
- Studies vary on return to mobility
  - No external rotation for 6 weeks, to more aggressive motion in supervised PT
- Recurrence after first dislocation
  - 40-90% depending on study and age of patient
- What are Bankart and Hill-Sachs lesions?

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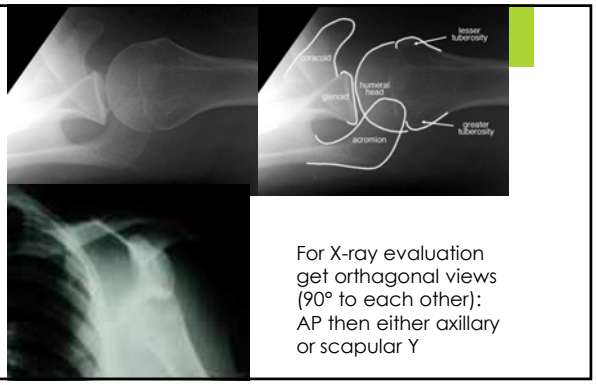

For X-ray evaluation get orthagonal views (90° to each other): AP then either axillary or scapular Y

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Hill-Sachs Lesion

50

Bankart Lesion in ABER

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Posterior Dislocation

- Acute traumatic far less common than anterior.
  - FOOSH, electricution or convulsion
- Loss of normal rounded front
- Marked limitation of external rotation
- Reduce with forward traction
- Similar rehab

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Adhesive Capsulitis

- A self-limiting condition
- Hx: Atraumatic, progressive painful restriction of movement of GH joint.
  - Ext rotation most restricted, then abduction
- Normal radiograph
- Female>male with peak age 56 yrs.
- Variable duration usually lasting 1-3 years
- Etiology greatly unknown

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Adhesive Capsulitis

- Risk Factors

• Previous trauma (immobilization)	• Increasing age
• Female	• Dyslipidemia
• Hypertension	• Thyroid dysfunction
• Diabetes Mellitus	• Stroke/cardiac event

- Meta-analysis 18/5411 articles from Embase and Pubmed
- DM pts 5x more likely for AC than controls. Prevalence in DM 13.4%
- No significant difference insulin vs non-insulin
- Prevalence of DM in AC ~30%

Zreik NH, et al. Muscles Ligaments Tendons J. 6(1):26-34, 2016

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Adhesive Capsulitis - Clinical

- Typically 3 phases
  - Initial painful phase "freezing" diffuse, sometimes severe pain worse at night, increasing stiffness (2 – 12 mos)
  - Phase 2 "frozen" ↓pain but significant loss of motion (4-12 mos)
  - Phase 3 "thaw" shows improving AROM (5-24 mos)
- EXAM:
  - Difficult secondary to pain
  - Can use anesthetic injection to help differentiate from other shoulder pathology
- XRAY:
  - Helpful to evaluate other pathology such as arthritis

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Adhesive Capsulitis - Treatment

- **Manual therapy and exercise for adhesive capsulitis (frozen shoulder)**
  - The best available data show that a combination of manual therapy and exercise may not be as effective as glucocorticoid injection in the short-term. It is unclear whether a combination of manual therapy, exercise and electrotherapy is an effective adjunct to glucocorticoid injection or oral NSAID.
  - High-quality RCTs are needed to establish the benefits and harms of manual therapy and exercise interventions that reflect actual practice, compared with placebo, no intervention and active interventions with evidence of benefit (e.g. glucocorticoid injection).
  - Page MJ et al. Cochrane Database of Systematic Rev. (8)CD011275, 2014 Aug 26.
- **Adhesive Capsulitis of the Shoulder: A Systematic Review of the Effectiveness of Intra-Articular Corticosteroid Injections**
  - **Systematic review PubMed, EMBASE, CINAHL, SportDiscus, MEDLINE and the Cochrane Central Register of** Controlled trials, Database of Systematic Reviews. Level I, II evidence (RCTs) ≥ 6 mos f/u. Led to 8 studies w/406 subjects, 409 shoulders. Steroid injection vs no

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Clavicle Fracture

- Most common in middle third
- History
  - Fall on outstretched arm or fall on point of shoulder
- Physical Exam
  - May be visible/palpable deformity
  - Auscultate lungs
- Treatment
  - Figure of 8 brace or regular sling
  - Distal 1/3 fx, are more difficult and

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AC Joint Injury

- Fall on point of shoulder, or direct blow
- Ligamentous stability of joint provided by:
- AC ligament, CC ligament (2 parts), CA lig
- Grade 1
  - Local tenderness, Sling, return 7-14 days
- Grade 2
  - Local tender, slight deform. Tx same. 3-6 weeks
- Grade 3

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Other Causes of Shoulder Pain

- Adhesive Capsulitis
  - Less common in athlete, unless already injured
- Biceps Tendonitis
  - Long head. Check Yergason Test for stability.
  - Localised therapy
- Rupture of the long head of the biceps
  - "Popeye" arm
  - Typically observational treatment

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QUESTIONS ??????

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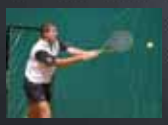
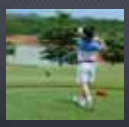
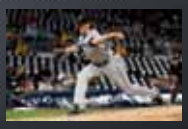
THE "SPORTS" ELBOW

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1

DISCLOSURES

- **Neither I, Kevin E. Burroughs, nor any family member(s), have any relevant financial relationships to be discussed, directly or indirectly, referred to or illustrated with or without recognition within the presentation.**

2

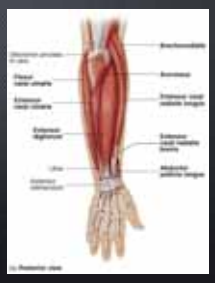
ANTERIOR ELBOW

- Biceps Tendonitis
- Pronator Syndrome
- Joint Effusion
  - Gout
  - OA
- Radial Head Fracture
- OA
- Anterior Capsule Sprain

3

POSTERIOR ELBOW

- Olecranon bursitis
- Triceps tendonitis
- Olecranon stress fracture
- OA
- Posterior Impingment



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MEDIAL ELBOW

- Medial epicondylitis
- Cubital tunnel
- UCL sprain
- Valgus overload syndrome

5

LATERAL ELBOW

- Lateral epicondylitis
- Radial head fracture
- OCD
- Radial tunnel syndrome

6

FUNCTIONAL ANATOMY – ELBOW

7

FUNCTIONAL ANATOMY – ELBOW

8

EXAMINATION OF THE ELBOW

- Inspection
- Neurovascular exam
- Active/functional range of motion
  - Touch shoulder with fingers
  - Supinate / pronate
  - Extend in supination
- Palpation
- Strength testing against resistance
- Assess medial and lateral collateral ligaments

9

ELBOW

- Elbow flexion test (Cubital Tunnel)
  - Elbow flex, wrist extended, ulnar n symptoms
- Varus/valgus stressing
  - (neutral and 30 deg)
- Milking maneuver
  - Elbow flexed >90, other arm under, grasp thumb and "milk" while palpating UCL

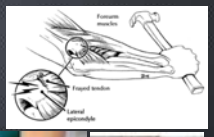
10

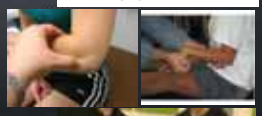
CASE

- 50 year old man who spent the weekend washing the windows of his house and pruning the bushes. He developed lateral elbow pain by Sunday afternoon and it has not gotten better with his work for the past two days. He describes pain when trying to turn the key in the car, open doors or typing on the computer. Ibuprofen does not help a lot.

11

LATERAL EPICONDYLITIS (TENNIS ELBOW)





- Related to acute and chronic use of the wrist extensor and supinator muscles.
- Symptoms: Pain at the lateral epicondyle.
- Exam: Pain increased with resisted extension/supination or passive flexion/pronation (stretch tests). Also pain with resisted long finger extension.

12

TESTS FOR THE ELBOW

- Cozen's Test
  - Resisted wrist extension
- Golfer's Elbow Test
  - Resisted wrist flexion
- Polk Test
  - Picking up a book palm down (lat epi), palm up (med epi)
- Mill's Test
  - Elbow extended, forearm pronated passive palmar flexion = pain at lat epi
- Maudsley's Test
  - Pain with resisted middle finger extension
- Grip Strength
  - 10% decrease reported 90% specificity lat epi

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LATERAL EPICONDYLITIS – ORTHOTIC

- Five RCTs (N per group 7-49) were included. Validity score ranged from 3-9 positive items out of 11. Subgroup analyses were not
- performed due to the small number of trials. The limited number of included trials present few outcome measures and limited longterm
- results. Pooling was not possible due to large heterogeneity amongst trials.
- No definitive conclusions can be drawn concerning effectiveness of orthotic devices for lateral epicondylitis. More well-designed and
- well-conducted RCTs of sufficient power are warranted.

Struijs PA, et al. Cochrane Database of Systematic Reviews (1)CD001821, 2002.

14

LATERAL EPICONDYLITIS – TREATMENT

- Comparative efficacy and safety of nonsurgical treatment options for enthesopathy of the extensor carpi radialis brevis
  - Lian J, et al. AJSM 47(12):3019-3029, 2019.
  - 36 RCT, 11 different modalities, 2746 patients
    - At short-term follow-up only CSI improved pain but then was worse than placebo at long-term follow-up. At midterm follow-up laser therapy and local Botox injection improved pain. At long-term follow-up ESWT provided pain relief. Laser therapy was the only intervention to improve grip strength. All modalities increase the odds ratio of adverse event.
- Comparison of the effects of short-duration wrist joint splinting combined with physical therapy and physical therapy alone on the management of patients with lateral epicondylitis.
  - Kachanathu SJ, et al. Eur J Phys Rehabil Med. 55(4):488-493, 2019 Aug.
    - RCT showed that bracing in addition to physical therapy for short duration is effective in decreasing pain intensity more so than physical therapy alone.
- Predictors for outcome in acute lateral epicondylitis.
  - Holmedal O, et al. BMC Musculoskelet Disord. 20(1):375, 2019 Aug 17.
    - Most consistent predictor for reduced treatment success all time points was high pain-free function index score signifying more pain on every day activities. Being on paid

15

LATERAL EPICONDYLITIS

- Kinesiotaping
  - Shows improvement in QuickDASH, VAS, Grip Strength
- Saline Injection
  - Improved DASH at 6 mos, VAS at 6 and 12 mos.
- Iontophoresis
  - RDBCT superior to galvanic current
- Deep friction massage
  - RCT 6 mos f/u improved VAS, DASH and grip strength
- PRP
  - Comparison of platelet rich plasma and CS in the mgmt. of lat epi. Meta-analysis of RCTs.
  - Xu Q, et al. International Journal of Surgery 67:37-46, 2019 Jul.
  - 7 RCT 515 pts. PRP gave significant superior pain scores at 6 mos compared to CSI.

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LATERAL EPICONDYLITIS (TENNIS ELBOW)

- Rest from the offending activity.
  - Ice or heat (whatever works best)
  - Stretching, then strengthening as pain resolves.
- Tennis specific:
  - 2-hand backhand.
  - Midsize racquet, less string tension, adjust grip (too large or small).
- *Counter* force brace and/or *wrist* splint as needed.
- Cortisone injection if above measures fail.

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WHEN IS TENNIS ELBOW NOT TENNIS ELBOW?

- Radial Tunnel Syndrome
  - Trapping of the Posterior Interosseous Nerve in the Arcade of Frohse
  - Pain and difficulty with resisted extension of the long finger with the elbow in extension
  - Tenderness 4-5 cm distal to the lateral epicondyle
  - +/- Finger and wrist extensor weakness

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MEDIAL EPICONDYLITIS (GOLFER'S ELBOW)

- Overall prevalence <1%, but ~4-8% pts in occupational settings
- 10-20% of epicondylitis
- Microtrauma/degeneration of the common flexor/pronator mass
- Typically 40-60 yo, M=F

- Flexor/pronator tendon confluence of 5 muscles
  - Pronator teres, flex carpi rad, flex carpi ulnaris, palmaris longus, flex digit superficialis
- Attached at med epi anteriorly
- Repetitive loading +/- valgus force at the elbow

Amin NH. JAAOS 23(6):348-355, 2015.

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MEDIAL EPICONDYLITIS

- Staged Process
  - Peritendinous inflammation → angiofibroblastic hyperplasia →replacement of normal tendon fibers and breakdown → fibrosis/tear and calcification
  - Significant damage → inc UCL strain (particularly in throwing athletes)
- Differential Diagnosis

• Ulnar Neuritis	• Tendinopathy	• Ligamentous instability
• Intra-articular Pathology (OCD)	• Capsulitis (inflammatory)	• Trauma

- Common in occupational settings
  - Repetitive forceful grip, manual handling of loads >44 lbs, constant vibratory forces at the elbow
  - ≤ 84% of occupational pts additional concomitant work-related disorders
    - Carpal tunnel, lat epi, RC tendonitis

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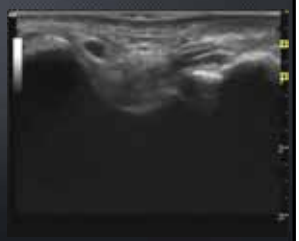
MEDIAL EPICONDYLITIS

- Eval for cervical radiculopathy
- Not uncommon to have ulnar neuritis as well
  - Tinel's
  - Elbow flexion test (max flexion elbow, pronation, wrist extension)
  - Eval for subluxation
- Xray
  - Rule out other issues, calcification
- Ultrasound
- MRI



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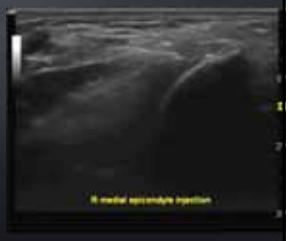
MEDIAL EPICONDYLITIS

- Treatment
  - Help with pain – analgesic +/- NSAID
  - Bracing/taping
    - If immobilization caution with duration
  - ? ESWT
  - CSI
    - Caution with location
    - Iatrogenic effects (hypopigmentation, lipoatrophy)
  - PT
    - Stretching/strengthening
    - Don't forget shoulder too
  - Modification to any equipment, ? Job position
  - Surgery



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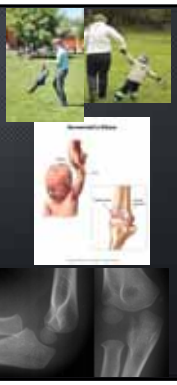
NURSEMAID'S ELBOW

- Sudden jerking of arm in an extended and pronated fashion (preventing a child from falling; merry-go-round)
- Head of Radius subluxes out of the annular ligament
- Most common before age 4 (before ossification of radial head)
- Can be associated with a fracture of the ulna (small greenstick fx; Monteggia fx) or supracondylar fx rarely
- Exam:
  - Child with elbow pronated, partially flexed and held close
  - Apprehensive to full extension or any supination
  - Tenderness isolated to radial head (not over ulna)
  - X-rays usually not clearly show subluxation but are



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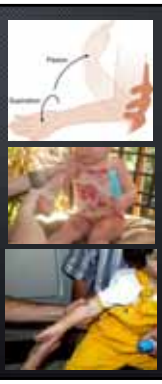
NURSEMAID'S ELBOW REDUCTION

- Hold the elbow from behind with your thumb over the radial head (to prevent movement of shoulder and apply pressure to radial head)
- Other hand holds the wrist and applies rotational force to put the hand into supination and then bends elbow into flexion
- Alternative Method: Hyperpronation
- May hear click
- Should have complete return of function
  - Be suspicious of fracture if not!
- Only immobilize if reduction is > 12 hours after subluxation
- May take a few attempts



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LATERAL EPICONDYLITIS INJECTION

- Indications:
  - Lateral tennis elbow that fails to improve with conservative therapy
- Clinical anatomy/landmarks
  - Radial head, appreciated by pronation/supination
  - Humeral lateral epicondyle
  - Extensor carpi radialis brevis

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LATERAL EPICONDYLITIS

- Identify landmarks
  - Olecranon
  - Lateral Epicondyle
  - Radial Head
- Confirm difference between epicondyle and radial head with sup/pro
- Confirm point of maximal tenderness with extension of wrist

26

LATERAL EPICONDYLITIS

- Identify landmarks
  - Olecranon
  - Lateral Epicondyle
  - Radial Head
- Confirm difference between epicondyle and radial head with sup/pro
- Confirm point of maximal tenderness with extension of wrist

27

LATERAL EPICONDYLITIS

- Identify landmarks
  - Olecranon
  - Lateral Epicondyle
  - Radial Head
- Confirm difference between epicondyle and radial head with sup/pro
- Confirm point of maximal tenderness with extension of wrist

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LATERAL EPICONDYLITIS

- Identify landmarks
  - Olecranon
  - Lateral Epicondyle
  - Radial Head
- Confirm difference between epicondyle and radial head with sup/pro
- Confirm point of maximal tenderness with extension of wrist

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LATERAL EPICONDYLITIS TENNIS ELBOW

- Technique:
  - Supine or seated
  - Elbow in 90 degrees of flexion and pronated
  - Area of maximal tenderness found at the anterior surface of the lateral epicondyle
  - Needle inserted directed at the anterior surface of the lateral epicondyle (near the common extensor origin)
  - "Peppering technique"

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LATERAL EPICONDYLITIS TENNIS ELBOW

- NEEDLE SIZE AND DOSAGE:
  - 25 TO 27 GAUGE 1 INCH NEEDLE
  - .5ML OF BETAMETHASONE WITH 0.5 ML OF 1 OR 2% LIDOCAINE

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TYPES OF ELBOW INJURIES IN YOUNG THROWING ATHLETES

- ANTERIOR COMPARTMENT
  - ANTERIOR CAPSULAR STRETCHING
  - BICIPITAL TENDONITIS
  - BICEPS WEAKNESS
  - OSTEOCHONDRITIS DISSECANS
- LATERAL COMPARTMENT
  - SUPINATOR MUSCLE STRAIN
  - LATERAL APOPHYSITIS
  - ANCONEUS MUSCLE STAIN
  - SUPRACHONDRAL FRACTURE
- Posterior compartment
  - Posterior impingement
  - Olecranon apophysitis
  - Triceps tendonitis
- Medial Compartment
  - Ulnar collateral ligament strain
  - Flexor muscle strain
  - Medial apophysitis
  - Ulnar nerve neurpraxia

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ELBOW OSSIFICATIONS

Ossification Centers
6 at the elbow
Appear, then fuse at different ages
Appear in distinct order:
Capitellum
Radius
Internal (medial) epicondyle
Trochlea
Olecranon
External (lateral) epicondyle

Ages they appear are variable but the standard answer is
1-3-5-7-9-11 years.

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TYPICAL HISTORY

- Medial elbow and proximal forearm pain occurring a few days after throwing to first base from third or shortstop or after pitching
- Pain abates with rest but returns with throwing
- Usually best "skill" player

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INJURY MECHANISM

- Overhand throwing subjects the elbow to forces of tension, compression, shear, and torsion
- Two main stages are acceleration, and follow through

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THROWING INJURIES TO ELBOW

- Acceleration Phase
  - Valgus force greatest
  - Causes medial tension stress
    - Ulnar collateral ligament and epicondyle
  - And lateral compression stress
    - Radiocapitellar joint
- Release/Deceleration Phase - elbow flexors stressed.
- Follow-thru Phase - hyperextension jams Olecranon into fossa.

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LITTLE LEAGUER'S ELBOW "SYNDROME?"

- MEDIAL ELBOW STRESS INJURY IN YOUNG OVERHEAD ATHLETES
- RECURRENT MICROTRAUMA OF THE ELBOW JOINT
  - DELAYED OR ACCELERATED GROWTH OF THE MEDIAL EPICONDYLE (MEDIAL EPICONDYLAR APOPHYSITIS),
  - TRACTION APOPHYSITIS (MEDIAL EPICONDYLAR FRAGMENTATION),
  - MEDIAL EPICONDYLITIS

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LITTLE LEAGUER'S ELBOW

- 9-14 YEAR-OLD PITCHERS
- SYMPTOMS
  - PAIN WITH ACTIVITY (PARTICULARLY ACCELERATION)
  - CLICKING, CATCHING, LOCKING
- PHYSICAL EXAM
  - PAIN W VARUS/VALGUS STRESS
  - TENDER @ MEDIAL EPICONDYLE
- X-RAYS
  - NARROWING OF LAT JOINT SPACE
  - SEPARATION MEDIAL EPICONDYLE

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LITTLE LEAGUE ELBOW

- TRACTION AT GROWTH PLATE OF MEDIAL EPICONDYLE (WEAKER THAN UCL).
- SYMPTOMS: INSIDIOUS ONSET OF MEDIAL ELBOW PAIN, OFTEN UNREPORTED
- EXAM: TENDER AT EPICONDYLE
- X-RAYS: MAY SHOW WIDENING AT GROWTH PLATE (COMPARE WITH IMAGES FROM OTHER ELBOW)
- TREATMENT: REST AND ICE, GRADUATED THROWING AFTER PAIN FREE 3-4 WEEKS OR LONGER. CONSIDER SURGERY IF DISPLACED.

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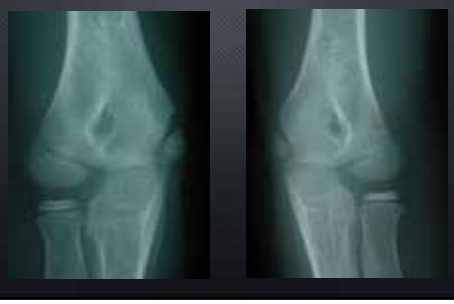
MEDIAL EPICONDYLE AVULSION

40

ELBOW EXTERNAL OBLIQUE



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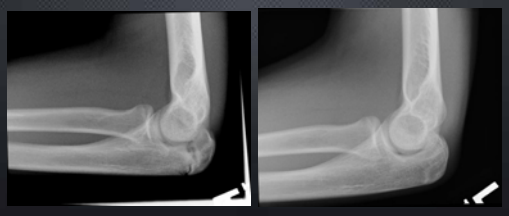
OLECRANON



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ULNAR COLLATERAL LIGAMENT STRAIN/TEAR

- Caused by valgus stress of throwing.
- Symptoms/Exam: *Medial* elbow pain, *worse* with valgus stress (done at 30°). May see laxity. *Milking* maneuver helpful.
- Treatment: *No* throwing, ice and NSAID's until pain gone.
  - Rehab exercises
  - Graduated throwing program
  - Surgery is last resort

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RADIOCAPITELLAR CHONDROMALACIA

- Due to compression forces created by valgus stress of throwing.
- Symptoms: *Lateral* elbow pain; Can lead to OCD and loose bodies.
- Exam: Tender at RC joint. Crepitus with sup/pronation
- Treatment: Same as for UCL injury

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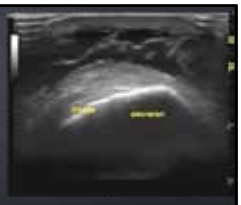
OSTEOCHONDRITIS DISSECANS CAPITELLUM

- Result of chronic compression forces.
- Symptoms: Lateral elbow pain, often with clicking or locking.
- Exam: Tender at RC joint and with supination-pronation. Lack of extension.
- X-ray: Flattening at capitellum, *crater* with loose body.
- Treatment: Rest (6-18 mos.). Last resort is drilling capitellar defect or remove loose body.

45

OLECRANON BURSITIS



- Synovium-lined sac allowing gliding of skin over olecranon
- Fluid in the bursa
  - Serous – aseptic olecranon bursitis
  - Sanguinous – trauma
  - Purulent – infection, gout, rheumatoid
- Septic most commonly caused by Staph Aureus
- Sayegh performed systematic review (PRISMA guidelines)
  - 29 studies, 1278 pts included
  - Aseptic- aspiration in all but one study
  - Compared with septic bursitis, higher complication rate w/aseptic
  - Surgical mgmt. less likely to resolve vs conservative care (in either) with a higher complication rate
  - CSI for aseptic assoc. w/inc overall complications, skin atrophy
  - Aspiration did not increase risk of bursal infection for aseptic bursitis

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DISTAL BICEPS TENDONITIS/TEAR

- Classically avulsion from the bicep tuberosity
- Dominant arm, M>F, 5th decade
  - Incidence 2.55/100k persons/yr.
  - 3% of all bicep ruptures
- Partial tears can occur
- Mechanism: rapid, forced extension of the forearm w elbow flexed → pop, weakness
  - Women ? more attrition and more in 6th decade
- Risk: anabolic steroid, Cushing's, oral steroids, tobacco use, aging
- Test: Hook (lateral), Passive Pronation Test, Biceps crease
- Loss of 27-60% supination strength, 21-30% flexion strength

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THANK YOU!

48

Common Hand and Finger Injuries

NCAFP Sports Medicine for the Active Patient

August 8, 2020

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Program Director
Cone Health Sports Medicine Fellowship
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1

Disclosures

- Neither I, nor my family, have any disclosures as it pertains to this lecture

2

Injuries to be discussed today

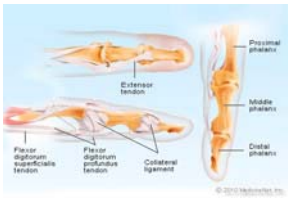
- Nail bed injuries
- Jersey finger
- Mallet finger
- PIP dislocation
- Boutonniere deformity
- Gamekeeper's thumb
- MCP dislocations
- Phalanx fractures
- Metacarpal fractures

3

Objectives

- Review basic anatomy of the hand and fingers
- Be able to recognize the most common types of injuries
- Learn which injuries you can manage in your office and which injuries you should refer

4



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Physical exam

- Inspection: Swelling, ecchymosis, deformity
- Palpation: tenderness, crepitus
- Range of Motion
- Stability: Important for ligamentous injuries
- Strength: Important to differentiate between true strength deficit and decreased strength secondary to pain
- Neurovascular status: radial and ulnar arteries, capillary refill

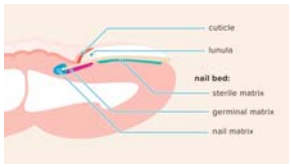
6

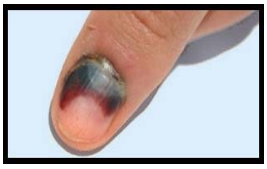
Nail bed injuries

- Disruption of the sterile or germinal matrix of the nail bed
- Usually result of a crush injury but can also be seen with an axial load injury to the fingertip
- Small hematomas (<50% of the nail bed): No treatment
- Can trephinate if painful
- Large hematomas: Remove nail and inspect nail matrix; suspect underlying fracture

7

Nail bed injuries





8

Trephination

9

Nail bed repair

- Digital block and remove nail
- Irrigate
- 7-0 resorbable suture for the nail bed
- 5-0 nylon suture for adjacent skin
- Replace nail and secure
- Splint distal phalanx
- Follow up in 3-5 days
- No need for antibiotics
- Suspect underlying fracture

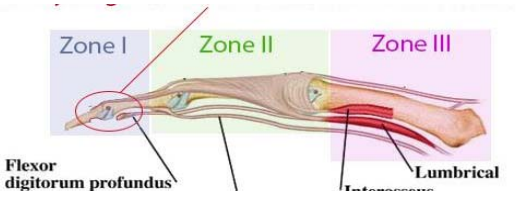
10

Prognosis and return to play

- If no nail bed repair, RTP immediately
- Following nail bed repair, can RTP with splinting
- Refer open fractures through the nailbed and displaced distal phalanx shaft fractures
- Prognosis for new nail growth is related to anatomical restoration of the nail bed and the ability to keep the eponychium open

11

Jersey Finger: Avulsion injury of the FDPfrom insertion at the base of the distal phalynx



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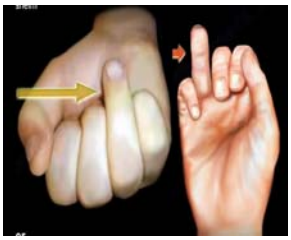
- Forced extension of a flexed DIP joint
- Variable degree of pain and swelling
- Can be a tendon avulsion or avulsion fracture
- Loss of active DIP joint flexion



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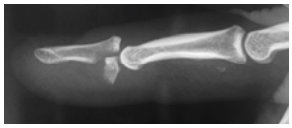

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Treatment and RTP

- Refer to orthopedics
- Tendon avulsions: 12 weeks of protected activity
- Bony avulsions: 6 weeks of protected activity
- Extensive hand PT post-op

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Mallet Finger

- Loss of terminal extensor mechanism attachment to the distal phalanx

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- Exam
  - Tenderness, swelling
  - Unable to fully extend isolated DIP
  - Swan neck deformity
- Xray
  - Bony avulsion fracture
  - Tendon rupture with no avulsion

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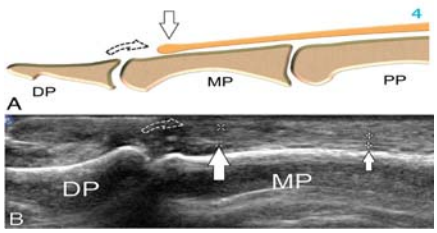
Ultrasound



18

Treatment

- Non-operative
  - Nondispalced bony injury - Splint in extension, 6-8 weeks, continuously
    - volar splinting has less complications
    - avoid hyperextension
    - begin progressive flexion exercises at 6 weeks
- Operative
  - Volar subluxation of distal phalanx
  - >50% of articular surface involved (relative indication
- May return to play within a week while splinted

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Finger Dislocations

- PIP joint most common
- Usually result of an axial load which forces the joint into extension
- Reduction can be done using a digital block if needed
- Once reduced, fingers can simply be buddy taped
- Occasionally, volar plate or flexor tendon will become lodged in the joint making it irreducible
- Be aware of volar plate fractures
- Swelling associated with this injury may be permanent

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Return to Play

- May return as soon as symptoms allow with protection (buddy tape, splint)
  - Monitor for signs of loss of reduction or malrotation
  - Protect until radiologic signs of healing

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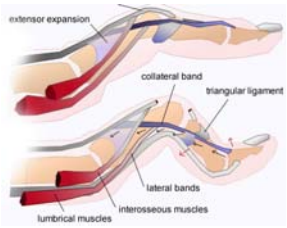
Boutonniere Deformity

- rupture of the central slip over PIP joint
  - causes the extrinsic extension mechanism from the EDC to be lost
  - prevents extension at the PIP joint
- Causes
  - Traumatic
  - RA complication



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Boutonniere Deformity

- Exam
  - Flexed PIP, Extended DIP
  - Elson Test (most reliable way to diagnose a central slip injury before the deformity is evident)
    - bend PIP 90° over edge of a table and extend middle phalanx against resistance
      - in presence of central slip injury there will be
        - weak PIP extension
        - the DIP will go rigid
      - in absence of central slip injury DIP remains floppy because the extension force is now placed entirely on maintaining extension of the PIP joint; the lateral bands are not activated
- Xrays possibly to rule out associated fx

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Treatment

- FULL-TIME extension splinting of the PIP with active DIP flexion/extension for 6-8 weeks
- Important to recognize early (within 2-3 weeks) as delayed presentations are difficult to treat (terminal extensor release and PIP fusion)

Oval-8® Finger Splint- Worn to reduce Boutonniere Deformity

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Gamekeeper's Thumb

- Ulnar Collateral Ligament rupture (Gamekeeper's thumb, skier's thumb)
  - Fall on outstretched thumb with hyperabduction of MCP joint
    - Common in:
      - Alpine skiing- caused by traction created when isolated thumb is pulled away from rest of hand when using pole.
      - Baseball
      - Cross-country skiing
      - Ice Hockey
      - Lacrosse
      - Swimming
      - Tennis
      - Water Polo
      - Wrestling

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- Physical exam:
  - Swelling and tenderness over the ulnar aspect of thumb MCP joint
  - MCP instability on radial stress (assess with MCP in 30 degrees of flexion)
  - Palpable lump, or gross instability- could be sign of Stener lesion
    - Torn end of UCL displaces superficially to the aponeurosis of adductor pollicis

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Imaging: US or MRI

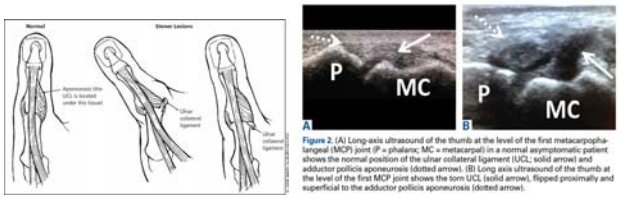

Figure 2. (A) Long-axis ultrasound of the thumb at the level of the first metacarpophalangeal (MCP) joint (P = phalanx; MC = metacarpal) in a normal asymptomatic patient shows the normal position of the ulnar collateral ligament (UCL; solid arrow) and adductor pollicis aponeurosis (dotted arrow). (B) Long axis ultrasound of the thumb at the level of the first MCP joint shows the torn UCL (solid arrow), flipped proximally and superficial to the adductor pollicis aponeurosis (dotted arrow).

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Gamekeeper's Thumb

- Treatment:
  - Immobilization for 4 weeks in thumb spica splint
  - Protected splinting for 2-4 months during competitive athletics
  - Surgical intervention with reattachment of UCL
    - Any injury with greater than 30-35 degrees of instability in flexion
    - any instability in extension
    - stener lesion
    - large bony avulsion

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Phalanx Fractures

- Proximal and middle
  - Common with contact sports, and catching balls
  - Proximal typically have volar angulation with proximal flexed (interossei) and distal extended (extensor tendons)
  - Middle can have either dorsal or volar angulation

30

- Treatment
  - Needs correction of any rotational deformity
  - No > than 10 degrees angulation in any plane
  - Nondisplaced can be treated with buddy taping and early ROM
    - Need to repeat xrays serially to ensure no displacement
  - Displaced required closed reduction and immobilization

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- Distal
  - 50% of hand fx
  - fibrous septa of skin minimized displacement
  - Examine for nail bed injury
    - Must repair nail bed to prevent deformity
  - immobilized DIP for 3-4 weeks, then ROM
  - Risk of **mallet finger** deformity if there is bony or tendinous disruption
    - Continuous extension splinting of the DIP for 6 weeks
      - Followed by removal of splint for ROM exercises for 2 weeks

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Volar Plate Avulsion Fractures

- Proximal middle phalanx volar plate
  - If involves >30% joint space, needs referral to surgeon
  - Early immobilization otherwise
    - Either buddy tape or extension block finger splint for 5 to 10 days
    - Reassess every week to check for signs of malalignment or displacement.
    - Repeat xrays at 1 and 4 weeks

Picture 1 In an x-ray of the finger, you can see the small avulsion fracture on the lower right side of the middle joint.

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MCP Dislocations

- Can be simple or complex
- Hyperextension injury at level of the MCP (border digits most common)
- Acute pain/ swelling and hyperextension of MCP joint
- Closed reduction vs open reduction in OR
- RTP with protection for6-12 weeks

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Metacarpal Fractures

- Metacarpal fractures
  - Account for 14% of all emergency room visits
  - Often from direct blows or crush type injuries, falls to hand
  - Typically present with apex dorsal angulation from intrinsic muscles force

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Metacarpal Fractures

- Transverse
  - Apex dorsal angulation- intrinsic muscle force
    - Reduction indicated if Angulation:
      - >20 degrees for ring finger
      - >30 degrees for pinky
  - Treatment:
    - Stable- non op with cast immobilization for 2 weeks, followed by orthoplast of digit and its neighbor for two weeks, followed by buddy taping at 4 weeks out
    - MUST CORRECT rotational deformity
    - Reduction and pinning/ORIF needed if surgical

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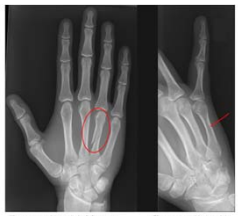
Metacarpal Fractures

- Oblique and spiral
  - From torsional forces
    - If untreated, will likely shorten and rotate
      - 5 degrees of malrotation can lead to 1.5-2.0 cm of overlap of digits
      - 5 mm shortening is functionally acceptable
  - Treatment:
    - Isolated, minimally displaced be treated like transverse fx
    - Otherwise, will need surgical pinning or ORIF



4th metacarpal spyral shaft fracture 5th metacarpal incomplete spyral fracture

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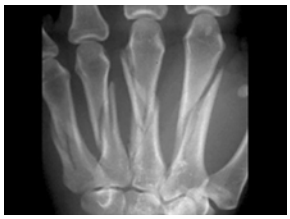
Metacarpal Fractures

- Comminuted
  - May have associated soft tissue loss
  - Often requires ORIF or external fixation to maintain length
  - may need delayed or primary bone grafting



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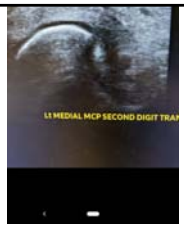
Metacarpal Fractures

- Head fractures
  - Rare
  - Occur from axial loading or direct trauma
    - Ensure not from "fight bite"
  - Nondisplaced treated non-op with initial splint mobilization, followed by buddy taping and early mobilization.
  - Can lead to limited motion and arthritis if immobilized too long.
  - Displaced need ORIF, with early mobilization.



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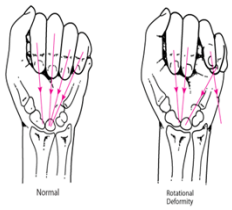
Metacarpal Fractures

- Neck fractures
  - Most common- ring and pinky (boxer's fx)
  - apex dorsal angulation and volar comminution make it difficult to maintain reduction
    - "10, 20, 30, 40" rule
    - Normal MC head to neck angle is 15 degrees
  - Treatment:
    - immobilize in short arm gutter splint with fingers in intrinsic plus position
      - 2 weeks of immobilization, then buddy taping
    - Weekly X-ray to ensure reduction is not lost
      - If lost, or if reduction is not achievable, refer for surgical evaluation



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Return to Play

- Return to Play:
  - May be initiated 1-2 weeks after injury depending on demands of sport
  - Protection for 8-12 weeks depending on demands
  - With surgery, early ROM at 2 weeks
    - 5-6 weeks can be buddy taped

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First Metacarpal Fractures

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In Summary

- Suspect a possible underlying distal phalanx fracture in subungual hematomas>50%
- Refer jersey fingers urgently for surgical repair
- Mallet fingers need 6 weeks of continuous extension at the DIP joint
- Be sure to recheck "jammed" PIP joints or PIP dislocations 2-3 weeks post injury to r/o early boutonniere deformity
- Many phalanx fractures can be treated with buddy tape and early ROM
- PIP dislocations are common and easily reducible if caught early
- Treatment of MC fractures (2-5) depends on amount of displacement and malrotation
- Refer all 1st MC fractures to Ortho

43

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- Saladino R, Antevy P: Management of fingertip injuries. In Stack A, Wolfson A, Wiley J (Eds) UpToDate Waltham MA. 2019
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44

EBM Running Injury

•Karl B. Fields, MD , Professor of Family Medicine and Sports Medicine
•NCAFP 2020

1

Goals – review EBM Running Injury

- Offer a few pearls that may help you better approach your patient with a running injury
- Discuss:
  - Risk factors for injury
  - Shoes and Orthotics
  - Stretching, eccentric exercise, warmup
  - PFP/ cavus foot issues
  - Running and Osteoarthritis
  - Mortality and Running

2

A Prospective Trial of Risk Factors for Running Injuries

- 115 runners in controlled training of 18 to 20 months:
  - 85% injured
  - Training distance was risk factor
- Previous Injury in preceding 12 months (RR 1.51)
- Mileage greater than 40 per week (RR 2.88) possibly daily running/ long runs *(Boven, et al Int J Sp Med, 1989)*
- *Higher running mileage causes running injury*

3

EBM for Causes of Running Injury Limited - Key Observations

1. Total Running Mileage - strong correlations at level of 64 Km per week or 40 miles per week A
2. Previous Injury A
3. Training errors. Ten studies found weak to moderate correlations with training patterns. B
4. Greater risk of stress fracture in females A
5. Possible greater risk for higher BMI. B

4

Training Error -

- Epidemiology to track the role of training error in sports injury used by Olympic and professional sports teams
- Data shows training loads above normal baseline for the individual has a high predictability for injury
- For recreational runners this likely indicates training error would lead to injury

5

History Pearls – to assess overtraining: 3 Key Questions

- How many KM/miles per week do you run?
  - Do they exceed 30 miles/ 60 KM per week – if so injury risk is higher
- What is the training pattern?
  - Do they do long runs of more than 90 minutes?
  - Frequency of speed work?
  - Rest days?
  - Did they increase their training above the traditional levels.
  - Did they do a "boot camp."
- Have you ever had a serious injury that took you away from running for 1 or more weeks?.

6

Cochrane 2011 Update on Preventing Running Injuries

- "Overall, the evidence base for the effectiveness of interventions to reduce soft-tissue injury after intensive running is very weak ..."
  - ***Interventions for preventing lower limb soft-tissue injuries in runners. Yeung and Yeung. Cochrane***

7

EBM since the Cochrane Reviews

- Interval training seems protective against knee injury
- Abrupt changes in training regimen – military and other boot camps cause injury
- Protection from injury by cross training
- Prospective analysis of 264 runners
  - Lower risk if more time spent in other sports
  - Lower risk if used multiple shoes
  - Lower risk with more KM covered per workout time

8

Pearls about Emerging EBM for running injury

- Many traditional theories about prevention of running injury are myths. E.g. Running faster may be safer!
- Runners have a high rate of injury but most are not very serious.
- Cross training seems helpful.
- Specific interventions may help individual runners – custom orthotics, patellar straps or a calf compression sleeve;

9

SHOES AND ORTHOTICS

- What shoes are best?
- Do you match the shoe and the foot?
- Will the shoe successfully block pronation
- Do orthotics prevent injury?
- Do custom orthotics offer unique benefits?

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Shoe Evolution

- Running shoes in 1912 looked like dress shoes today
- Shoe design has steadily changed and improved? Over past 40 years
- However, injury rates are similar
- Demographic is dramatically different
  - 1970 thin males 75% and generally elite
  - 2019 females now 54%, generally recreationaland average BMI much higher

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Jim Thorpe 1912/ Nike 2020

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Shoes and Injury

Ryan et al BJSM 2014

- 2 studies of cushioned shoes did not show reduction of injury
- Neutral vs. minimalist vs. full minimalist shoes in 103 runners neutral or mild pronation
- High compliance with shoe use
- RR increase: 160% in minimalist and 310% partial minimalist
- Greater drop out of minimalist groups
- Greater Shin and calf pain full minimalist

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Heel to toe drop in running shoes

Malisoux AJSM 2016

- Trial of 553 runners followed 6 mos.
- Assigned to 10mm, 6 mm or 0 mm drop
- Occasional runners saw reduced HR of 0.48 in 6 mm drop and 0 mm drop
- Regular runners saw a significant 1.67 HR increase using low drop

14

Barefoot Running

- Will work for certain individuals but surface can still be a problem
- Overall studies point to some increase in injury rate but are mixed
- More injuries seen in heavier runners or those who don't adjust to going barefoot
- Metatarsal stress fracture likely at increased risk – accidental foot strike?

15

Comfort Hypothesis for Running Shoes

Nigg, BJSM, 2015

- Runners will consistently pick shoes that provide the most comfort
- Comfortable shoes have association with lower injury
- Comfortable shoes lower VO2 Max required for a given running effort
- "Best shoe is most comfortable"

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Orthotics choice

- Nigg hypothesis – there is a preferred path of muscle firing for a given runner. If a shoe or orthotic supports this path, this could potentially reduce injury
- Individuals chose insoles based on comfort just like they choose shoes -
- Military study trying 5 insoles – those choosing comfort had 53% lower injury than those assigned by foot shape (*Muendermann, et al. MSSE 2001*)
- Softer insoles proved more comfortable

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Orthotics and Injury

- Overall studies suggest that orthotics decrease running injury risk (5 early studies)
- Two good military studies
  - 400 runners – orthotic 21/ flat insole 61 injuries
  - 306 runners – orthotic 27/ flat insole 40 injuries
- Other studies show reduction in lower extremity pain with cavus foot and PFP
- Custom vs. prefab – variable results but favor custom

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Pearls about Shoes and Orthotics

- Comfort hypothesis is best strategy for picking shoes and may reduce injury
- Shoe design (motion control, etc.) does not effectively reduce injury
- Insoles and custom orthotics also work best when comfortable
- Custom orthotics have potential to reduce injury and pose little risk
- Minimalist, low drop shoes and barefoot running may increase injury risk

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Stretching to Prevent Sports Injury

- Stretching historically favored by a number of experts and in surveys by up to 95% of coaches
- Meta-analysis and multiple studies show strong EBM that stretching before running did not reduce injury.
- More recent emphasis to look at Yoga, Pilates, Tai Chi and moving stretching to other times or after work outs
  - *Thacker, et. al. Medicine and Science in Sport and Exercise 2004.*

20

Is Stretching or eccentric strengthening Better for Lower Limb Flexibility?

- Meta-analysis of eccentric strength programs and lower limb flexibility *(O'Sullivan, BJSM, 2012)*
- Meta-analysis found 6 RCT that looked at joint ROM or muscle fascile length
- Consistent strong evidence from all 6 studies of 3 different muscle groups showed that eccentric exercise improved lower limb flexibility by either type of measure
- Correlation with injury prevention has not been done

21

Warm Up for Prevention

- Studies of warm up and overall injury rates have generally been favorable but limited to study populations in middle/high schools and did not examine competitive runners
- In some stretching studies of running injury the control group focused on warm up and had lower injury rate than stretching group
- Warm Up probably prevents injury in physical education and maybe in running – EBM C

22

Pearls stretching and warm up

- Stretching before running is not helpful for injury prevention but a good warm up may be
- Runners who stretch should do so after the run
- Flexibility may be gained more efficiently by using yoga, pilates or tai chi and doing this twice weekly or more
- Eccentric strength workouts may prevent injury and often increase flexibility better than stretching

23

What EBM Relates to PFPS – "Runner's Knee"

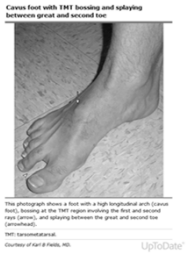
- 3 early studies showed more runners knee in *supinators* - often cavus foot
- Hip abduction weakness in particular seems to relate to PFPS or an imbalance
- *Orthotics often work*
- *Patellar straps help a number of runners*
- *VMO weakness is common and hard to rehabiliatate*

24

Cavus Foot – Longer Term Prospective Study

DiCaprio J Spts Science and Med 2010

- 166 adult runners with average age of 31, all levels
- 5 Year follow-up after initial assessment of foot morphology and running style
- Non-traumatic injury to lower extremity limiting activity by 2 weeks
- Highest risk were rearfoot varus (87.5 % of injured runners) or pes cavus (71.4%)
- Most common injuries were plantar fasciitis (31%) and Achilles tendinopathy (24%)
- Competitive runners accounted for 70% of injuries



25

Prospective Trial of Running and OA of Knee

- Duration 14 years with intial radiographs on all runners and controls.
- Cohort of 48 runners and 53 controls with average age of 58 at onset
- At start of study 6.7% of runners and 0% of controls had signs of OA
- At end of study 20% of runners and 32% of controls had OA
- At end 2.4% runners and 9% of controls with severe OA
- Risk factors for worsening were OA on initial Xray, BMI and age – NOT RUNNING
  - » Amer J Prev Med, Chakravarty, et al. 2008

26

Is Running Really High Impact ?

- Peak knee joint forces are much higher in running than walking
- High Peak joint forces have been associated with development of Knee OA
- Why do runners not show high levels of knee OA?
- Per Unit Distance (PUD) loads may be a key measure for predicting OA
- Study looked at running vs. walking and PUD and Peak loads

27

Why don't most runners get knee osteoarthritis? A case for per-unit-distance loads. Med Sci Sports Exerc. 2014 Mar;46(3):572-9. Miller, et al.

- 14 healthy adults at self selected running & walking paces
- Ground reaction forces and motion camera analysis calculated the Peak and PUD forces
- Peak load was 3x higher in running but the PUD was not
- Peak load increased with faster running pace but PUD actually decreased
- Short duration of ground contact and long stride length for running blunt the effect of peak force on overall stress to the knee
- Altered running mechanics may negate this effect

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Is Running Actually Protective Against OA

Williams, MSSE 2013

- Longitudinal study of 74,752 runners and 14,625 walkers for 7.1 yrs.
- Runners 2004 OA cases (1/37) and 254 THR (1/294)
- Walkers 696 OA cases (1/21) and 114 THR (1/128)
- Low/Medium and High activity lowered OA by 15 to 18% and THR by 35 to 50%
- Other non-running sport increased OA by 2.4% and THR by 5%
- Risk reduction in running was negated by increased BMI
- Conclusion: Running lowers OA risk partly because of decreased BMI

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Is Running More Efficient for Weight Loss than Walking?

- 6.2 yr. prospective follow up of energy expenditure in running and walking correlated to change in BMI
- BMI declined with increasing energy expenditure in both running and walking
- For equivalent energy expenditure BMI declined more with running than walking
- Running led to greater loss in BMI in all 4 quartiles of men and in the 4th quartile of BMI in women
- At the 4th quartile in men and women there was 90% greater weight loss per MET-hours per day run
- Age related weight gain was attenuated in both sexes by running and by walking in women
  - *Williams, MSSE, 2013*

30

Running and Mortality

- Strong EBM particularly from Blair, et al and studies at the Cooper Clinic demonstrate that fitness has a strong inverse correlation with mortality A
- 284 runners and 156 controls over age 50 completed a 21 year follow-up to assess mortality and disability
- Disability scores were higher in controls at all time points and increased more than in runners with age
- At 19 years, 15% of runners and 34% of controls had died ----lean BMI and low smoking rates in runners
- After adjustment of co-variables the survival benefit for runners was 0.61 (reduction 39%)
  - » *Chakravarty, Ann Int Med, 2008*

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Summary - Running Injury Risk

- Running injury affects ~ 50% of LDR yearly and ~ 25% are injured at any time - A
- Strong EBM links training error- primarily total running distance with injury and interventions to reduce running miles did reduce injury A
- EBM strongly suggests that previous injury is a risk for subsequent injury. Weaker EBM that additional rehabilitation would change risk A
- Moderate EBM links cavus foot type with increased injury risk but less EBM to suggest that interventions reduce risk B

32

Summary – shoes and orthotics

- Comfort hypothesis is a key to choice - C
- Path of preferred muscle firing may explain why shoes and orthotics can work to reduce injury - C
- Minimalist and low drop shoes and barefoot running pose some risk and challenges - B
- Custom and some OTC orthotics show potential for injury reduction - B

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Summary - Running Injury Prevention

- Some EBM supports warm-up but the research was not done on runners. - C
- Strong EBM show that eccentric strength exercises increase flexibility - A
- Pre exercise stretching to prevent running injury has not shown benefit and other approaches – stretch post exercise or alternatives like yoga merit study - A
- EBM for PFP support hip abduction exercises for treatment and prevention; use of patellar straps for pain reduction; and use of orthotics B

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Summary – running and long term health

- Running appears to reduce the risk of OA of knee and of THR A
- Peak impact is higher in runners but cumulative impact per unit of distance is similar to walking B
- Running specifically and other activities that improve fitness lessen mortality and disability A

35