RUNNING AND OSTEOARTHRITIS: IS THERE A RELATIONSHIP

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OBJECTIVES

• The participant will understand the epidemiology of running injuries and its potential effect on causing osteoarthritis and low back pain.
• The participant will be able to discuss with knowledge the relationship of long distance running with lower extremity osteoarthritis.
• The participant will have knowledge of long distance running and its effect on the articular cartilage through animal studies, and diagnostic imaging on lower extremities and the lumbar spine.
• Participants will understand intervention strategies that may prevent the running athlete in developing symptomatic lower extremity osteoarthritis.

Contact Information

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INCIDENCE OF RUNNING INJURIES

• Literature is inconsistent in defining running-related injury
  – Presence of physical complaint
  – Interruption of training
  – Need for medical assistance

• The Question at hand:
  – How do “injuries” correlate to Osteoarthritis?
  – Do they?

INCIDENCE OF RUNNING INJURIES

• Review article found:
  – Incidence of running injuries: 19.4-79.3 %
    – Most at knee
  – Conflicting evidence if age is a risk
  – Females more risk for hip injuries
  – Higher mileage training increased injuries in men > women
    – > 64 km per week
    – Protection?

INCIDENCE OF RUNNING INJURIES

• Systematic review
  – Women at lower risk than men
  – Strong-Moderate evidence for increased risk of injury:
    – History of previous injury
    – Orthotics/inserts
Van der Worp MP et al. Injuries in runners: a systematic review on risk factors and sex differences. PLOS ONE DOI:10.1371/journal.pone0114937
Increased Incidence of Running Injuries: Women versus Men

- **Women:**
  - Age
  - Previous sports activity
  - Running on concrete
  - Running a marathon
  - 30-39 miles per week
  - Wearing running shoes 4-6 months

- **Men**
  - Previous Injury
  - Running experience 0-2 years
  - Restarting running
  - > 40 miles per week

Van der Worp MP et al. Injuries in runners: a systematic review on risk factors and sex differences. PLOS ONE DOI:10.1371/journal.pone0114937

INCIDENCE OF RUNNING INJURIES

- Systematic review looking at running related musculoskeletal injuries (28 total)
  - Medial tibial stress syndrome: 13.6-20.0%
  - Tendinopathy
    - Achilles: 9.1-10.9%
    - Patellar: 5.5-22.7%
    - Patellar femoral: 5.5%
  - Ankle sprain: 10.9-15.0%
  - Iliotibial band: 1.9-9.1%
  - Tibial stress fracture: 9.1%
  - Low back pain 5.5%


INCIDENCE OF RUNNING INJURIES

- Descriptive study on NCAA Cross Country
  - Men 4.66/1000
  - Women 5.85/1000
  - Women 1.25 > Men
  - Majority of injuries classified as “overuse”
  - Diagnosed as:
    - Strains (> Men)
    - Inflammation (> Women)

Kerr ZY et al. J Athl Train. 2016;51:57-64
INCIDENCE OF RUNNING INJURIES

OSTEOARTHRITIS?

Low Back Pain

Medial Knee Pain

Obltropes

Anterior Tibialis

Achilles Tendinopathy

KNEE OSTEOARTHRITIS

Epidemiology

- Defined by:
  - Radiographic
    - Kellgren-Lawrence scale
      - > 2 higher
  - Symptomatic
    - Combination of pain and radiographic evidence
  - Clinical
    - Patient clinical information

- Murphy, Helen G. Orthop Nurs. 2012;31-85-91

KNEE OSTEOARTHRITIS

Prevalence and Incidence

- Using prevalence estimates from the Framingham OA Study, it has been estimated in 2005, that 9.3 million (4.9%) of US adults (> 26 years old) had symptomatic knee OA

Lower Extremity OSTEOARTHRITIS

Prevalence and Incidence

Prevalence

- Radiographic OA
  - 0.9 (1.2 Female; 0.4 Male)
- Symptomatic OA
  - 12.1% (Age > 60 years)
  - 13.6 % Female; 10.0% Male
  - 16% (Age > 45 years)
  - 18.7% Female; 13.5% Male


Incidence (Per 100,00 person years)

- Increases with age, and levels off
  - age 80
- Knee: 240
- Hip: 88
- Women:
  - Knee Radiographic: 2%
  - Knee Symptom: 1%
  - Progressive knee: 4%
- Men have 45% lower incident risk of knee OA than women


EPIDEMIOLOGY AND INCIDENCE OF OSTEOARTHRITIS

- Lifetime risk of symptomatic Knee OA
  - Overall: 44.7%
  - Previous Knee injury: 56.8%
  - Obese: 60.5%
  - ~44% of adults with diagnosed arthritis report no leisure time physical activity compared with 36% of adults without arthritis


- Longitudinal study looked at risk factors of knee osteoarthritis
  - Age
    - Rates of incidence: Increased 2.5% per year
    - Rates of progression: Increased 3.6% per year
  - BMI > 25.4 had a great than 9 X risk of developing grade 1 knee OA
  - Previous knee injury
    - Odds ratio 4.8 (95% CI 1.0-24.1)
  - History of regular sports participation
    - Did not find significance


EPIDEMIOLOGY AND INCIDENCE OF OSTEOARTHRITIS: Women versus Men

Knee OA Female to Male ratio: 1.5:1 to 4:1


Epidemiology of Low Back Pain and Runners

- Retrospective review 2002 patients with running related injuries
  - Low back pain: 3.4%
  - Baseline characteristics
    - Age: 39.6 years
    - BMI
      - Women 21.5
      - Men 23.9
    - Weekly hours: 6.4


Risk Factors: Obesity

- Obesity associated with higher prevalence of arthritis:
  - Hip AOR 2.18
  - Knee: AOR 2.11

- Obese individuals reported with Hip OA and knee OA:
  - Greater pain
  - Greater stiffness
  - Worse function
  - Greater disease severity

**Osteoarthritis Risk Factors**

- Increasing age
  - Increased prevalence > 40 years
- Female
- Genetic disposition
- Obesity
- Trauma
- Occupations with repetitive activities

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**Osteoarthritis Risk Factors**

- Painful Knee OA
  - > 50 years old
  - Overweight:
    - OR 1.98
  - Obesity:
    - OR 2.66
  - Female:
    - OR 1.98
  - Previous Knee injury:
    - OR 2.83


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**Osteoarthritis Risk Factors**

- Risk factors
  - Joint injury
    - Meniscectomy: OR 7.4
    - Developed 1.5-36 years
  - Obesity
  - Occupational activity
- Inconclusive
  - Sports activity
  - Case reports: Soccer, hockey, gymnastics, tennis
  - Physical activity
    - Protective
    - Midlife, no cause,
    - Early adult: relative risk

KNEE OSTEOARTHRITIS: Functional Decline Risks Influencing Outcomes

- Study looked at risk factors with WOMAC scores at baseline, 3-months, and 18-months
  - Factors that decreased WOMAC the most:
    - Baseline
    - Laxity
    - BMI
    - Knee pain
    - Baseline to 18-months
      - Increase in knee pain


KNEE OSTEOARTHRITIS: Functional Decline Risks Influencing Outcomes

- Studies have shown risk factors for functional decline as:
  - Physical impairments
    - Pain
    - Decreased strength
    - Knee joint laxity
    - Impaired proprioception
  - Poor balance
  - Obesity
  - Psych / anxiety
  - Socio-economic


KNEE OSTEOARTHRITIS: Functional Decline Risks Influencing Outcomes

- Factors that improved WOMAC Scores
  - Baseline
    - Good mental scores
    - Social support
    - Better efficacy
    - > Aerobic exercise minutes

Knee Osteoarthritis and Perception

- Qualitative study looked at effect of OA on adults age 35-65 years old
  - Disruption in physical, emotional, and social life
  - Reported they had a "new awareness of their knee, and they no longer "trusted their knee"

Mackay C et al. A qualitative study of the consequences of knee symptoms: ‘It’s like you’re an athlete and you go to a couch potato’ JRM 2014

OSTEOARTHRITIS: Effect on the Patient

- Observational longitudinal study found there was a 63.2% frequency in falling in patients over 65 years old with severe knee osteoarthritis
  - Cause of Fall:
    - Walking 89.23%
    - Stumbling 41.54%


Articular Cartilage: Normal

- Low level of metabolic activity
- Composition
  - Chondrocytes
  - Extracellular Matrix
  - Tissue Fluid
  - Structural Macromolecules

http://www.lab.anhb.uwa.edu.au/mb140/CorePages/Cartilage/Cartil.htm
**Chondrocytes**

- 1% of total volume
- Contain organelles needed for matrix synthesis
  - Endoplasmic reticulum
  - Golgi membranes
- Surrounded by extracellular matrix
- Assists with turnover of matrix macromolecules in response to joint use


**Chondrocytes and Collagen**

- Chondrocytes produce the “Ground Substance” which includes:
  - Glycoaminoglycans (GAG)
    - Includes: Hyaluronic Acid, Chondrotin Sulfate, Keratin Sul fate, and Dermatin Sulfate
  - Type II Collagen
    - 90-95% of articular cartilage collagen
    - Other Collagen Types: IX, XI
- Synthesis of collagen and GAG is stimulated by mechanical tension

**Extraceullar Matrix**

- Tissue Fluid
  - 85% of articular cartilage weight
  - Contains: gases, small proteins, metabolites, and cations
- Structural Macromolecules
  - 20-40% of articular cartilage weight
  - Contains:
    - Collagen
    - Proteoglycans
    - Non collagenous proteins
    - Glycoproteins
Articular Cartilage Zones

**• Superficial Zone**
- Thinnest
- 2-layers:
  - Parallel Fibrils
  - No Cells
  - Low proteoglycan
  - Barrier to larger molecules
  - "Skin"
- Good tensile stiffness
- Resists shear forces

[Link to Articular Cartilage Rehabilitation](http://lowerextremityreview.com/article/articular-cartilage-rehab)

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**• Transitional Zone**
- High concentration of organelles
- Larger collagen fibrils
- High in Proteoglycans
- Low in Water and Collagen

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**• Middle Zone**
- Largest Collagen fibrils
- Pass into the tidemark
- Highest amount of proteoglycans

[Link to Articular Cartilage Rehabilitation](http://blog.naver.com/PostView.nhn?blogId=medico&logNo=10086993978)
Articular Cartilage Zones

Calcified Cartilage Zone
– Separates cartilage from the subchondral bone

Normal Cartilage to Aging Cartilage

• Reduced ability of the molecules to retain water
  – GAGs become shorter
  – Type 6 Keratin Sulfate increases
  – Decrease in proteoglycan synthesis

• Reduced chondrocytes
  – Decrease in capacity of cartilage to synthesize matrix

• Altered Collagens


Normal Cartilage to Aging Cartilage

• Systematic changes that occur with aging and may contribute to OA include:
  – Sarcopenia
  – Increased fat mass
  – Pro-inflammatory state
  – Decrease in hormone and sex steroids
  – Decreased bone mass
  – Decreased proprioception and balance

Histologic Phases of Osteoarthritis

**PHASE I**

- **Edema and Micro-cracks**
  - Edema of extracellular matrix
  - Middle layer
  - Smoothness of cartilage gone
  - Micro cracks appear
  - Local loss of chondrocytes

**PHASE II**

- **Fissuring and Pitting**
  - Microcracks deepen perpendicularly
    - In direction of the forces of tangential cutting
    - Along fibrils of collagen
  - Formation of Vertical Clefs in subchondral bone
    - Clusters of chondrocytes form around clefs
Histologic Phases of Osteoarthritis

PHASE III

Erosion

- Fissures cause fragments of cartilage to detach and “fall” into the articular cavity
  - Osteocartilaginous loose bodies
  - Uncovering the subchondral bone
  - Localized Synovial inflammation

- Sclerosis of subchondral bone
- Osteophyte formation

OSTEARTHRITIS: PATHOGENESIS

Osteoarthritis

• Failure of chondrocytes within the joint to:
  - Synthesize a “good quality matrix”
  - Maintain balance between Synthesis and Degradation of the extracellular matrix

OSTEARTHRITIS: PATHOGENESIS

• Chondrocyte hypertrophy contribute to the progression of OA through:
  - Decreased Collagen II
  - Increased synthesis of matrix metalloproteinase13
    - Break down collagens and aggregans
    - Promotion of calcification

• Synovial cells phagocytize the fragments of cartilage released into the joint
  - Causes synovial inflammation
OSTEOARTHRITIS: PATHOGENESIS

• Osteoblasts from subchondral osteoarthritic bond demonstrates an altered phenotype
  – Produce more:
    – Alkaline phosphatase
    – Osteocalcin
    – Insulin-like growth factor (IGF)-1
    – Urokiase

OSTEOARTHRITIS: PATHOGENESIS

CYTOKINES

• Stimulate chondrocytes to release cartilage degrading enzymes
  – Bind to the chondrocytes receptors
    – Interleukin 1 (IL-1) is the "pivotal" cytokine release
      Jacques et al. Vitam Horm. 2006
  – May be regulatory or inhibitory
    – Interleukin 4 and 13 counteract the catabolic effects of IL-1
    – IL-1 decreases synthesis of Type II and Type IX collagens, and increases synthesis of Type I and Type III collagens

OSTEOARTHRITIS: PATHOGENESIS

CYTOKINES

• New family of Cytokines:
  – Adipokines
    – Leptin, Adiponectin, resistin
    – In Plasma and Synovial fluid of patients with OA

  – Role is largely unknown
OSTEOARTHRITIS: PATHOGENESIS

LIPID MEDIATORS

• Prostaglandin synthesis by pro-inflammatory cytokines can facilitate the synthesis of Matrix Metalloproteinase
  — The mediators activate the cell by specific cellular and nuclear prostaglandin receptors
  — Produced by Synovial cells, chondrocytes, and subchondral osteoblasts

OSTEOARTHRITIS: PATHOGENESIS

REACTIVE OXYGEN SPECIES

• Play a big part in the regulation of a number of basic chondrocyte activities
  — Cell activation
  — Proliferation
  — Matrix remodeling

• If the ROS production exceeds the antioxidant properties of the cell, structural and functional cartilage damage may occur
  — Cell death
  — Matrix degradation

OSTEOARTHRITIS: PATHOGENESIS

Cell Survival versus Cell Death

<table>
<thead>
<tr>
<th>Promotes survival</th>
<th>Promotes death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth factors</td>
<td>Mechanical injury</td>
</tr>
<tr>
<td>TGF-β</td>
<td>Excessive loading</td>
</tr>
<tr>
<td>GM-CSF</td>
<td>Blunt impact trauma</td>
</tr>
<tr>
<td>VEGF-A</td>
<td>Cartilage damage</td>
</tr>
<tr>
<td>Integrins (β1, β3)</td>
<td>Reactive oxygen species</td>
</tr>
<tr>
<td>Osteoblasts</td>
<td>Cytokines (under certain conditions)</td>
</tr>
<tr>
<td>Antioxidants</td>
<td>TNF-α</td>
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<tr>
<td>IL-1</td>
<td>Fas ligand</td>
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<tr>
<td>IL-6</td>
<td>MDR-1</td>
</tr>
</tbody>
</table>

Pathogenic Factors in Osteoarthritis

Obesity
Anatomic abnormalities
Microfractures and bony remodeling
Loss of joint stability
Trauma

Aging
Genetic and metabolic diseases
Inflammation
Immune system activity

Compromised cartilage

Abnormal stresses
Abnormal cartilage

Biophysical changes
Collagen network fracture
Proteoglycan unraveling

Biochemical changes
Inhibitors reduced
Proteolytic enzymes increased

Cartilage breakdown

MECHANICAL CAUSES OF KNEE OSTEOARTHRITIS
Valgus Mal-alignment

- Study of 5,053 knees found that a valgus malalignment > 3 degrees increased the risk of knee OA incidence and progression
  - Ages 50-79
  - Increased lateral cartilage and meniscal damage

MECHANICAL CAUSES OF KNEE OSTEOARTHRITIS
History of Injury

ACL Injury
- High proportion of patients develop knee OA
- ACL Reconstruction
- Factors to developing knee OA
  - Altered biomechanics
  - Age
  - Meniscal status
  - Cartilage injury
  - Patient factors

Incidence of OA in Former Athletes

- Systematic review on prevalence of osteoarthritis on former elite athletes
  - Hip: 2 to 60%
  - Knee: 16 to 95%
  - Higher rates of OA in athletes in team and individual sports compared to general populations

Gouldebarge V et al. Prevalence of osteoarthritis in former elite athletes: a systematic overview of the recent literature. Rheumatol Int. 2015;35:405-418

Incidence of OA in Former Athletes

- Hip OA
  - 14.2% athletes
  - 7.9% controls
- Knee OA
  - 19.4% athletes
  - 3.8% controls
- Risk of having arthroplasty was more than doubled in former athletes than in controls
- Soft tissue injury increases risk of developing knee OA in impact athletes (not in non-impact)


Participation in Sports a cause for Knee Osteoarthritis?

- Compared with “unexposed persons”, participants in soccer, competitive weight lifting, wrestling, and long distance running had a higher prevalence of knee OA
  - 3 to 7 X higher prevalence
- High loading sports had a higher prevalence of knee OA
- Sport participants with a history of knee injury had an increased prevalence of knee OA compared to unexposed persons
  - Unexposed: 14%
  - Previous Injury: 27%
  - Not statistically significant
- No female sports participants were evaluated
- Prevention of knee injury and obesity lessen risk of OA
Activity and Effect on Knee and Hip Osteoarthritis

- Systematic review studied which activities in 4 domains should or should not be recommended in those with knee and hip OA
  - Daily life
  - Exercises
  - Sports
  - Occupational

- Both healthy and patients with OA can pursue high level of activity, as long as it is not painful or predispose to trauma
- Radiographic or clinical OA is NOT a contraindication to promoting activity
- High level athlete should be informed that the risk of OA is associated with the duration and intensity of exposure
- The patient with OA who practices a sport at risk for joint trauma should be encouraged to change sport

PATIENT QUESTIONS ABOUT RUNNING AND OSTEOARTHRITIS

- What does the literature say?
- Am I doing permanent damage to my joints?
- I heard that running will hurt my knees, is this true
RECENT REVIEW ARTICLES

- Low to moderate volume do not present risk to knee or hip osteoarthritis

- Insufficient evidence exists to identify relationship between recreational running and the risk of knee OA

- No support for an association or casual relationship between low and moderate distance running and osteoarthritis
  - Older runners are generally healthier than their non-running matches

Animal Studies: Aggressive Running and Knee OA?

- Rat Study
  - 2 running regimens
    - 30 km in 3-weeks
    - 55 km in 6-weeks
  - Looked at both knees
  - Looked at running analysis

Animal Studies: Aggressive Running and Knee OA?

- No joint swelling
- Proportion of the calcified cartilage zone in full thickness of articular cartilage was increased:
  - 60% at week 3
  - 80% at week 6
- Paw print "step" angles between left and right showed a significant change after running
  - Worsened from week 3 to week 6
Animal Studies: Intensity of Running and its Effect on Cartilage

- 3 intensity running groups
  - Osteoarthritic changes seen in High Intensity group
  - Low and Moderate groups had significant increase in
    - Cartilage thickness
    - Chondrocytes
    - GAG content
  - High Intensity group had non-significant decrease in
    - Cartilage thickness
    - Chondrocyte number
    - GAG content


Animal Studies: Intensity of Running and its Effect on Cartilage

- Normal histological cartilage sections were seen for sedentary, low intensity and moderate intensity
- Surface irregularities, cell cloning, and moderate decrease in Safranin-O staining observed

Animal Studies: Intensity of Running and its Effect on Cartilage

- Pictures of collagen fibers
  - Sedentary, low and moderate intensity exercise levels with parallel organization.
  - High intensity level with irregular collagen cell alignment
Animal Studies: Strenuous Activity

- Dogs running on treadmill observed
  - Normal radiographs
  - Decreased thickness of cartilage by 6% in femoral medial condyle
  - Glycosaminoglycan decreased 11% along WB summits of femoral condyles
  - Equivalent at margins


Animal Studies: Benefit of Moderate Exercise

- Canines with moderate running
  - Thickness of uncalcified cartilage increased
    - Lateral condyle 19%
    - Patellar surface of femur: 23%
    - No alterations
    - GAGS were augmented by 28%
    - Medial > Lateral


Animal Studies: Lifelong Exercise on Articular Cartilage

- Dogs exercised 527 weeks on treadmill with weighted jackets
  - 130% body weight
- None of the joints observed had any ligaments, meniscal injuries, cartilage erosions, or osteophytes
- Lifetime of “regular” weight bearing exercises did not cause histological changes of articular cartilage that might lead to degeneration

Summary of Animal Studies

• What do animal studies tell us?
  —(Dogs are tougher than rats; and aren’t Scary!)
  —Exercise in Moderation

HUMAN STUDIES ON RUNNING AND OSTEOARTHRITIS

• Retrospective observational study found hip joint on runners had radiographic changes with increased:
  —Subchondral sclerosis
  —Osteophyte formation
  —Joint space narrowing
• Running > 97 km per week and a faster running pace were strong predictors of subsequent degenerative hip disease
  —Pace > mileage
• Only runners reported occasional hip pain


HUMAN STUDIES ON RUNNING AND OSTEOARTHRITIS

• Runners who ran an average of 29 miles per week for 12 years
  —Pain comparable in runners and non runners
  —No noticeable changes in radiograph between runners and non runners
  —Difference in hip IR with runners and non runners

Radiographic Imaging

- Radiographic Comparative study of male runners and non runners

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<thead>
<tr>
<th></th>
<th>RUNNERS</th>
<th>NON RUNNERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSTEOPHYTES</td>
<td>7.4</td>
<td>8.4</td>
</tr>
<tr>
<td>Collagen Thickness</td>
<td>4.65</td>
<td>4.34</td>
</tr>
<tr>
<td>Hips</td>
<td>5.06</td>
<td>5.00</td>
</tr>
<tr>
<td>Knee Medial</td>
<td>5.85</td>
<td>5.69</td>
</tr>
<tr>
<td>Knee Lateral</td>
<td>5.85</td>
<td>5.69</td>
</tr>
</tbody>
</table>


HUMAN STUDIES ON RUNNING AND OSTEOARTHRITIS

- 18 year longitudinal study
  - Initial radiographs
    - Runners 6.7% OA
    - Non Runners 0%
  - End radiographs Prevalent OA
    - Runners 20%
    - Non runners 32%
  - No association seen with gender, education, or previous knee injury
    - Runners did decrease their running time by 55%, but still maintained ~ 300 minutes per week
    - Greater progression of OA in controls
      - Difference was not significant


HUMAN STUDIES ON RUNNING AND OSTEOARTHRITIS

- Observational study:
  - 1st lumbar vertebra bone mineral content 40%> in runners
  - Female runners had more Knee sclerosis and spur formation
  - No between groups differences

Lane NE et al. Long-distance running, bone density, and osteoarthritis. JAMA.1986;255:1147-1151
HUMAN STUDIES ON RUNNING AND OSTEARTHRITIS

- Found 6/20 runners had varying degree of knee osteoarthrosis
  - History of knee injury
  - Medial meniscus
  - Ligament laxity
  - Genu varum
- Poor quality study

McDermott M. Brit J Sport Med. 1983;17:84-87

Lower Extremity Osteoarthritis from Long Term Running

- Longitudinal study compared hip, knee radiographs and progression of joint changes in runners and non runners
  - Runners had lower disability scores
  - Osteophyte progression showed significant increase of:
    - 178% in runners
    - 142% in non runners
  - Radiographic progression of joint space narrowing was
    - 22% in runners
    - 32% in non runners
  - Similar for both males and females
- Found that Runners no accelerated development of radiographic OA of the knee or hip


Weight bearing versus Non Weight Bearing and Joint Pain

- Retrospective study
  - 504 collegiate cross country runners
  - 287 collegiate swimmers
  - Incidence of knee pain
    - Runners: 15.5%
  - No difference found between high mileage and low mileage
    - Runners: 19.5%
    - Swimmers: 2.1% (4 THA, 2 osteotomies, 1 patellectomy)

Diagnostic Imaging

- MR of the hip and knee before and after a marathon
  - In all runners, did not find any:
    - Marrow edema
    - Periosteal stress reactions
    - Joint effusions
- High impact forces in long-distance running are well tolerated and do not show on MR images


Diagnostic Imaging

- MR of pre and post marathon
  - Cartilage lesions
  - Bone Marrow edema
  - Joint effusion
- Found only "subtle" changes
  - Joint effusion
  - Meniscal changes if already damaged


Diagnostic Imaging

- MRI performed on asymptomatic knees before and after running a marathon
  - Had "abnormality"
    - 8/10 marathoners
    - 7/12 controls
  - Running a single marathon did not change the MR findings significantly

Stahl R et al. Prevalence of pathologic findings in asymptomatic knees of marathon runners before and after a competition. Skeletal Radiol. 2008;37:627-638
Diagnostic Imaging

- MRI performed before, immediately after and 6-8 weeks after running a marathon
  - Found that healthy individuals had no long-term effects
  - Individual with pre-existing meniscal injury showed signs of progressive osteoarthritis 2 months after


Diagnostic Imaging

- From radiographs, 86% of women and 78% men over age 65 years show evidence of OA
  - 40% to 70% of these people are symptom free


Diagnostic Imaging

- 2 groups of runners
  - 1: < than 6 months, < 2 X per week < 32 km/week
    - (n=16)
  - 2: > 6 months, > 2 X per week, > 32 km per week
    - (n = 10)
- Grade 1 meniscal injury in 6 high trained and only 4 low trained
- Grade 1 cartilage injury found in 3 high trained and only 1 low trained
- Runners with higher training level showed statistically > score for all chronic knee lesions than those with a lower training level
- Training pace had no impact on incidence of chronic knee lesions

So...There are no changes on MRI...It Must be okay to Run, right?

— All of the studies were done on small numbers
— Did not study on obese / overweight runners
— Studies were done with 1 marathon performance...
  — What if done on the multiple marathoner?
— What about the multiple 5k and 10k runner
— What about the Ultra marathoner?
Do Bad Radiographs Mean Functional Limitation

• Cohort study of those with high risk of knee OA
  – Radiographs
    – 53% None
    – 6% Incidental
    – 1.8–1.9 X Risk
  – 14% Stable
  – 2.2 X Risk
  – 27% Worsening
  – 2.3 X Risk


Degenerative Arthritis of the Hip in Runners

• Systematic review looked into association of Running and premature degenerative arthritis of the hip
  – 10 retrospective
  – 5 prospective
  – Pooled estimate of the included studies showed a slight increased risk for degenerative arthritis, but not at level of statistical significance


Risk of Osteoarthritis from Long-term Weight Bearing Sports

• Retrospective study looking at female athletes
  – Ex athletes lighter by 5.9 kg
  – Athletes BMI: 22.1
  – Controls: BMI: 25.6
  – Ex athletes had similar rates of symptom reporting, but with higher pain thresholds than controls

Risk of Osteoarthritis from Long-term Weight Bearing Sports

- Ex athletes found to have 1.6 to 3.6 fold increased risk of OA at the hip and knee
- Joint spaces
  - Knee
    - > in Athletes by 0.41 mm
  - Hip
    - > in Athletes by 0.13 mm
- Osteophytes
  - Tennis players had almost double the rate of osteophytes at the knee and at the hip compared to ex runners
  - Runners had more osteophytes and narrowing at the patellofemoral joint

Knee Osteoarthritis Related to Ground Reaction Forces?

- Peak joint loads in running have been found to be ~ 3 X greater than those in walking
- Study looked at ‘load per unit distance’ to refute concept of peak joint loads
  - The average load per stride
- Found:
  - Peak knee joint contact force to be
    - Running: 8.02 ± 1.62 BW
    - Walking: 2.72 ± 0.41 BW
  - Load per unit distance unchanged
  - Peak load increased with running speed, where as the load per unit decreased
- So what? May explain why running does not seem to increase the risk of osteoarthritis

Lower Extremity Osteoarthritis from Long Term Running

- Longitudinal study
  - Runners in 1950, re-examined with radiographs and questionnaire
    - > 40 years of running
  - 1 stopped running due to hip OA
  - Had bilat THA
  - 27 were still running 20-40 km per week
  - 6 had pain
  - No roentgenographic differences observed between matched runners and non runners
Gait Changes With Knee OA and Reported Instability

- Investigative study in lower extremity OA, compared patients with and without self reported knee instability
  - Gait analysis
  - WOMAC
- Knee instability was associated with > odds of reporting mod to severe gait related pain
  - Walked with > knee flexion excursion
  - Reduced hip extension and ankle PF
- This was Not a Running study...
  - Reports of knee instability and OA, expect alterations in hip, knee, and ankle during stance phase
  - Need for external support?


Low Back Pain and Runners

Biomechanical Variables for Low Back Pain

<table>
<thead>
<tr>
<th>Varus Knee</th>
<th>Valgus Knee</th>
<th>Pes Planus</th>
<th>Pes Cavus</th>
<th>Leg Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>16%</td>
<td>5%</td>
<td>11%</td>
<td>8%</td>
<td>19%</td>
</tr>
</tbody>
</table>


Epidemiology of Low Back Pain in Runners

- Type of practitioner seen with history of low back pain
  - MD: 30%
  - Chiropractor: 23%
  - Massage Therapist: 21%
  - Physical Therapist: 19%
  - Acupuncturist: 2%

Woolf SK et al. The Cooper River Bridge Run study of low back pain in runners and walkers. J South Ortho Assoc. 2002;11:138-143
Low Back Pain in Runners

- Survey found
  - Previous history of LBP
    - Runners 75%
    - Walkers 68%
  - Most frequently occurred in obese runners (BMI > 27)
    - Both Men and Women
    - Not in walkers

- Shoe Wear
  - Equal shoe wear
    - 69% were less likely to relate to previous LBP (p < 0.03)


Epidemiology of Low Back Pain in Runners

- Questionnaire of “middle aged” runners
  - Injuries reported by 90% of respondents
  - Muscle strains
    - Achilles 56%
    - Hamstrings 17.5%
  - Joint sprains
    - Knee 22.5%
    - Ankle 17%

- Foot problems
  - 95%

- Back pain
  - 9.2%
  - Only had 1 episode of stopping jogging temporarily
  - No permanent stoppage in running


DIFFERENTIAL DIAGNOSIS: Running and Back Pain

- Sacral Fracture
  - 26 yo Female runner
  - Left LBP
  - Increased running to 12 miles, then to 16.5 miles
  - Tenderness to touch
  - Only temporary response to PT

DIFFERENTIAL DIAGNOSIS: Running and Low back Pain

- Sacral Fracture
  - 36 yo male marathoner
  - 2-month history of LBP and buttck pain
  - Started after running a marathon
  - No radicular symptoms
  - Paraspinal hypertonicity
  - Tenderness over SI and PSIS


Physical Activity and Lumbar Joint osteoarthritis

- Studied activity level and amount of Lumbar zygapophyseal joint osteoarthritis
  - Only significance activity was “heavy activity” > 3 hours per day
  - Odds ratio: 2.13 (95% CI)
  - Jogging or running was non significant with presence of Lumbar OA


Does Foot Strike Have an Effect on the Lumbar spine

- Comparative study between forefoot and rear foot strikers
  - Decrease in overall lumbar ROM with forefoot strike
  - No difference in the amount of flexion or extension
  - Decrease in peak leg impact with forefoot
  - Increase in comfort with rear foot strike
  - Lack of familiarity?

Lower Extremity Joint Stiffness and Runners with Low Back Pain

- Gait analysis study looked at lower extremity joint stiffness in runners with and without Low back pain.
  - LBP group had greatest knee stiffness, although not significant.
  - No differences found in ankle and hip stiffness.
  - Concluded that perhaps LBP group has decreased attenuation of foot-ground impact.

Lumbo-pelvic Kinematics and Low Back Pain

- Systematic Review
  - People with LBP
    - No difference in lordosis angle.
    - Reduced Lumbar ROM.
    - No difference in standing pelvic tilt.
      - Small, but non significant effect towards anterior tilt.
    - Slower movement.
    - Reduced proprioception.
    - Present prior to LBP?

Running Biomechanics in Runners with Chronic Low Back Pain

- Looking at biomechanics of the trunk of runners with chronic low back pain and healthy controls:
  - CLBP had less pelvis and unchanged thoracic rotation compared to controls.
  - Peak ground reaction forces did not change significantly.
  - Running speed or step length did not change.
Pelvis and Trunk Coordination in Runners with Low Back Pain

• Comparison of walking and running on treadmill
  — Running:
    — LBP had > pelvic axial rotation than control
    — More of the gait cycle in-phase in the transverse plane
    — Even if pain had resolved, upper body coordination was different compared to those with no LBP history

Lumbar Disc Changes With Running

• Running exercises restored the degenerative discs and increased the cell densities of the annulus fibrosus and nucleus fibrosus
• Greater cell proliferation found in the running group
• Had a decrease in withdrawal thresholds

Intervertebral Disc and Running:

• Rats ran for daily for 3-weeks
  — The intervertebral disc showed:
    — Increase in cellularity
    — Annulus: Increased by 25%
    — Increase in expression of
      — Type II Collagen
      — Agreican
      — Proteoglycan


Running and the Intervertebral Disc

- 1 Hour after running while sitting in neutral, flexed and extended postures
  - Significant reduction in whole lumbar spine
  - Mean reduction in disc height in neutral was 4.88 mm
  - 92% or runners had disc degeneration
  - Highest % of disc degeneration was at L5 S1
  - Males less than females
  - Males with > low back pain

Paraspinal Muscle Fatigue, and its Effect on Running

- Upon fatiguing lumbar paraspinal muscles, observed:
  - Reduced moments in:
    - External knee flexion, Knee adduction
    - Knee internal rotation
    - Hip external rotation
  - Increased moments in:
    - Knee extension
  - Persons with history of LBP rely more on quadriceps while jogging

CONCLUSION on Running and Low Back Pain

- History of low back pain does appear to have effect on gait kinematics
- Intervertebral disc height and cellular matrix increased
- Low back pain in runners is not common
Final Thoughts

• Literature has a significant selection bias

• Insufficient evidence to identify the relationship of recreational running and osteoarthritis


CONCLUSION
What Should we Tell Our Patients?

• Do the benefits of running out weigh the risks?

• What is too much?
  – Miles
  – Intensity

• Previous knee injury

Bottom Line on Running and Osteoarthritis

Social Media

@runningphysio
@ProfTimNoakes
@KariEllynBrown
@rwilly2003
@runnersworld

Thank You!

http://ptdayofservice.com/

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