Exercise, Obesity and Knee Osteoarthritis

Knee Osteoarthritis

- Commonest cause of disability in the elderly.
- 80% of people over age 70
- 33% of radiographs in patients over 60.
- Similar to CVS disease in limiting activities of daily living in the elderly.

Quality of Life

- Obesity epidemic adds to frequency of comorbid knee arthritis
- Knee OA associated with metabolic syndrome
- Fourth leading cause of non-fatal health burden ages 50-84
- Women – especially black women disproportionately affected

Women and Knee OA

- Pelvic width increases angulation stress
- Genu valgum more frequent.
- Increased joint laxity with hyperextension.
- Quadriceps strength often exceeds hamstring strength.
- More femoral anteversion
- More external tibial torsion

Mortality Predictors in Elderly

- Physical performance
- Level of disability
- Cognitive performance
Exercise, Obesity and Knee Osteoarthritis

Questions Regarding Knee OA

If maintenance of physical activity and prevention of disability are important to quality of life with ageing:

- What is the role of exercise in causing knee OA?
- Is exercise helpful or harmful in established knee OA?

Questions Regarding Knee OA

If obesity and metabolic syndrome are strongly associated with knee OA:

- Is the probable cause mechanical or metabolic?
- Is further exercise likely to make the problem better or worse?
- Is weight loss important?

Diagnosis of Knee OA

- Loss of hyaline cartilage is the signature event.
- Presence of inflammation is inconsistent but may play a part in causation.
- Diagnosis is both clinical and radiographic.

Clinical Diagnosis

- Onset after age 40; usually progressive
- Asymmetrical, but might be bilateral
- Pain with weight bearing and morning stiffness (usually < 30 min)
- Crepitus or reduced flexion (advanced)
- Tenderness on patellar pressure or over joint space
- Bone enlargement or deformity (advanced)
- Absence of heat or inflammation
- Occasional effusion containing a WBC count < 2000/mm3, with normal viscosity

Radiographic Diagnosis

- Joint space narrowing—tibiofemoral or patellofemoral
- Subchondral sclerosis
- Marginal osteophytes
- Subchondral cysts
- Patellofemoral views improve diagnostic yield.
- Discordance with clinical signs. X-ray evidence of OA correlates with symptoms between 15 and 85% of the time.

Non-Modifiable Causes and Risk Factors

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Older age</td>
<td>Incidence increases with age</td>
</tr>
<tr>
<td>Female sex</td>
<td>Greater prevalence of OA in women</td>
</tr>
<tr>
<td>Genetics</td>
<td>May contribute to 40-60% of incidence</td>
</tr>
</tbody>
</table>
### Exercise, Obesity and Knee Osteoarthritis

#### Modifiable Causes and Risk Factors

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obesity</td>
<td>Higher incidence of OA among obese patients.</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>Associated with higher incidence and slower progression.</td>
</tr>
<tr>
<td>Trauma</td>
<td>Occupation, sports, accidents.</td>
</tr>
<tr>
<td>Muscle weakness/dysfunction</td>
<td>Increases in OA with inactivity, poor training, and injury.</td>
</tr>
<tr>
<td>Proprioceptive deficit</td>
<td>Increases with age, comorbid illness, and ACL injury.</td>
</tr>
</tbody>
</table>

#### Trauma may be more common than we think:

- 991 randomly selected subjects aged 50-90 for MRI of R knee.
- Prevalence of tears 19-56% depending on age and gender.
- Meniscal tears highly associated with knee OA.
- Meniscal tears had very low association with pain.
- 61% of subjects with meniscal tears had no pain or symptoms within the previous month.


### Exercise, Obesity and Knee Osteoarthritis

#### Does Exercise Cause Knee OA?

A 60-year-old man has been running 30 km/wk for 35 years. He has no history of noteworthy illness and has never had a sports- or running-related injury. He has been told that he is wearing out his knees and that he will get arthritis if he continues to run, but he wishes to remain active as he gets older. He asks your advice.

### Exercise, Obesity and Knee Osteoarthritis

#### Level of Evidence

<table>
<thead>
<tr>
<th>Basis for Clinical Decision</th>
<th>Marker</th>
<th>Level of Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evidence</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Evidence</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Evidence</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Evidence</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Evidence</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Evidence</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Evidence</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Evidence</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Evidence</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Evidence</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Evidence</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Evidence</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Evidence</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Evidence</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Evidence</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Evidence</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Evidence</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Applies only to surgeons

_Based on: Fitzgerald B. Seven alternatives to evidence based Medicine. BMJ 1993; 307: 643._
Exercise, Obesity and Knee Osteoarthritis

Does Exercise Cause Knee OA?

- All studies Level 2 evidence due to problems with compliance and blinding
- Observational on self-selected populations with no imposed intervention
- Many studies are prospective cohorts followed for long periods of time.
- Poor correlation between x-ray findings and symptoms. "OA" often a surrogate for lower extremity pain and disability.

Exercise, Obesity and Knee Osteoarthritis

Does Exercise Cause Knee OA? Stanford Runners Study*

- Average age 59 at onset, followed with cohort 21+ years. Many now in their 90’s.
- Primarily a knee OA study. No comparative increase in incidence or progression.
- Runners had fewer symptoms and higher level of functioning with similar apparent joint pathology.
- Mortality rate at 21 years – 34% in sedentary cohort and 15% in runners.
- Selection bias an obvious issue

Exercise, Obesity and Knee Osteoarthritis

Does Exercise Cause Knee OA? Compression of Morbidity

- Morbidity and disability determined by smoking, body weight and exercise level.
- Over time, smoking incidence is down, but obesity levels are rising. Exercise levels have probably fallen.
- Continued exercise into old age has potential to delay major morbidity closer to time of death.
- Hypothesis is not provable, but has been tested in 2 prospective cohort studies, which support the concept.

Exercise, Obesity and Knee Osteoarthritis

Does Exercise Cause Knee OA? Exceptions

- Elite athletes showed higher OA levels – possibly injury induced.
- Higher levels in extremes of physical activity involving work and recreation.
- Some sports such as soccer and wrestling associated with increased knee OA.

Exercise, Obesity and Knee Osteoarthritis

Does Exercise Cause Knee OA?

This man can be reassured that, as a self-selected runner, he will not develop accelerated knee OA as a result of his activity, and that his risk of disability might even be minimized as he ages because of his level of exercise. A physician-imposed recommendation for the same level of activity in a sedentary person would not be risk free, however it is reassuring to note that activity at a moderate level with avoidance of trauma does not seem to increase the risk of knee OA. X-ray would not be helpful, as changes do not predict future appearance of clinical symptoms.
Exercise, Obesity and Knee Osteoarthritis

**Does Exercise Worsen Knee OA?**

**Case study:**
A 55-year-old woman has been experiencing increasing knee pain with physical activity for the past several years. She has been told by her physician that she presents early stages of knee arthritis on x-ray, and she occasionally uses over-the-counter anti-inflammatory medications for relief. She is overweight and finds that she cannot lose weight by dieting. She is sedentary and is afraid to start exercising as an aid to weight loss because she is afraid that this will make her knee arthritis worse as she becomes older. She asks your advice.

**Results:**
- Small to moderate improvement in disability
- Small to moderate improvement in pain
- Improvement similar to that achieved with chronic NSAID use.
- No correlation between severity of OA at onset of activity and degree of benefit

**Comorbidities:**
- Benefit can occur without weight loss
- No intervention resulted in harm in obese subjects.

**Resolution:**
It is reasonable to suggest that, even if she achieves minimal weight loss, continued exercise will minimize both pain and disability. She might expect improvement in symptoms and disability similar to benefits obtained from nonsteroidal anti-inflammatory drugs, without the side effects. She might consider stopping the medication or switching to acetaminophen or topical NSAID.
Case study: A 66-year-old woman has had low-grade knee pain increasing with activity for ten years. She has metabolic syndrome, and has been told by her physician that she has moderate knee arthritis on x-ray. She cannot use NSAIDs because of hypertension. She is obese with a BMI of 32, and has had no success with diet. She is sedentary because of time constraints, but also because of fear of increased pain and OA progression with activity. She asks your advice.

OA has a metabolic association with obesity:

- Meta-analysis: Obesity associated with hand OA: RR=1.9*
- Inflammatory cytokines secreted by fat cells – especially in ectopic and visceral sites.
- OA associated with 5.25 fold risk of metabolic syndrome. Both are associated with obesity, high rates of visceral fat and inflammatory cytokines.
- Increasing age associated with increasing visceral fat and inflammatory cytokines.


Inflammatory factors act locally and systemically:

- Obesity is a systemic inflammatory condition; particularly if central
- Inflammatory cytokines found in high concentrations in infrapatellar fat vs subcutaneous fat*.
- This fat pad may also serve as a paracrine source of inflammation


Is weight loss important?:

- Loss of visceral fat balanced by gain in muscle mass. Wt may remain neutral.
- Multiple studies now demonstrate improvement in mortality, morbidity, quality of life and fitness without wt loss.
- Weight loss can be beneficial in presence of weight-related co-morbidities.
- Maintenance of present weight minimizes mortality risk. Default is weight gain of .25-.50 kg/year.

Exercise, Obesity and Knee Osteoarthritis

What Can We Do about Obesity?

Is weight loss important?

- Symptom improvement shows more association with fat loss than weight loss.
- Improved QOL associated with exercise with or without wt loss.
- Incorporation of exercise preserves strength and lean tissue mass.
- Pedometer use or waist circumference may be more useful goals than weight measurement.

Biomechanics of obesity:

- Increased joint loading.
- Increased potential for injury.
- Shorter stride length.
- Reliance on hamstring strength for knee stability with relative quadriceps weakness.
- Downhill walking and deceleration are likely to present problems.
- Muscle imbalance likely to become more marked with ageing.

Effective exercise modalities:

- Swimming
- T’ai chi
- Resistance exercise
- Aerobic exercise

Swimming:

- Avoids mechanical loading
- Buoyancy reduces energy consumption
- Upper body is able to augment exercise benefit
- Appetite may increase following exercise in cold water
- Requires an expensive facility which can be available year-round.

T’ai Chi:

- Minimal joint loading
- Improves extensor muscle endurance
- Improves bone density
- Reduces fear of falling
- Can reduce symptoms and disability
Exercise, Obesity and Knee Osteoarthritis

What Can We Do about Obesity?

**Resistance exercises:**
- Accomplished with normal joint loading
- Improves muscle strength. Quads can be targeted
- Can correct for abnormal loading and misalignment
- Aids cartilage synthesis and preservation
- Improves joint stability
- Small metabolic benefit

**Aerobic exercise:**

- **Tibial forces**
  - Swimming: <1
  - Rowing: <1 (repeated flexion/extension)
  - Exercise bicycle: 1.0
  - Walking: 1.8-2.5
  - Elliptical: 2.25 (high exercise levels without loading)
  - Stair-master: 2.2-3.0
  - Golf, Tennis: 3.5-4.0
  - Stairs: 5.0
  - Running: 7.0-22.0

- **Cycling**
  - Relatively low tibial force
  - Avoids deceleration forces
  - Repeated flexion/extension
  - Tolerated less well by obese and by women
  - Favors flexors over extensors.
  - Requires quads supplementation
  - Increasing cadence does not increase tibial forces

- **Treadmill**
  - Peak forces were 1.8 to 2.5 times body weight for treadmill walking
  - Slower walking (range, 1–3 mph) had no effect on peak tibial forces
  - Power walking (4 mph) generated higher forces
  - Jogging peak forces were higher than those of power walking
  - Uphill slope can allow reduced cadence with similar energy used.
Exercise, Obesity and Knee Osteoarthritis
What Can We Do about Obesity?

Aerobic exercise: Land walking
- The most available and affordable form of exercise
- Involves downhill and deceleration with potential for both injury and strengthening of quadriceps
- Considered the gold standard for aerobic exercise for the average person

Aerobic exercise: Nordic walking
- Improved compliance with exercise vs. walking.
- Excellent transition from or substitute for jogging
- No evidence for unloading knee joint while walking.

Modality | Advantage | Energy Considerations | Comments
--- | --- | --- | ---
Swimming | Balanced muscle use | Buoyancy decreases energy expenditure | Requires expensive facility and some skill
Tai Chi | Low risk | Improves balance | May increase appetite
Nordic walking | Low energy expenditure | Best for energy expenditure in/outdoor option
Nordical | 10-20% upper body participation | Best higher-energy outdoor option
Elliptical | Higher cadence allows increased energy expenditure | Best gym option

Resolution:
She is 66 years old and has a BMI of 32 (class I obesity):
• Weight gain slows or reverses beyond age 60
• Overweight and class I obesity may be protective in the elderly in absence of wt related co-morbidities
• Her only wt related co-morbidity is knee OA, which will improve symptomatically with diet and exercise.
• Wt loss may be a consequence, but should not be a goal.
• Realistic goals are maintenance of diet quality and quantity, and exercise time and intensity.
Exercise, Obesity and Knee Osteoarthritis

Diet or Exercise to Improve Knee Pain and Function?

- Single blind RCT lasting 18 months
- Diet deficit of 800-1000 calories per day
- Exercise 1 hour 3 days per week
- Third group combined exercise and diet
- Adherence 85-90% over 18 months

Messier SP, et al. JAMA 2013; 310(12): 1263-1273

<table>
<thead>
<tr>
<th>Modality</th>
<th>Exercise</th>
<th>Diet</th>
<th>Exercise+Diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wt Loss</td>
<td>-1.8 kg</td>
<td>-8.9 kg</td>
<td>-10.6 kg</td>
</tr>
<tr>
<td>Pain Score</td>
<td>-28%</td>
<td>-27%</td>
<td>-45%</td>
</tr>
<tr>
<td>Change</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Function Score</td>
<td>24%</td>
<td>29%</td>
<td>42%</td>
</tr>
<tr>
<td>Change</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Messier SP, et al. JAMA 2013; 310(12): 1263-1273

Conclusions:
- Moderate exercise not very effective for wt loss alone
- Diet and exercise similar for pain reduction and physical function
- Combination of the two is the best option

Messier SP, et al. JAMA 2013; 310(12): 1263-1273

Exercise, Obesity and Knee Osteoarthritis

Treatment: Acetaminophen
- 3 gm/day equivalent relief to 1200mg ibuprofen/day
- May have similar incidence of blood loss to NSAIDS.
- Blood loss is additive if the 2 are used together*

*Docherty M, et al. Arthritis Care & Research 2011; 70(6)

Exercise, Obesity and Knee Osteoarthritis

Treatment: NSAIDS
- Effective for symptoms: NNT=4.
  - COX-1 – GI side effects.
  - All increase BP
  - Exercise gives similar symptom benefit to NSAIDs.

Exercise, Obesity and Knee Osteoarthritis

Treatment: NSAIDS
- CVS effects vs. Placebo (RR=1)
  - Naproxen RR=0.8
  - Ibuprofen RR=1.6
  - Celecoxib 200mg bid RR=2.6
  - Celecoxib 400 mg bid RR=3.4
  - Indomethacin, diclofenac high risk
Exercise and Knee Osteoarthritis

Treatment: Topical NSAIDS

- Effective for symptoms: NNT=4.
- Serum levels 1/20th of oral agents
- Few side effects. Skin rash equal to placebo.
- Diclofenac, ibuprofen best studied
- Cochrane review of 40+ RCT's confirms benefit*.  


Exercise and Knee Osteoarthritis

Arthroscopic Debridement

- 165 subjects randomly assigned to arthroscopic debridement or sham surgery
- No difference in pain score or functional outcomes at any point postoperatively.
- No advantage of debridement as compared non-blinded to optimized medical therapy

Exercise, Obesity and Knee Osteoarthritis

Conclusions

- Exercise does not lead to OA in absence of injury
- Symptoms and disability from developing OA can be minimized or improved with continued exercise.
- Quadriceps isometrics are especially important in the obese who exercise.
- Walking, cycling and elliptical training cause least joint loading of land-based aerobic activities.
- Nordic walking may be especially helpful
- Exercise is under-utilized in treatment of knee OA

Exercise, Obesity and Knee Osteoarthritis

Avoiding Drug-Induced Obesity

<table>
<thead>
<tr>
<th>Condition</th>
<th>Preferred Drugs</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td>Metformin, GLP1 agonists</td>
<td></td>
</tr>
<tr>
<td>Diabetes requiring insulin</td>
<td>Oral meds above, add basal insulin</td>
<td>Insulin promotes fat storage</td>
</tr>
<tr>
<td>Hypertension</td>
<td>ACE or CCB</td>
<td>Avoid beta blockers</td>
</tr>
<tr>
<td>Depression</td>
<td>Fluoxetine, Sertraline, Bupropion</td>
<td>Avoid Pantoprazole or sedating agents</td>
</tr>
<tr>
<td>Psychosis</td>
<td>Older agents</td>
<td>Atypical increase wt 7.18%</td>
</tr>
<tr>
<td>Anticonvulsants</td>
<td>Lamotrigine, Phenytoin</td>
<td>Wt gain common with gabapentin</td>
</tr>
</tbody>
</table>

Exercise and Knee Osteoarthritis

END
Exercise, Obesity and Knee Osteoarthritis

Avoiding Drug-Induced Obesity

<table>
<thead>
<tr>
<th>Condition</th>
<th>Preferred Drugs</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contraception</td>
<td>Oral contraceptives</td>
<td>Avoid injectable progestins</td>
</tr>
<tr>
<td>Antiretrovirals</td>
<td>Most cause wt gain</td>
<td>Monitor CV risk factors</td>
</tr>
<tr>
<td>Rheumatic Disease</td>
<td>DMARDs, NSAIDs</td>
<td>Avoid corticosteroids</td>
</tr>
<tr>
<td>Antihistamines</td>
<td>Least potent</td>
<td>Prescription and sedating agents cause wt gain</td>
</tr>
</tbody>
</table>