Effects of Knee Positions On Patellofemoral Joint Stress During Cycling
Outline

- Background
- Epidemiology
- Previous Study
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- Method
A recent statistic showed that over 66.7 million people have been cycling in the last 12 months (reference).

Good form of exercise with many health benefits (Bassett et al., 2008).
Epidemiology

- The patellofemoral pain syndrome (PFPS) is the most common injury in cycling.

- Prevalence of PFPS: 42% – 65% (Conti-Wyneken, 1999).
The problem: PFJ

- PFJ: patellofemoral joint
- Misalignment of the patella can cause wear on the cartilage (Emami et al., 2007; Pal et al., 2013).
- Excessive wear will cause pain known as PFPS.
The problem: PFJ

(Besier et al., 2011)
Alignment and Q angle

- Proper tracking of the patella requires proper alignment.
- Alignment can be measured through the Q angle.
- Around 13° in males to 18° in females (reference).
PFPS and Q angle

- Lateral knee compartment is more vulnerable to develop PFPS (Elias et al., 2004).

- Females have 2.23 times the incidence of PFPS compared with males (Boling et al., 2010).
Knee position and PFPS

- Improper knee positions during cycling have been thought to cause patellar maltracking by inducing abnormal Q-angle (Bailey et al., 2003).

- No study has reported the actual PFJ contact stress with different knee positions during cycling.
Previous Research

- PFJ: one degree of freedom
- 3D musculoskeletal model (Roos, et al., 2012; Lenhart, et al., 2014)

- Limitations
  - Stress cannot be computed
  - Maltracking cannot be reflected in the model
Previous Research


1. Defining the geometry and morphology of the various tissues.
2. Defining the material properties of the tissues.
3. Prescribing the joint orientation/kinematics.
5. Simulation and validation.
Defining the geometry and morphology

- High-resolution MRI
- Supine
- Fully extended knee
- An undeformed cartilage
Defining the material properties

- Cartilage
  - MRI & Mechanical Property
- Bone
  - Bone density by CT
- Tendons
  - Based on experimental data
Prescribing the joint kinematics

- Open-bore MRI
  - Weight bearing
  - Knee flexion Angle
    - 60° - Stair Climbing (Besier et al., 2015)
    - 30° - Running (Besier et al., 2007)

- Cycling
  - 80° (Ericson et al., 1987)
  - Kinematic from motion capture system
Estimating muscle forces
Simulation and validation

- Contact areas measured from weight-bearing MRI

- The final orientation of the patella compared to that from weight-bearing MRI
Statement of Purpose

The purpose of this study is to examine the effects of three different knee positions (knee-in, knee-out and neutral) on the PFJ contact stress during stationary cycling.
Participants

- Young adults: 18-30 years old
- Number: 20
- Have recreational cycling experience
- Have no previous lower extremity injuries within the past six months
Instrumentation & Procedures

- **Bicycle ergometer**: 120 W, 60 rpm, with 3 knee positions
- **Instrumented pedal**: Pedal Reaction Force
- **3D Motion analysis system**: Kinematic
- **EMG**: Muscle Activation
- **OpenSim**: Estimating Muscle force at peak knee extension moment (approximately 80° knee flexion).
- **MRI**: Supine, Geometry; 80° knee flexion, Joint kinematics
- **ABAQUS**: Finite Element Modeling
Reference


