Patient-Specific Modeling Core

Gait analysis

Musculoskeletal Simulation

Imaging

Muscle

Cartilage

MUSCLE FORCES
MUSCLE SYNERGY
JOINT CONTACT FORCES

MUSCLE ARCHITECTURE
MUSCLE ATROPHY
CARTILAGE GEOMETRY
Post-Traumatic Osteoarthritis

A. DMM+Veh

B. DMM+ZA

- Indicates loss of PG, fibrillations, and/or erosions

C. Average OA Damage Score

- DMM+ Veh (n=4)
- DMM+ ZoI (n=6)

OA Damage Score

0 1 2 3 4

Medial Tibia Medial Femur

p<0.01
p<0.01

"OA" Threshold
Does OA affect the fluid pressurization and lubrication response of cartilage?

1. Low friction due to poorly understood biphasic tissue mechanics
2. Does local degradation reduce pressure → higher friction, higher matrix stresses → unfavorable cell response → damage progression → OA
3. **Goal: model the response, predict outcomes**

In-situ area and stress measurements

**Modeling:**

**Hertz & Darcy**

\[
F' = \frac{P}{P + \sigma_c} = \frac{E_t}{E_t + E_c} \cdot \frac{V \cdot a}{V \cdot a + E_c \cdot k}
\]
Is OA a bone disease?
Can we inhibit bone remodeling to delay and treat OA?

Fig. 1. (A) Osteoarthritic knee (B) Articular cartilage, subchondral bone, and sandwiched calcified cartilage (C) Proposed mechanisms of bisphosphonates in treating OA by inhibiting transport of bone-derived factors.
How is the mechanosensing capability altered in osteocytes during aging and osteoporosis?
Collaborative Research

**FastFES:** post-stroke treadmill training with Functional Electrical Stimulation

**Mobility training:** with novel robots and interfaces for children aged 6 – 24 months

**Robotic exoskeletons:** powered and passive devices to assist with gait and upper extremity rehabilitation

**Composite AFOs:** lightweight customized AFOs

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