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Examining Movement Function in Patients with Knee Osteoarthritis

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Biomechanical Gait Analysis for Improving Clinical Outcomes: Applications for Orthopedics, Geriatrics and Community Based Research

UMCCTS Research Retreat
Mini Symposium

Katherine Boyer, PhD
Assistant Professor
Department of Kinesiology
Memorial gait analysis clinic

- Partnership between UMMS Orthopedics and UMass-Amherst Kinesiology

- Memorial gait analysis clinic- 1st floor North wing Memorial
Memorial gait analysis clinic

- The goal of this new facility
  - is to foster and support across campus collaborations
  - to incorporate biomechanical testing and monitoring of joint mechanics into the standard clinical care
  - development of new monitoring devices as part of the UMass-Amherst Center for Personal Health Monitoring in the Institute of Applied Life Sciences.
Mini symposium

1. PROs in TJR Clinics - Surrogate for Measures of Activity? Dr. Franklin

2. Measures of Activity/Mobility in TJR Practice - Where Are We Now? Dr. Ayers

3. Examining Movement Function in Patients with Knee Osteoarthritis. Prof. Boyer

4. Increasing Physical Activity Amounts and Intensity in Older Adults Using Low Cost Wearable Devices - "Cadence Training". Prof. Tudor-Locke
Examining Movement Function in Patients with Knee Osteoarthritis

Katherine A. Boyer
2016
Disclosure Slide

- I have no actual or potential conflict of interest in relation to this program/presentation
Patient reported outcomes

Key constructs
- Mobility
- Physical Function
- Pain and Stiffness

Methods
- Short Form 12 or 36
- Knee or Hip OA Outcomes Scores (KOOS, HOOS)
- Visual Analog Pain Scales

Patient perception of abilities and disease severity
Gait mechanics

- Force and motion at joint surface
- Tissue/Cell mechanobiology
- Joint mechanics
- Tissue level strains and morphology
- Human Movement
- Pain severity
- Physical activity pattern
- Physical function

Adapted from Andriacchi et al., 2004
What is gait analysis
What is gait analysis?

- Force platform
- High speed
- Infrared camera
Gait outcomes in walking - Knee

Vert. Ground Rxn force

Knee Flexion moment
[\% BW * Ht]

Knee Adduction moment
[\% BW* Ht]

Knee Flexion Angle [deg]

Load distribution
Gait mechanics

Adapted from Andriacchi et al., 2004

Musculoskeletal and Orthopedic Biomechanics Laboratory

Human Movement

Force and motion at joint surface

Tissue level strains and morphology

Joint mechanics

Tissue/Cell mechanobiology

Pain severity

Physical activity pattern

Physical function

Adapted from Andriacchi et al., 2004

Musculoskeletal and Orthopedic Biomechanics Laboratory
Knee angle at heel-strike → Location of thickest cartilage
(Koo et al., 2011, Scanlan et al., 2013)
Gait and cartilage morphology

Medial/Lateral Thickness vs. Adduction Moment

Medial/Lateral Thickness Ratio vs. Adduction Moment (%Bw*ht)

Healthy: $R^2 = 0.51$

OA: $R^2 = 0.73$

Andriacchi et al, Annals of Biomedical Engineering, 2004
Gait mechanics

Force and motion at joint surface

Tissue/Cell mechanobiology

Joint mechanics

Tissue level strains and morphology

Human Movement

Pain severity

Physical activity pattern

Physical function

Adapted from Andriacchi et al., 2004
Gait and OA exercise induced pain

- Exercise recommended for OA management
  McAlindon et al. 2014 OARSI guidelines *Osteoarthritis Cartilage*

- Acute exercise exacerbates pain in OA on a short term basis Fotch et al., 2002, Sandal et al., 2015.

- Are there gait characteristics that contribute to greater pain flares with weight bearing exercise?
Gait and exercise induced pain

- **Participants**
  - 15 healthy older adults (50 – 75 years)
  - 15 symptomatic knee OA

- **Exercise protocol for flare**

  - 20 min treadmill walk
  - 40 min seated rest
  - 20 min “fitness pace” treadmill walk

- **Pain reported - Verbal numeric rating scale**
Gait and exercise induced pain

- 8 OA participants – clinically significant pain increase ≥ 2pts
- 7 OA participants – non-responders to exercise flare

Boyer et al., in prep
Magnitude of load on the knee joint in walking influences the pain flare

Boyer et al., in prep
Gait mechanics

Force and motion at joint surface → Tissue/Cell mechanobiology

Human Movement

Joint mechanics

Physical function

Physical activity pattern

Pain severity

Tissue level strains and morphology

Adapted from Andriacchi et al., 2004
Acknowledgments

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