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Engineering & Scientific Consulting

Derek Holyoak, Ph.D.

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Professional Profile

Dr. Holyoak specializes in preclinical assessments, regulatory compliance, and postoperative performance of medical devices. His primary focus is the biomechanical interaction between medical devices and surrounding tissue, particularly in the spine and joints. Dr. Holyoak leads biomechanical evaluations of medical devices and ex vivo tissue specimens, using custom setups on electromechanical and servohydraulic mechanical test systems. He performs MRI compatibility assessments of medical devices using ASTM and ISO standards. Dr. Holyoak assesses wear debris and particulate generation with scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS). He also manages and assists failure analyses and legal matters involving medical device product liability and intellectual property. Professionally, Dr. Holyoak contributes to ASTM standards development for shoulder arthroplasty and MRI compatibility test methods.

Prior to joining Exponent, Dr. Holyoak obtained his Ph.D. in Biomedical Engineering from Cornell University where he developed and tested novel approaches to treat osteoarthritis. Specifically, he applied novel loading regimens to attenuate the progression of osteoarthritis in animal models. He designed, fabricated, and tested synthetic hydrogel systems for intra-articular drug delivery. Dr. Holyoak was a key contributor to preclinical studies investigating the role of the gut microbiome, obesity, and metabolic syndrome in osteoarthritis onset and progression. Through his graduate work, he gained skills working with in vivo and ex vivo models, micro-surgeries, intra-articular injections, micro-computed tomography (μCT), histology, immunohistochemistry, and image processing, in addition to mechanical assessments involving custom-made loading fixtures, uniaxial mechanical testing, fatigue analysis, and rheology. He has research, teaching, and work experience with human studies, gait analysis, motion capture systems, electromyography (EMG), and force plates. Dr. Holyoak's primary research interests are tissue biomechanics, osteoarthritis, medical devices, spine, arthroplasty, trauma, and exercise science.

In addition to his Ph.D. work, Dr. Holyoak examined the effects of malnutrition on post-operative infection after total hip replacement as part of a clinical study at the Hospital for Special Surgery. He also analyzed pre- and post-operative canine walking gait working with the Cornell University College of Veterinary Medicine. At Cybex, International (now Life Fitness), Dr. Holyoak performed exercise biomechanics studies to investigate the effects of body position on lower limb joint stresses during the forward lunge exercise.

Academic Credentials & Professional Honors

Ph.D., Biomedical Engineering, Cornell University, 2018

M.S., Biomedical Engineering, Cornell University, 2016

B.S., Biomedical Engineering, University of Connecticut, 2013

Cornell Biomedical Engineering Teaching Assistant of the Year, 2018

Cornell Three Minute Thesis Competition Runner-up, 2018

Prior Experience

Graduate Research Assistant (Orthopedic Biomechanics), Cornell University, 2013-2018

Research Assistant (Arthroplasty), Hospital for Special Surgery, 2014-2018

Technical Consultant (Gait Analysis), Cornell University College of Veterinary Medicine, 2015-2018

Graduate Teaching Assistant (Physiological Measurements and Instrumentation), Cornell University, 2016-2018

Research Assistant (Exercise Biomechanics), Cybex, International (Now Life Fitness), 2012-2013

Professional Affiliations

American Society of Testing and Materials: F04 Medical and Surgical Materials and Devices

Orthopaedic Research Society

Biomedical Engineering Society

Publications

Rapp van Roden E, Riggin C, Holyoak D, Amin D, Hall P, Paredes JJ, Day C, Rodowicz K, Siskey R, Carhart M. Influence of spinal bridging ossification on mechanical properties and fracture tolerance under flexion/extension loading. Annals of Biomedical Engineering 2025; In press.

Kurtz SM, Holyoak DT, Trebse R, Randau TM, Porporati AA, Siskey RL. Ceramic wear particles: Can they be retrieved in vivo and duplicated in vitro? Journal of Arthroplasty 2023; 38(9):1869-1876.

Holyoak D, Andreshak T, Hopkins T, Brook A, Frohbergh M, Ong K. Height restoration and sustainability using bilateral vertebral augmentation systems for vertebral compression fractures: A cadaveric study. The Spine Journal 2022; 22(12):2072-2081.

Ziemian SN, Adebayo OO, Rooney AM, Kelly NH, Holyoak DT, Ross FP, van der Meulen MCH. Low bone mass resulting from impaired estrogen signaling in bone increases severity of load-induced osteoarthritis in female mice. Bone 2021; 152:116071.

Holyoak D, Chlebek C, Kim M, Wright T, Otero M, van der Meulen M. Low-level cyclic compression attenuates early osteoarthritis progression after joint injury in mice. Osteoarthritis Cartilage 2019; 27(10):1526-1536.

Adebayo O, Holyoak D, van der Meulen M. Mechanobiological mechanisms of load-induced osteoarthritis in the mouse knee. Journal of Biomechanical Engineering 2019; 141(7).

Holyoak D, Wheeler T, van der Meulen M, Singh A. Injectable mechanical pillows for attenuation of load-induced post-traumatic osteoarthritis. Regenerative Biomaterials 2019; 6(4):211-219.

Guss J, Ziemian S, Luna M, Sandoval T, Holyoak D, Guisado G, Roubert S, Callahan R, Brito I, van der Meulen M, Goldring S, Hernandez C. The effects of metabolic syndrome, obesity, and the gut microbiome on load-induced osteoarthritis. Osteoarthritis Cartilage 2019; 27(1):129-139.

Holyoak D, Otero M, Armar N, Ziemian S, Otto A, Cullinane D, Goldring S, Wright T, Goldring M, van der Meulen M. Collagen XI mutation lowers susceptibility to load-induced cartilage damage in mice. Journal of Orthopaedic Research 2018; 36:711-720.

Hofmann C, Holyoak D, Juris P. Trunk and shank position influences lead and trail limb patellofemoral stress during the forward lunge. Journal of Orthopaedic & Sports Physical Therapy 2017; 47:31-40.

Holyoak D, Tian Y, van der Meulen M, Singh A. Osteoarthritis: Pathology, mouse models, and nanoparticle injectable systems for targeted treatment. Annals of Biomedical Engineering 2016; 44:2062-2075.

Book Chapters

Bergerson C, Holyoak D, Ong K. US National Databases – Total Knee Arthroplasty: Lessons Learned. Essentials of Cemented Knee Arthroplasty, Ed. 1, pp. 447-462. Edited by Erik Hansen and Klaus-Dieter Kühn. Springer Nature 2022.

Invited Guest Lectures

Holyoak D. Bone & Cartilage: Mechanical Adaptation and More. Clarkson University, February 2025.

Holyoak D. Medical Devices: Quality & Risk. Clarkson University, March 2025.

Presentations

Rapp van Roden E, Riggin C, Holyoak D, Amin D, Hall P, Paredes JJ, Day C, Rodowicz K, Siskey R, Carhart M. Influence of spinal bridging ossification on mechanical properties and fracture tolerance under flexion/extension loading. ePoster, North American Spine Society, Denver, CO, 2025.

Moshage S, Petersen C, Dillon A, Brightbill E, Delgorio P, Torres W, Holyoak D, Siskey R. From benchtop to in silico: Factors influencing radiofrequency-induced heating of bone. Power Pitch Presentation, International Society for Magnetic Resonance in Medicine, Honolulu, HI, 2025.

Petersen C, Moshage S, Dillon A, Brightbill E, Delgorio P, Torres W, Holyoak D, Siskey R. High-fidelity modeling required for reliable RF heating assessments in bone. Poster Presentation, Orthopaedic Research Society, Phoenix, AZ, 2025.

Holyoak D, Brightbill E, Delgorio P, Petersen C, Moshage S, Fox J, Siskey R. RF Heating methods for implants in bone: An ongoing challenge in MRI compatibility. Poster Presentation, Orthopaedic Research Society, Long Beach, CA, 2024.

Riggin C, Holyoak D, Paredes JJ, Hall P, Siskey R, Rapp van Roden E, Amin D, Carhart M, Rodowicz K. Mechanical properties of spines with diffuse idiopathic skeletal hyperostosis vs. healthy spines: A pilot cadaveric study. Podium Presentation, Biomedical Engineering Society, Seattle, WA, 2023.

Holyoak D, Torres W, Siskey R, Pearle A, Su E. A combinatorial approach to evaluate fixation methods in cementless unicompartmental knee replacements. Poster Presentation, Orthopaedic Research Society, Dallas, TX, 2023.

Holyoak D, Dillon A, Torres W, Bullard A, Siskey R. Analysis burden and accuracy for evaluating RF-induced heating of medical devices in MRI scanners. Poster Presentation, Orthopaedic Research Society, Dallas, TX, 2023.

Holyoak D, Andreshak T, Hopkins T, Brook A, Frohbergh M, Ong K. Height restoration and sustainability with bilateral vertebral augmentation for vertebral compression fractures. Podium presentation (Featured abstract), Society of Interventional Radiology, Boston, MA, 2022.

Torres WM, Holyoak DT, Siskey RL, Pearle A, Su E. Evaluation of Fixation Methods in Cementless Unicompartmental Knee Replacements Using a Combinatorial Approach. Biomedical Engineering Society, Orlando, FL, 2021.

Holyoak D, Robertson B, Siskey R. Characterization of UHMWPE wear particles from orthopedic implants. Podium presentation, International Society for Technology in Arthroplasty, Online Symposium, 2020.

Holyoak D, Obradovic M, White J, Siskey R. Digestion Techniques and characterization of UHMWPE particles from orthopedic implants. Podium presentation, Biomedical Engineering Society, Philadelphia, PA, 2019.

Wheeler T, Holyoak D, van der Meulen M, Singh A. Injectable inflammation-responsive "mechanical pillows" attenuate symptoms of load-induced osteoarthritis. Podium and poster presentation, Society for Biomaterials, Seattle, WA, 2019.

Holyoak D, Chlebek C, Kim M, Wright T, Otero M, van der Meulen M. Low-level cyclic tibial compression attenuates osteoarthritis progression after joint injury in mice. Podium presentation, Orthopaedic Research Society, Austin, TX, 2019.

Wheeler T, Holyoak D, van der Meulen M, Singh A. Intra-articular injection of synthetic hydrogels attenuates symptoms of load-induced osteoarthritis. Poster presentation, Orthopaedic Research Society, Austin, TX, 2019.

Holyoak D, Chlebek C, Kim M, Wright T, Otero M, van der Meulen M. Low-level cyclic tibial compression attenuates osteoarthritis progression after joint injury in mice. Podium presentation, Orthopaedic Research Society, Austin, TX, 2019.

Wheeler T, Holyoak D, van der Meulen M, Singh A. Intra-articular injection of synthetic hydrogels attenuates symptoms of load-induced osteoarthritis. Poster presentation, Orthopaedic Research Society, Austin, TX, 2019.

Holyoak D, Wheeler T, Rebollo N, van der Meulen M, Singh A. Injectable hydrogels with tunable mechanical durability and on-demand drug release for intra-articular osteoarthritis treatment. Poster presentation, 8th World Congress of Biomechanics, Dublin, Ireland, 2018.

Ziemian S, Adebayo O, Rooney A, Kelly N, Holyoak D, Ross F, van der Meulen M. ERα deletion from mature osteoblasts increases severity of load-induced osteoarthritis in female mice. Podium presentation, 8th World Congress of Biomechanics, Dublin, Ireland, 2018.

Earle A, Holyoak D. Instructor and student opinions on an online versus written feedback system for homework. Podium presentation, Connecting Research and Teaching, Ithaca, NY, 2018.

Holyoak D, Wheeler T, Rebollo N, van der Meulen M, Singh A. Injectable hydrogels for intra-articular delivery demonstrate mechanical integrity and on-demand drug release. Podium presentation, Orthopaedic Research Society, New Orleans, LA, 2018.

Ziemian S, Adebayo O, Rooney A, Kelly N, Holyoak D, Ross P, van der Meulen M. ERα deletion from mature osteoblasts increases severity of load-induced osteoarthritis in mice. Podium presentation, Orthopaedic Research Society, New Orleans, LA, 2018.

Guss J, Ziemian S, Luna M, Holyoak D, Guisado G, Sandoval T, Roubert S, van der Meulen M, Goldring S, Hernandez C. Relationships between metabolic syndrome, adiposity, and the gut microbiome in a mouse model of load induced osteoarthritis. Podium presentation, Orthopaedic Research Society, New Orleans, LA, 2018.

Holyoak D, Wheeler T, van der Meulen M, Singh A. Injectable hydrogels for intra-articular delivery maintain mechanical integrity after cyclic compression hydrolytic degradation. Poster presentation, Orthopaedic Research Society Upstate New York and Northeast Regional Symposium, Rochester, NY, 2017.

Guss J, Ziemian S, Luna M, Sandoval T, Holyoak D, Guisado G, van der Meulen M, Goldring S, Hernandez C. Metabolic syndrome resulting from disturbances in the gut microbiome does not exacerbate cartilage pathology in a mouse model of load induced osteoarthritis. Poster presentation, Orthopaedic Research Society Upstate New York and Northeast Regional Symposium, Rochester, NY, 2017.

Earle A, Holyoak D, Shah S. Evaluating efficacy and student response to a two-stage homework system in an introductory thermodynamics class. Podium presentation, Connecting Research and Teaching, Ithaca, NY, 2017.

Holyoak D, Otero M, Armar N, Wright T, Goldring S, Goldring M, van der Meulen M. Collagen XI mutation in mice results in thinner, less dense cortical bone and lower susceptibility to load-induced cartilage damage. Poster presentation, Orthopaedic Research Society, San Diego, CA, 2017.

Holyoak D, Otero M, Armar N, Wright T, Goldring S, Goldring M, van der Meulen M. Mice with a collagen XI mutation are less susceptible to load-induced cartilage damage and have thinner, less dense cortical bone. Poster presentation, Albert Einstein College of Medicine Musculoskeletal Repair and Regeneration Symposium, Bronx, NY, 2016.

Holyoak D, Otero M, Kulley K, Wright T, Goldring S, Goldring M, van der Meulen M. Abnormal cartilage matrix in mice does not influence the response of the knee joint to mechanical loading. Poster presentation, Orthopaedic Research Society, Orlando, FL, 2016.

Hofmann C, Holyoak D, Juris P. Trunk position and shank angle alter the biomechanics of the lead and trail limb during the forward lunge. Poster presentation, 7th World Congress of Biomechanics, Boston, MA, 2014.