NATHAN T. CARRINGTON, Ph.D.

PROFESSIONAL BIOGRAPHICAL OUTLINE

BACKGROUND

Dr. Carrington earned a Bachelor of Science in Biomedical Engineering from Mississippi State University while working as a research and development engineer with Kimberly-Clark and Halyard Health. He went on to obtain his Ph.D. in Bioengineering from Clemson University before serving as a joint post-doctoral Research Fellow between Clemson and Aravis Biotechnologies, LLC. Dr. Carrington's scientific research focused on injury prevention through the development of innovative devices that investigated the forces and accelerations applied during static and dynamic situations. This includes special attention on spinal injury biomechanics, tolerance levels, and associated injury mechanisms for the intervertebral discs. He has also performed novel experimentation with cadavers, surrogates, and computational models that evaluated human joint kinematics and kinetics during potentially injurious scenarios.

Dr. Carrington continues to study injury biomechanics through various scientific test programs, including automotive sled tests and crash tests, as well as studies that implement advanced biomechanical tools such as instrumented anthropomorphic test devices. He has hands-on experience investigating the dynamic responses of individuals during inertial and impact environments, such as motor vehicle collisions or slip, trip, and fall events. This training and experience provide a unique understanding of physics and engineering in the context of human anatomy and physiology, enabling Dr. Carrington to perform thorough scientific investigations of a wide range of circumstances.

SUMMARY OF EXPERIENCE

- Has applied biomedical engineering principles to analyze forensic evidence for the purpose of reconstructing dynamic events such as motor vehicle collisions, and evaluated the response of the human body to inertial and impact forces.
- Utilized peer-reviewed and generally-accepted techniques to evaluate the severity of events, the response of the human body, and the forces applied to determine the presence or absence of various injury mechanisms.
- Investigated injury causation through the analysis of the magnitude and direction of applied forces, injury metrics, established Injury Assessment Reference Values (IARVs), and scientifically accepted human tolerance thresholds.
- Conducted investigations exploring the static and dynamic biomechanics of fracture constructs through mechanical, computational, cadaveric, and surrogate modeling.
- Designed and performed experimental protocols to investigate compressive cervical and lumbar forces with instrumented intervertebral devices.
- Led product investigations and design research for the application of radiofrequency ablation systems with neurologic and intervertebral disc-based injury.

AREAS OF SPECIALTY

- Injury causation biomechanics
- Spinal Injury Biomechanics Investigations
- Scientific Testing Design, Setup, and Execution
- Analyzing Human Response Kinematics and Kinetics
- Vehicular Accident Reconstruction
- Slip, Trip, and Fall Biomechanics
- Fracture Pattern Investigations and Tolerance Levels

EDUCATION

- Bachelor of Science (B.S.) in Biomedical Engineering from Mississippi State University, Starkville, Mississippi, September 2011 to December 2015
- Doctorate of Philosophy (Ph.D.) in Bioengineering from Clemson University, Clemson, South Carolina, June 2016 to July 2020

PROFESSIONAL EXPERIENCE

July 2021 – Present | ARCCA, LLC | Senior Biomechanist

- Utilizes peer-reviewed and generally-accepted techniques to evaluate the severity of events, the response of the human body, and the forces applied to determine the presence or absence of various injury mechanisms
- Applies biomedical engineering principles to analyze forensic evidence for the purpose of reconstructing dynamic events such as motor vehicle collisions, and evaluates the response of the human body to inertial and impact forces
- Performs injury causation analysis using knowledge of anatomy, physics, and biomechanical principals
- Investigates the relationship between accident kinematics and the human response
- Utilizes scientific testing experience to design and execute test programs to evaluate dynamic events

July 2020 – July 2021 |Clemson University/Aravis |Post-doctoral Research Fellow

- Conducted device development activities for novel strain-sensing implants and intervertebral fusion devices
- Led cadaveric research studies testing the application of strain-sensing technology with cervical and lumbar intervertebral fusion devices

June 2016 – July 2020 |Clemson University | Research Assistant

- Designed and developed a novel strain-sensing implant to measure the magnitude and direction of applied forces during static and dynamic activities
- Evaluated human kinematics and kinetics during potentially injurious activities through mechanical and computational modeling
- Conducted studies with cadaveric and animal surrogate models to assess tolerable levels of fracture loading during daily activities
- Led a nationwide NSF-funded investigation focusing on traumatic fracture causation and loading mechanics

May 2015 – June 2016 |Halyard Health | R&D Engineer, Acute Pain Management Team

- Conducted design testing and analysis for acute pain management systems
- Utilized knowledge of fluid mechanics and computational modeling to achieve optimal drug delivery with prototype elastomeric infusion pumps

January 2014 – July 2014 |Kimberly-Clark Health Care | R&D Engineer, Chronic Pain Management Team

- Investigated biomechanical forces contributing to intervertebral disc injury and chronic pain
- Conducted exploratory studies researching the application of novel radiofrequency ablation systems towards addressing intervertebral disc herniation and radiculopathy
- Studied spinal responses and biomechanical changes due to radiofrequency ablation with cadaveric and animal surrogate testing

TEACHING AND EDUCATIONAL EXPERIENCE

Teaching Assistant, Bioengineering Design Theory/Applied Bioengineering Design, January 2017 – July 2020

Clemson University

- Taught class sections covering topics including, but not limited to: biomedical needs finding, developing device needs statements, prototype development, statistical analysis, and design documentation
- Mentored design teams throughout the year-long device development process

FUNDED RESEARCH

- **Developing a Strain Sensing Vertebral Interbody Spacer STTR**
  - NIH | January 2021– Current
- **I-Corps: Integrated Strain Sensor for Dynamic Hip Screws**
  - NSF | June 2019 – August 2019
- **Developing an *in vivo*, X-Ray Detectable Strain Sensing Device for Use in Dynamic Hip Screws**
  - NIH R01 | 2016-2018

PROFESSIONAL AFFILIATIONS

- Biomedical Engineering Society (BMES), 2015—Present
- Orthopaedic Research Society (ORS), 2016—Present
- SAE International, 2022—Present

PUBLICATIONS

N. Carrington, P. Millhouse, C. Behrend, T. Pace, J. Anker, J. DesJardins, *Measuring Intertrochanteric Fracture Stability with a Novel Strain-Sensing Sliding Hip Screw*, (pending review) https://www.medrxiv.org/content/10.1101/2020.09.04.20183251v1

H. Pelham, D. Benza, P. Millhouse, **N. Carrington**, Md. Arifuzzaman, C. Behrend, J. Anker, J. DesJardins, *Implantable strain sensor to monitor fracture healing with standard radiography*, Scientific Reports **7**, 1489 (2017)

CONFERENCE PROCEEDINGS (PEER REVIEWED)

N. Carrington, P. Millhouse, C. Behrend, T. Pace, K. Jeray, J. Anker, J. DesJardins, *An Ovine Model for Monitoring Intertrochanteric Fracture Stability with a Strain-Sensing Dynamic Hip Screw*, Proceedings of the Annual Meeting of the Biomedical Engineering Society, Presentation 2172, October 16-19, 2019, Philadelphia, PA.

N. Carrington, P. Millhouse, C. Behrend, T. Pace, K. Jeray, J. Anker, J. DesJardins, *Strain Sensing in Dynamic Hip Screws to Measure Fracture Stability*, Proceedings of the Annual Meeting of the Orthopaedic Research Society, Poster 1060, February 2-5, 2019, Austin, TX.

N. Carrington, P. Millhouse, C. Behrend, T. Pace, J. Anker, J. DesJardins, *A Cadaveric Model for Passive Strain Sensing in Dynamic Hip Screws to Measure Fracture Stability*, Proceedings of the Annual Meeting of the Biomedical Engineering Society, Poster 2877, October 18th, 2018, Atlanta, GA.

N. Carrington, B. Kunkle, C. Behrend, T. Pace, J. Anker, J. DesJardins, *An Integrated Passive Strain Sensor for Dynamic Hip Screws to Monitor Intertrochanteric Fracture Stability with Radiography,* Proceedings of the Annual Meeting of the Orthopaedic Research Society, Poster 0910, March 9 -March 13, 2018, New Orleans, LA.

N. Carrington, B. Kunkle, C. Behrend, T. Pace, J. Anker, J. DesJardins, *Developing an in vivo, X-Ray Detectable Strain Sensing Device for Use in Dynamic Hip Screws,* Proceedings of the Annual Meeting of the Orthopaedic Research Society, Poster 1959, March 19 -March 22, 2017, San Diego, CA.

CONFERENCE PROCEEDINGS (NON-PEER REVIEWED)

N. Carrington, P. Millhouse, C. Behrend, T. Pace, J. Anker, J. DesJardins, *Monitoring Ovine Intertrochanteric Fracture Stability with a Strain-Sensing Dynamic Hip Screw*, Prisma Health Research Symposium, Poster, April 11, 2019, Greenville, SC.

N. Carrington, B. Kunkle, C. Behrend, T. Pace, J. Anker, J. DesJardins, *Developing an in vivo, X-Ray Detectable Strain Sensing Device for Use in Dynamic Hip Screws,* International Biomaterials Symposium-China, Poster, April 10, 2017, Clemson, SC.

N. Carrington, B. Kunkle, C. Behrend, T. Pace, J. Anker, J. DesJardins, *Developing an in vivo, X-Ray Detectable Strain Sensing Device for Use in Dynamic Hip Screws,* Proceedings of the Greenville Health System Research Symposium, Poster, March 27, 2017, Greenville, SC.

MENTORSHIP

- **Chair of the Laboratory of Orthopaedic Design and Engineering Publishing Group**
  - 10 Members | May 2020 –July 2021
- **Graduate Student Mentor for the Laboratory of Orthopaedic Design and Engineering**
  - 6 Students | Fall 2016 –Fall 2020
- **Senior Design Graduate Mentor**
  - 4 Teams, 20 Students | Fall 2016 –Fall 2017