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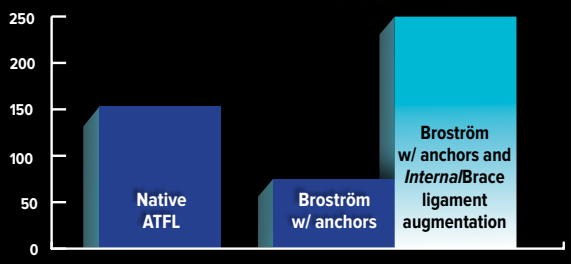

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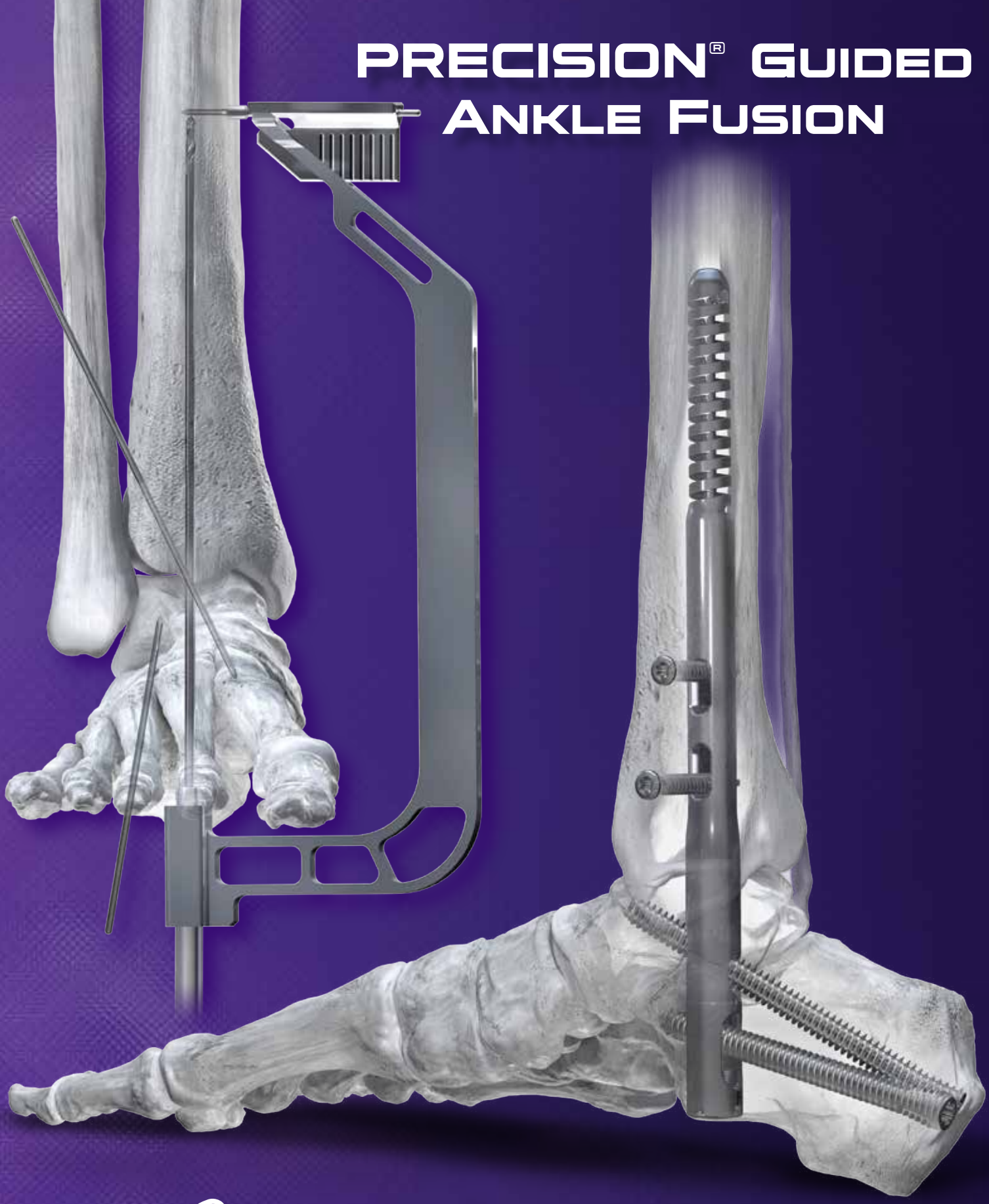

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Volume 6, May 2020

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Campbell Clinic Orthopaedics • The Campbell Foundation

University of Tennessee-Campbell Clinic Department of Orthopaedic Surgery & Biomedical Engineering

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Letter from the Editor-in-Chief

S. Terry Canale, M.D.

Department Chair, Emeritus
UT-Campbell Clinic Department of Orthopaedic Surgery and Biomedical Engineering
University of Tennessee Health Science Center

As I write this letter in late March, 2020, our community, our country, and our world are in the midst of a global pandemic with enormous impact as healthcare systems, businesses, and individuals deal with a fast moving, highly contagious, and virulent novel coronavirus, discovered in 2019, called COVID-19. This virus is spreading rapidly, and deliberate and strong measures are being taken to "flatten the curve" as suggested by our epidemiologist friends. I hope that by the time you read this, the adjustments and precautions taken in mid-March in the U.S. will have proven effective, and the threat to our healthcare systems will have eased somewhat.

While many sources remind us that COVID-19 isn't the first global pandemic – we've been reminded of the "black death" bubonic plague that ravaged Europe, Africa and Asia in the fourteenth century, the cholera pandemic of the mid-nineteenth century, and even the Spanish flu pandemic of the early twentieth century - it is safe to say that none of us have lived through times such as these. "Clean" and "screen" seem to be the prevailing themes for healthcare businesses, and "social distancing" is the new norm for day-to-day public interactions. Impact on our businesses and the stock market in the short and long term are still unknown.

I'm reminded of a story from of one of my mentors, Dr. Alvin J. Ingram, one of the world's leading authorities on treating polio in children. He once shared with me the kinds of extreme precautions that he and all healthcare providers took when working with pediatric patients with polio. He described that upon returning to his home at the end of his workday, he would shed his clothing outside his home, depositing all of it in a special receptacle set aside for this purpose. He would "rinse down" in his garage before entering his home. Then, once inside, he would take a vigorous and lengthy shower. His clothing would then be bagged up and laundered, and his wife would run a second, empty cycle of their washing machine to 'disinfect' it. Battling the scourge of polio required extreme measures, but he remained dedicated to treating the young children affected by the disease. He continued to carry on with the care of his patients and his work to uncover better treatments.

For me, the situation reinforces the significant value of the scientific pursuit of answers and the great respect I have for those scientists and physicians who conduct research projects. Since the beginning of time, society has benefitted from those individuals who have an innate curiosity, wondering, "Why is it this way?" These scientists work diligently to uncover answers, or to highlight trends that may provide the answers. Just like when British physician, John Snow traced the cholera pandemic to a hand-pump well in an impoverished area of London that led to the identification of contaminated water as the source for the disease.

Within the pages of this 6th volume of the Campbell Orthopaedic Journal (COJ), you will learn more about the questions orthopaedic surgeons, residents and fellows are pursuing for the benefit of their patients. Ways to ensure better outcomes of orthopaedic interventions. The projects described herein are the result of a great deal of collaborative work, all done because someone asked, "Why?"

As you enjoy the 2020 edition, I hope that you are inspired to pursue that nagging question you have, and to find others to join you in the pursuit. Despite your weariness, I urge you to carry on. Your patients are relying on you. Thank you for all that you do.

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Departmental Update from the Chairman

James H. Beaty, M.D.

Department Chairman, Harold B. Boyd, M.D. Professor
UT-Campbell Clinic Department of Orthopaedic Surgery and Biomedical Engineering
University of Tennessee Health Science Center

The UT-Campbell Clinic Department of Orthopaedic Surgery and Biomedical Engineering is committed to significant improvements in musculoskeletal health through the dedicated efforts of devoted faculty, researchers and scientists, and health care providers devoted to the pursuit of new discoveries. There is considerable breadth and depth of experience in the Department, with our scientists making genuine progress in both translational and basic science pursuits related to the genetic, individualized and cellular influences on bone and soft tissue mechanisms of injury, and healing. Their work offers the promise of discoveries that clinicians will be able to provide for their patients who are limited by musculoskeletal diseases, disorders, and conditions.

Last year, we welcomed Scott Strome, MD, FACS, as the Robert Kaplan Executive Dean of the College of Medicine and vice chancellor for Health Affairs at the University of Tennessee Health Science Center. Dr. Strome comes to the role from the University of Maryland School of Medicine where he served as chair of the Department of Otorhinolaryngology – Head and Neck Surgery, where he was a highly respected cancer surgeon and investigator. We were honored to have Dean Strome as our Graduation Keynote Speaker for the Class of 2019 Resident & Fellow Graduation held in June. Dr. Strome spoke to the noble mission of caring for patients, combined with advice for the graduates to cultivate a dedication to lifelong learning and a commitment to give back to their communities.

RESEARCH

As we near the end of the 2019-2020 academic year, the department consists of nine full-time basic science researchers: Hongsik Cho, PhD, Denis DiAngelo, PhD, Weikuan Gu, PhD, Karen Hasty, PhD, Yan Jiao, MD, Susan Miranda, PhD, Richard Smith, PhD, and Brooke Sanford, PhD; along with clinician scientist, Bill Mihalko, MD, PhD. This includes three Chairs of Excellence:

- George Wilhelm, Chair of Excellence,
- Harold Boyd Chair of Excellence and,
- Hyde Chair of Excellence.

Our scientists have robust extramural funding, including NIH R01 grants, and support from multiple other sources. Select publications from this group in 2019 are highlighted within these pages.

On the clinical side, our research effort has been equally impressive, with 111 scientific articles published in peer-reviewed publications, along with 70 podium presentations, and 82 posters highlighting our research presented at national and international meetings last year. We are expanding our participation in higher order Level 1 and Level 2 clinical trials, with randomization, to truly provide comparative evidence of therapeutic treatments. There is considerable breadth and variety in our work, examining the safety and efficacy of surgical procedures performed in an outpatient surgical setting, alternative methods of pain management (particularly timely in light of the opioid epidemic in the United States), and results with a number of operative interventions to build an impressive array of clinical evidence. Our work crosses all orthopaedic subspecialties in patients of all ages and races, and both genders. Notably, we have doubled our industry- and government-sponsored clinical research studies and grants over the prior year. In support of the additional work, our team expanded last year with the addition of a sixth research coordinator.

EDUCATION

Musculoskeletal education from the department occurs at all post-graduate levels, including medical students, orthopaedic residents and fellows, engineers, clin-

ical and research fellows, scientists and PhD candidates. On the scientific side, the Department oversees a joint MA and PhD program with the University of Tennessee and the University of Memphis. Drs. William Mihalko (University of Tennessee) and Gene Eckstein (University of Memphis) serve as Co-Directors. We are working on curriculum changes that give 3rd and 4th year medical students the ability to participate in 2-week and 4-week rotations, respectively, in Orthopaedics to allow them to determine their interest in this as a career.

Our orthopaedic surgical residency program is ranked in the top 10% nationally, with eight residents per class, in a five-year program. We are accredited through the Accreditation Council for Graduate Medical Education (ACGME), and present our students with a greater than 1:1 ratio of faculty to students. Instruction is provided in all orthopaedic subspecialties by fellowship-trained orthopaedic surgeons. Dr. Thomas W. 'Quin' Throckmorton and Dr. Derek M. Kelly ably serve as Program Director and Assistant Program Director, and do an outstanding job in supervising and advising the residents. Fellowships in the subspecialties are available, and we trained six clinical fellows this year.

Monday night continues as our traditional 2½ hour interactive didactic educational meeting sprinkled with case presentations. Weekly subspecialty conferences are held as well as a monthly journal club. The Visiting Professors Program is designed for distinguished orthopaedic surgeons to give "Grand Rounds" four times a year with our premier CME meeting, known as the Alvin J. Ingram Memorial Lecture held in the spring. Since the fall of 2015, we have sustained a Visiting Professor Lecture Series, funded with donor support. This important series, which is open to area orthopaedic surgeons, nurses, physicians assistants, engineers and researchers, allows us to supplement the educational experience since it brings prominent thought leaders in each orthopaedic subspecialty to Memphis for engaging discussions about important and challenging issues in orthopaedic subspecialties, and culminates in a lecture on a prominent topic within the subspecialty.

We are also hard at work on the fourteenth edition of *Campbell's Operative Orthopaedics*. This new edition upholds the intention established by Dr. Willis C. Campbell and his partners in 1939 to provide a comprehensive overview of every relevant orthopaedic surgical procedure performed. We are proud to be known across the globe for this effort, and we spend extensive time and energy writing this series every four years.

The department continues to make strong progress in education, research and innovation. We are well-positioned to advance toward the centennial anniversary of our residency training program in 2024. Dr. Campbell would be proud.

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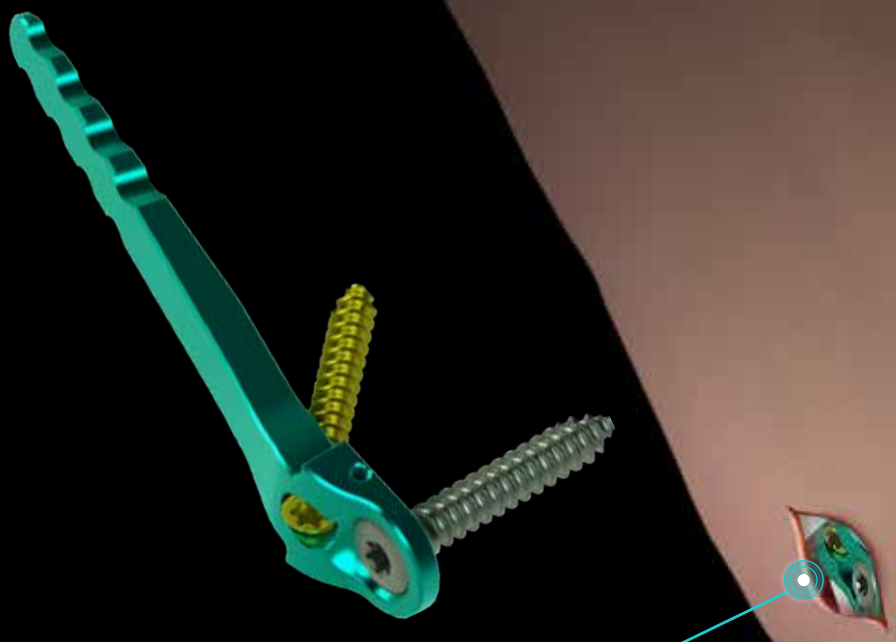

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News from Campbell Clinic

Frederick M. Azar, M.D.

Chief of Staff, Campbell Clinic Orthopaedics
Professor and Sports Medicine Fellowship Director

As we enter this new decade, the physicians at Campbell Clinic remain dedicated to the standards of excellence in patient care established by our founder, Willis C. Campbell, MD, more than 110 years ago in 1909. While the healthcare environment has changed significantly since the early years of the twentieth century, our commitment to faith, family, and patient care remain steadfast.

At the close of 2019, Campbell Clinic celebrated our commitment to providing the very best for our patients as we opened our new outpatient center in Germantown, Tennessee. This state-of-the-art facility covers four stories and 120,000 square feet and represents the next phase of expansion for Campbell Clinic. We designed this new center with future patients, staff and trainees in mind.

Located on five adjacent acres behind our existing Germantown clinic, the new facility houses the ACCEL program, located in the S. Terry Canale Family Performance and Wellness Center. ACCEL offers its members facilities and personnel to provide patrons with personalized performance training programs designed to ensure that they reach their goals – and surpass them.

The new outpatient center is a destination for musculoskeletal care in our region, and it will serve as a training ground for future orthopaedic surgeons who will shape our specialty worldwide for generations to come. The facility includes an expanded physical therapy floor and an outpatient clinic. The outpatient clinic features the James L. Chappuis, MD, Resident & Fellow Study Hall, a quiet, light-filled space for residents, fellows, and others to study, plan and review orthopaedic treatment protocols and therapies. A highlight of the building is an eight-suite ambulatory surgery center where our physicians will continue to perform innovative procedures ranging from joint replacement to minimally-invasive spine surgery to regenerative therapy.

On the research front, our staff continues to seek answers to challenging clinical issues. Over the past year, we have expanded our research into new ways to help mitigate surgical patients' post-operative pain while greatly decreasing their dependence on the use of opioids. Utilizing numerous multimodal pain management protocols, we are building clinical evidence to support protocols that eliminate or greatly reduce dependence upon opioids. Campbell Clinic is determined to be part of the solution to the U.S. opioid crisis. We are also working on a myriad of projects that seek to define new thresholds of bone and soft tissue healing to accelerate patients return to an active and pain-free lifestyle. We have several prospective, randomized clinical trials underway that compare existing orthopaedic standards-of-care with new technologies, ever mindful that innovation must only be adopted after the safety and efficacy of it has been soundly established.

We continue to build clinical evidence in support of safe and effective total joint, and spine surgeries, performed in an ambulatory surgery center. These surgeries, once limited to the inpatient hospital setting deliver greater patient satisfaction in a cost efficient manner, and represent the future of orthopaedic surgery. We share the results of our research at numerous scientific conferences throughout the United States and internationally.

We continue the legacy begun in 1939 by Dr. Willis C. Campbell and his partners to describe every relevant orthopaedic surgical procedure in *Campbell's Operative Orthopaedics*, with the 14th edition to be published this year. The entire staff contributes to this publication, and we all appreciate the experienced editorial support provided by Kay Daugherty and Linda Jones. We are proud to be known across the globe through this work.

We also welcomed two new physicians to our staff. Dr. David L. Bernholt and Dr. Stephen T. Brown. Dr.

Bernholt joined the Campbell Clinic family in August 2019. Dr. Bernholt specializes in sports medicine, with a strong interest in clinical research. Dr. Bernholt completed a Fellowship in Sports Medicine Orthopaedic Surgery at The Steadman Clinic in Vail, Colorado, following completion of his orthopaedic residency at Washington University in St. Louis, Missouri. Dr. Brown joined the Campbell Clinic family in April 2020, and is fellowship-trained in sports medicine primary care.

As our practice continues to grow, we recently spent some strategic time focusing on maintaining our culture. The result was a revised Mission Statement and the addition of a Vision Statement and our Core Values. In order to reinforce these messages, we added a Monday Morning Message which is emailed to our entire Campbell Clinic and Campbell Foundation family along with a quote of inspiration for the week.

P.S. At the time of this journal going to press, we join all of you in working to protect our patients and employees while providing safe access to orthopaedic care for our patients.

Campbell Clinic Mission

The mission of the Campbell Clinic is to provide unsurpassed patient care while being recognized as a leader in teaching and research in the profession of orthopaedic surgery.

Campbell Clinic Vision Statement

Another century of world-class orthopaedic care restoring function and quality of life.

Campbell Clinic Core Values

Excellence

We aim to exceed expectations by providing an exceptional patient experience through accessible & efficient quality care, a comfortable and safe environment, and effective communication.

Integrity

We embrace, expect, and exhibit honesty, accountability and professionalism toward patients, each other, and outside partners.

Compassion

We commit to cultivating an environment of compassion for each patient and family member through sensitivity, sincerity, and empathy.

Innovation

We commit to delivering innovative technologies, products, and services through our rich orthopaedic heritage and a strong research foundation.

Commitment

We commit to each other, to excellent patient care, to education, to innovation and research, to community service, and to orthopaedic leadership.

Legacy

We will do what is right for the Campbell Clinic, our patients, and our employees.

Unity

Everything we do, we do together.

State of the Residency

Thomas W. 'Quin' Throckmorton, M.D.

Orthopaedic Residency Director, Professor

UT-Campbell Clinic Department of Orthopaedic Surgery and Biomedical Engineering

For nearly 100 years, the Campbell Clinic, in conjunction with the University of Tennessee-Campbell Clinic Department of Orthopaedic Surgery and Biomedical Engineering, has been proud to train orthopaedic surgeons from all over the country and, indeed, all over the globe. Over 575 orthopaedic surgeons have trained at our institution and our graduates include 7 presidents of the American Academy of Orthopaedic Surgeons (AAOS), 7 directors of the American Board of Orthopaedic Surgery (ABOS), 4 presidents of the American Orthopaedic Association (AOA), and numerous presidents of subspecialty societies. Surgeon education is a hallmark of our program, and the staff, in addition to our responsibilities for teaching our residents, continue to author Campbell's Operative Orthopaedics, now preparing its 14th edition. While orthopaedic knowledge continues to expand, our educational goal has remained constant: to produce excellent, well-rounded orthopaedic surgeons who have the opportunity to pursue the subspecialty training of their choice.

Our residents train in each orthopaedic subspecialty, both as junior and senior residents, and our rotations combine an exposure to the academic/tertiary medical center environment as well as the private practice setting. This comprehensive approach offers the ability to see all subspecialties from different angles and maximizes true understanding of orthopaedic principles and their application. Our training program is designed to prepare residents for the Orthopaedic In- service Training Examination (OITE) and Step I of the American Board of Orthopaedic Surgery examination, through a combination of Core Curriculum training combined with subspecialty conferences in trauma, pediatric orthopaedics, sports medicine and shoulder/ elbow surgery, hand surgery, foot and ankle surgery, and spine surgery. And in this era where medicine and business continuously intersect, we have augmented our curriculum with business training and an awareness of quality and value as they pertain to orthopaedic care.

Additionally, we have focused on strengthening and building our clinical and biomechanical research infrastructure, which includes multiple research nurse coordinators, 2 research fellows, database access to track patient outcomes, our outstanding editorial staff, a biomechanics laboratory and an extensive orthopaedic library staffed by a full-time librarian. We currently are conducting over 150 active clinical and biomechanical research projects. Investigators have been awarded funding from both internal and external sources to conduct these studies, in addition to additional extramural (NIH, NSF, etc.) awards among our basic science research staff. We remain committed to sharing our research at regional, national, and international meetings, and in academic and scientific publications. In short, orthopaedic research has never been stronger at the Campbell Clinic.

Our international elective medical mission program continues, with sponsorship of an international community service medical mission. Our residents have served in Nicaragua, Guatemala, Honduras, Tanzania, Uganda, the Dominican Republic, and, this year, Ghana. In this way, we imbue a commitment to community service within our residents.

This year, we will celebrate the graduation of our 95th residency class, whose members are profiled within this publication. We are very proud of these eight orthopaedic surgeons. Their senior research efforts are depicted within these pages, and thousands of patients will benefit from the clinical discoveries these projects have yielded. Simultaneously, I am pleased to recognize the incoming Class of 2025 which will begin training in July. We are confident these exceptional young physicians will continue the tradition set forth by their predecessors.

In summary, we are proud of our heritage at the Campbell Clinic, but we are equally proud of our present and we look forward to our future. With our comprehensive, diverse, high-volume brand of training, we will continue to strive for excellence in the training of orthopaedic surgeons.

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Alvin J. Ingram, MD

Dedicated Lectureship Series:

Alvin J. Ingram, MD Memorial Lecture

Each year, the Campbell Foundation proudly hosts a Distinguished Professor in memory of a fine surgeon. The annual Alvin J. Ingram, MD Memorial Lecture was initiated in memory of former Campbell Clinic Chief of Staff and Department Chairman Alvin J. Ingram, M.D., through a gift from members of his family, to honor his commitment to education. Dr. Ingram was a graduate of our residency project, and was a world authority on the treatment of polio.

The lecture series highlights achievements in surgeon education, and features a Keynote Address by a Distinguished Professor, followed by presentations from the Campbell Foundation graduating residents. Beginning in 2014, under the guidance of course director Derek M. Kelly, M.D., the Ingram Lecture was expanded considerably and included not only lectures by our Distinguished Professor, faculty and the residents, but also an Expert Panel and technical exhibits. The Ingram Lecture is open to the public, with continuing education credits available for physicians and other allied health professionals. The Ingram Lecture regularly attracts an audience of more than 150 surgeons, engineers, scientists, and others dedicated to excellence in orthopaedics.

2019 Alvin J. Ingram, MD Memorial Lecture • May 10, 2019

Distinguished Professor: Joseph A. Bosco, III, M.D.

Professor and Vice-Chair for Clinical Affairs
New York University School of Medicine
Department of Orthopaedic Surgery
Director, Quality and Patient Safety, NYU Langone Orthopaedic Hospital
New York, New York


Joseph A. Bosco, III, MD

Joseph A. Bosco, MD, is an attending surgeon at NYU Langone Medical Center in New York City. He specializes in knee and shoulder conditions, primarily sports-related injuries and total knee replacements. Along with his work at NYU Medical Center, Dr. Bosco is a Professor of Orthopaedic Surgery at the NYU School of Medicine.

Dr. Bosco was installed as the President of the American Academy of Orthopaedic Surgeons (AAOS) in 2020. Originally from Englewood, New Jersey, Dr. Bosco attended college at Union College (Schenectady, NY), and then earned his medical degree from the University of Vermont. He completed his Internship and residency in orthopaedic surgery at the University of North Carolina, Chapel Hill. Dr. Bosco completed a Fellowship in Adult Reconstructive Surgery at the University of Arizona, in Tucson, Arizona.

Dr. Bosco has served on the boards of directors of many national orthopaedic organizations including the American Academy of Orthopaedic Surgeons (AAOS), American Orthopaedic Society for Sports Medicine (AOSSM), as well as serving as the President of the Board of Directors for the Orthopaedic Learning Center (OLC) at AAOS. Dr. Bosco has also been active on the board of the New York State Society of Orthopaedic Surgeons, serving as both Treasurer and Secretary.

Dr. Bosco is an active researcher, with a focus on quality of care, treatment outcomes, health care disparities, and patient safety, particularly with regard to infection control. He has published more than 250 scientific peer-reviewed articles, book chapters and other important works, and has presented his research all over the world. His research earned numerous extramural grants, and he holds four patents for knee replacement implants. During the 2019 Ingram Memorial Lecture, Dr. Bosco's Keynote Address, *"Value Creation in Total Joint Arthroplasty,"* highlighted the latest innovations delivering value. He also participated in an Expert Panel

Symposium during which he shared *"Crystal Ball Predictions for Total Knee Arthroplasty."*

Another highlight of the 2019 Ingram Lecture was the presentation of the research of our graduating class of residents. Resident research at the Campbell Foundation is only possible through donor support. These financial gifts offset the costs of research, including supplies, testing equipment and support personnel. In addition, through a gift from the family of Dr. Hugh Smith, the Hugh Smith Research Award is presented each year during the Ingram Lecture to one of the graduating residents. Dr. Hugh Smith, a former Campbell Clinic Chief of Staff, and one of the founders of the Campbell Foundation, believed strongly in the power of innovation to unlock solutions to challenging clinical programs. Dr. Smith recognized the significant role that research can play in developing new surgical techniques and implants that will lead to a better quality of life for patients, and his family wanted to formally celebrate recognize the importance of ongoing research through this award.

A panel of Ingram Lecture faculty judges evaluated each presentation based upon the design, content, and originality of the research, clinical significance and potential for publication in a peer-reviewed journal. The 2019 Hugh Smith Presentation Award was presented to Dr. Kirk M. Thompson, for his presentation entitled *"Pre-operative Narcotic Use is Associated with Markedly Inferior Outcomes After Anatomic Total Shoulder Arthroplasty: A Clinical and Radiographic Analysis."*

2020 Alvin J. Ingram, MD Memorial Lecture • June 29, 2020

Distinguished Professor: Daniel K. Guy, M.D., FAAOS

Emory Southern Orthopedics
Medical Director, Emory Surgery Center at La Grange
Attending Orthopaedic Surgeon, WellStar/West Georgia Health System
La Grange, Georgia


Daniel K. Guy, MD

Georgia orthopedic surgeon Daniel K. Guy, M.D. specializes in hip and shoulder surgery, and sports medicine. He is in private practice at Emory Southern Orthopedics in LaGrange, Georgia and is on staff at WellStar/West Georgia Health System.

Dr. Guy was installed as the First Vice President of the American Academy of Orthopaedic Surgeons (AAOS) in 2020, and will ascend to the Presidency at the 2021 Annual Meeting. He received his Bachelor of Science from Murray State University in Murray, Kentucky and earned both a Master of Science and a Medical Degree from the University of Louisville. Dr. Guy completed his orthopedic residency at the University of Texas Health Science Center in San Antonio, Texas, where he served as Chief Resident. During his training, he also served in the U.S. Army Reserves beginning in 1976 and was Honorably Discharged from the Medical Corps with a rank of Captain in 1989. After residency, he completed an A-O fellowship in adult reconstruction at the Inselspital in Bern, Switzerland.

In 1992, Dr. Guy became a Fellow in the American Academy of Orthopaedic Surgeons (AAOS). He was elected to the Board of Councilors in 2010 and served as Secretary in 2015-16, and then Chair in 2017-18. In addition, he has served on the AAOS Board of Directors, the AAOS Council of Research and Quality, Council on Education, Council on Advocacy and the Publications Committee. Dr. Guy is a diplomate of the American Board of Orthopaedic Surgery and is a member of the Alpha Omicron Alpha Medical Honor Society. He is past president and board member of the Georgia Orthopaedic Society.

Clinically, Dr. Guy has a special interest in Shoulder and Hip Surgery as well as Sports Medicine. He has taken a particular interest in Advocacy at the local, regional, and national level, ensuring access to orthopaedic specialized care for patients. He enjoys traveling, sports, reading and outdoor activities. He actively participates in his community as team physician to three local high schools and two colleges, and as an elder at First Presbyterian Church in La Grange, Ga. Dr. Guy and his wife Jill have two children and three grandchildren.

Dr. Guy's Keynote Address during the 2020 Ingram Memorial Lecture will be *"History of Orthopaedics,"* and he will join an Expert Symposium on Advocacy and will provide perspectives on advocacy at the national level from the American Academy of Orthopaedic Surgeons.

Dedicated Professorship:

The James H. Beaty, MD Visiting Professorship in Pediatric Orthopaedics

Sponsored by the Pediatric Orthopaedic Faculty of Campbell Clinic, with support from alumni and friends, the James H. Beaty, MD Visiting Professorship in Pediatric Orthopaedics was established to honor the lifetime contributions of James H. Beaty, MD, Chairman of the UT-Campbell Clinic Department of Orthopaedic Surgery, former Chief of Staff of Campbell Clinic, and Past President of the Pediatric Orthopaedic Society of North America and the American Academy of Orthopaedic Surgeons.

It has been a tradition for the Pediatric Orthopaedic Faculty of Campbell Clinic to bring a prominent Visiting Professor (such as the President of the Pediatric Orthopaedic Society of North America (POSNA)) to Memphis each year for an annual Lecture and extended Case Discussions. Since 2014, POSNA Presidents Peter Waters, MD, Lori Karol, MD, James McCarthy, MD, and Richard Schwend, MD have come to Memphis as Visiting Professors.

In 2019, this educational professorship was officially endowed and named in honor of Dr. James H. Beaty. Two James H. Beaty, MD Visiting Professors came to Memphis in 2019. Steven L. Frick, MD, 2018-2019 POSNA President and Professor of Orthopaedics at Stanford University was the inaugural Visiting Professor on February 12, 2019. Dr. Frick kicked off the series with a fantastic interview of Dr. Beaty, done in the style of "Inside the Actor's Studio." Following the interview, Dr. Frick's Keynote address was "*Decision Making in Developmental Dysplasia of the Hip*," during which he included pearls and pitfalls from his experience caring for children with DDH. The day included case presentations from Campbell Foundation residents and a "Turn the Tables" case discussion during which Dr. Frick presented challenging cases from his experience.

The Beaty Professorship continued on October 24, 2019 with a visit from Dr. Stephen A. Albanese, MD, Professor and Chairman, Department of Orthopaedics, SUNY Update Medical University, Residency Program Director, and 2019-2020 President of POSNA. The Professorship followed a similar format with a Keynote Address from Dr. Albanese, followed by an engaging case presentation discussion period. Dr. Albanese presented an intriguing overview of his observations from a lifetime treating pediatric scoliosis, through his Keynote entitled "*Long Term Outcome After Posterior Fusion for Adolescent Idiopathic Scoliosis*."

The afternoon provided ample opportunity for academic exchange, and it was a fitting way to honor Dr. James H. Beaty, a legend in the field of pediatric orthopaedics.

The James H. Beaty Visiting Professorship in Pediatric Orthopaedics will annually highlight a leader in the field, and will bring new perspectives to residents and fellows, medical students, healthcare providers, orthopaedic surgeon faculty and others in the community interested in and providing orthopaedic care to children.

Steven L. Frick, MD
2018 – 2019 POSNA President
Professor & Vice Chairman
Department of Orthopaedic Surgery
Stanford University School of Medicine
February 21, 2019

Stephen A. Albanese, MD
2019 – 2020 POSNA President
Professor & Chairman
Residency Program Director
SUNY Upstate Medical University
October 24, 2019

Dedicated Lectureship Series:

2020 Campbell Foundation & UT-Campbell Clinic Department of Orthopaedic Surgery & Biomedical Engineering Visiting Professor Lecture Series: Schedules of Lectureships and Conferences

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Dean G. Sotereanos, MD

"Distal Radioulnar Joint Arthritis"

Orthopaedic Specialists
University of Pittsburgh Medical Center
Pittsburgh, Pennsylvania
January 22, 2020
MidSouth Hand Club
Napa Cafe
Memphis, Tennessee

Mark A. Frankle, M.D.

"Trials & Tribulations of Bringing the Reverse Total Shoulder to the U.S."

American Shoulder & Elbow Surgeons
Chief, Shoulder & Elbow Service
Florida Orthopaedic Institute/ Foundation for Orthopaedic Research and Education (FORE)
Shoulder & Elbow Fellowship Director
Assistant Editor, JSES
Associate Editor, Journal of Shoulder & Elbow
January 23, 2020
Folk's Folly Restaurant
Memphis, Tennessee

Alvin J. Ingram, M.D. Memorial Lecture

Daniel K. Guy, MD, FAAOS - Keynote Speaker

"History of Orthopaedics"

Emory Southern Orthopedics
Medical Director, Emory Surgery Center at La Grange
Attending Orthopaedic Surgeon, WellStar/West Georgia Health System
La Grange, Georgia
PLUS
Evaluating & Acquiring New Technology:
Perspectives from Key Stakeholders (A Panel Discussion)
Presentations by the Class of 2020 Residents
And an Expert Panel on Orthopaedic Advocacy
June 29, 2020
The Zone, FedEx Institute of Technology

Campbell Foundation Achievements

Jack R. Blair

Chairman, Board of Trustees
Campbell Foundation

Within the Campbell family, we monitor our research activity using a metric we call the "3 P's" – which stands for **p**ublications, **p**resentations, and **p**osters – in peer-reviewed journals and in scientific or academic conferences. This measurement, the "3Ps," serves as a proxy for our impact, describing the number of venues and journals in which we share our discoveries. Like many other institutions who report similar metrics, it is helpful to monitor research performance over time in order to ensure that steady progress is made.

However, as I reflected on research at the Campbell Foundation, I was struck by three different "Ps" about research – namely the **p**ath, the **p**ace, and the **p**oint of research.

I have worked with the team at Campbell Clinic for my entire tenure within the orthopaedic field (nearly forty years). And, I have been privileged to serve as the Chairman of the Board of the Campbell Foundation for the latter half of that time, thus I have the benefit of the long view. What I've observed over that time has been a steady pursuit of continuous improvement. A consistent **path** of measuring and monitoring results, especially post-surgical results. Perhaps because they are an academic practice, but Campbell Clinic surgeons deliberately review outcomes, and make course corrections as needed. Furthermore, they share their findings with the world by publishing those results.

In terms of pace, "sure" and "steady" are the terms that come to mind. When reviewed in isolation, it seems that some research projects take a really long time. For example, when a surgeron review post-surgical results of joint replacements he's performed, it is possible to look at results in the 90-day post-surgical episode of care (the global period). However, it is often more meaningful to look at the results over the longer term – two year follow-up at a minimum - and that kind of project can take five years or more. Viewed though this lens, the **pace** of research can seem slow, but the magnitude of the changes become more apparent.

Progress and discoveries made through steady orthopaedic research are nothing short of amazing. Major surgeries like total joint replacement and complex spinal procedures once required a week-long hospital stay, but are now done in the outpatient setting, with patients going home within a few hours of their procedure. Research into ways to control post-surgical pain, blood loss, and infection, as well as protocols for diagnosis, patient selection and surgical techniques have built extensive clinical evidence to assure the safety and efficacy of this approach. Furthermore, technologies used today including peri-operative measures, but also the use of advanced implant designs and orthobiologic solutions, have dramatically changed how orthopaedic conditions and injuries are treated. These advancements have come as a result of steady, deliberate, and consistent research – over decades.

Which brings me to the **point** of all this. When I speak to Campbell Clinic surgeons about their research, similar themes emerge. These doctors have an innate curiosity about why things are the way they are. Why some patients achieve excellent outcomes and others less so, for the same type of intervention. Why there is variation in surgical recovery rates for some patients compared with others. Why results among patients operated on in Memphis, TN, differ from results reported from other parts of the US or the world. And, most important of all, how the doctors can ensure that each patient has a chance for the very best outcome. Even things like measuring and monitoring patient-reported outcomes – not

just what the surgeon sees when he or she looks at the x-rays – but how the patient feels about the result of the orthopaedic intervention provide evidence of genuine progress.

That, it seems, is the point of all this work.

Taken altogether, these three Ps – a steady path, a consistent pace, focused on the point of improvement for all – lead to progress.

As you review the research described in these pages, you will see that these three "Ps" are alive and well at Campbell Clinic. Donors to the Campbell Foundation have enabled these projects.

For this, I thank you, and wish to assure you that your support of our research has made tremendous progress possible.

Jack R. Blair, Chairman
Campbell Foundation Board of Trustees

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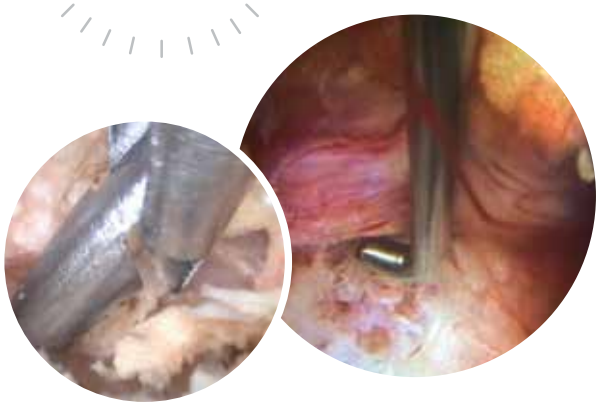

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*REFERENCES:
Gibson, JN., Subramanian, A., and Scott, C. (2016). A randomized controlled trial of transforaminal endoscopic discectomy vs microdiscectomy. European Spine Journal. DOI 10.1007/s00586-016-4885-6.

Zhimin, P., Yoon, H., Seong, Y., and Kai, C. (2016). Efficacy of Transforaminal Endoscopic Spine System (TESSYS) Technique in Treating Lumbar Disc Herniation. Medical Science Monitor, 22: 530-539.

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CAMPBELL PRESENCE ACROSS THE GLOBE

Nearly a Decade of Medical Mission Internationally and Locally

In 2012, Daniel Shumate, Campbell Clinic CFO, was inspired by a local business leader to "Do what you can and serve where you are." With that motivation, and to honor his wife, Shumate founded the Molly Shumate Community Service Scholarship at the Campbell Foundation to sponsor medical missions nationally and internationally as a way to provide excellent orthopaedic care to patients in need - here and across the globe. Shumate stated, "I wanted to help patients who needed orthopaedic care, but I'm not a physician. I thought, 'What can I do? What are my talents and how can I use them? I knew I didn't have the skill set to do medical missions myself, but I had access to people who could.'"

Thanks to the scholarship, eight orthopaedic surgery residents in training at the Campbell Foundation and one international orthopaedic resident have participated in this educational exchange and medical mission. We've built educational connections with outposts in the Dominican Republic, Guatemala, Honduras, Nicaragua, Tanzania, and Uganda. During each trip, our residents have been able to deliver critical medical supplies, including vital orthopaedic implant sets, and additional operating room supplies. Furthermore, they share insights and information about the very latest surgical techniques and research to optimize orthopaedic outcomes. It is a bit like the proverb: "If you give a man a fish, he will eat for a day, but if you teach a man to fish, he will never go hungry." One of our in-country partners estimates that each volunteer teaches and trains, on average, 15 local providers during every mission trip. Using this average, since inception, we've trained 120 healthcare providers through this initiative.

Dr. Catherine Olinger, Class of 2020, with Keyfren

Dr. Derek Kelly and Dr. Brian Madison with a young patient in Memphis

So many things that surgical teams in the U.S. take for granted require deliberate measures in developing and underserved countries. The agencies we've partnered with have well-organized infrastructures and, are dedicated to improving the

Dr. Carson Rider with a patient from the Montellano Clinic

availability and quality of health care through the education, training and professional development of the health workforce in resource-scarce countries.

Our residents reported assessing between 250 – 600 patients during each medical mission, and operating on approximately 200 patients each trip, on average.

This international medical outreach has transformed the lives of many – people like 8-year-old Keyfren, a boy in the Dominican Republic who had surgery on his hand to correct a congenital deformity - a condition that would have been corrected while Keyfren was an infant if he had been born in the U.S. Keyfren's joy after the surgery was palpable, reported Dr. Catherine Olinger, the 2018-19 Molly Shumate Scholarship winner, since Keyfren would be able to play baseball, a dream of his. Dr. Zachary Pharr shared stories of ACL reconstructions on Guatemalan residents David Carlos and Alfredo Bautista, two construction laborers who needed the surgery to return to work to provide for their families. Hundreds of stories like these have emerged from these medical missions.

Further, because of the educational "bridge building" during Dr. Sean Calloway's mission trip to Tanzania in early 2016, Dr. Brian Madison, a young resident in training at the Kilimanjaro Christian Medical Clinic, traveled to the United States and trained with the team at Campbell Clinic for six weeks. During his time here, spent primarily at Regional One Health ("The Med") and Le Bonheur Children's Hospital, Dr. Madison observed hundreds of pediatric orthopaedic and orthopaedic trauma surgeries. Following his return to training in Tanzania, Dr. Madison shared information about "the Campbell way" of treating orthopaedic injuries. A year after his training in the U.S., Dr. Madison graduated from residency, and returned to the country of his birth – South Sudan – where he became the third residency-trained orthopaedic surgeon serving the country of 12 million people.

The experience is life changing for the trainees, too. Dr. Sean Calloway, Class of 2016 and a scholarship winner stated, "I gained great insights into what makes this kind of enterprise successful. It is more than just a 'come in and cut' mentality. Much like orthopaedic training in the United States, resident education is critical. I am so grateful for this experience. I know that this is one way that I will work to continue to give back. We are so fortunate in the U.S., and this is one small thing we can do to make a difference in the world."

In early 2020, Dr. Carson Rider, Class of 2020, traveled with Health Talents International to the Montellano Clinic in Guatemala. Dr. Rider was a


Dr. Carson Rider with some new friends from Montellano

member of a 60-person medical team that provided orthopaedic and ophthalmologic care to residents in the city. "It was an amazing experience," Dr. Rider shared. "In this small way, we were able to help people return to more active lives – in most cases, providing for their families. The experience was both humbling and gratifying."

Since inception, the Molly Shumate Community Service Scholarship has enabled the following trainees to deliver vital orthopaedic care to people across the globe. Listed below are the Scholarship recipients, along with their graduation year and the location of their mission and the name of the local partner agency. Donor support sustains this effort.

Mission Year	Scholarship Winner, Class Year	Mission Location & Local Agency
2013	**Robert F. Murphy, MD, 2014**	Managua, Nicaragua with Health Volunteers Overseas (HVO)
2014	**Collin C. Bills, MD, 2016**	Montellano, Guatemala with Health Talents International (HTI)
2015	**Eric N. Bowman, MD, 2017**	Tegucigalpa, Honduras with Global Health Outreach (GHO)
2016	**Sean P. Calloway, MD, 2016**	Moshi, Tanzania with Health Volunteers Overseas (HVO)
2016	**Brian Madison, MD**	From South Sudan, 6-week experience in Memphis, TN
2017	**D. Christopher Carver, MD, 2018**	Kampala, Uganda with Health Volunteers Overseas (HVO)
2018	**Zachary K. Pharr, MD, 2020**	Montellano, Guatemala with Health Talents International (HTI)
2019	**Catherine R. Olinger, MD, 2020**	Santiago, Dominican Republic with the Institute for Latin American Concern (ILAC)
2020	**Carson M. Rider, MD, 2020**	Montellano, Guatemala with Health Talents International (HTI)

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Connections & Vision Provide Hope for Children with Cerebral Palsy

Call it "six degrees of separation" or the "ripple effect," but one seldom recognizes how events and circumstances may be connected while experiencing them. With hindsight though, the connections become apparent and the opportunities they represent become visible.

It is this sort of 'ripple effect' that led to the formation of a multidisciplinary center of care for children with cerebral palsy at Le Bonheur Children's Hospital. Led by a team from Campbell Clinic, the Center opened in January 2018, following a transformational gift in late 2017.

Here's some background from a few years ago. In 2013, the Campbell Clinic pediatric orthopaedic surgeons decided to invite opinion and thought leaders in the pediatric orthopaedic world to Memphis to speak to the faculty, residents and fellows of the Campbell Foundation program who work with pediatric orthopaedic patients. Because of the reputation of the Campbell pediatric orthopaedic staff and their contributions to the pediatric orthopaedic field, each year, they were able to secure 'the best of the best" pediatric orthopaedic speakers – typically, the president of the Pediatric Orthopaedic Society of North American (POSNA) – to come and speak in Memphis. It became a highlight of the academic year to hear from such prominent leaders, speaking on a variety of important topics in pediatric orthopaedics.

So it was that Dr. James McCarthy, 2016-17 POSNA President, came to Memphis in early 2017 to speak to the group. Dr. McCarthy described the organization and approach to the care and treatment of children with cerebral palsy within the Cincinnati Children's Hospital structure, in an address entitled, "The Orthopaedic Evaluation and Treatment of Children with Cerebral Palsy." He spoke of a multidisciplinary effort, with specialits working in concert, to provide comprehensive, coordinated care plans for children with cerebral palsy. He described a system wherein the orthopaedic surgeon serves as the 'quarterback' of a team comprised of orthopaedic surgeons, physical, speech, and occupational therapists, physiatrists, neurosurgeons, neurologists, and others working together for each child.

Following Dr. McCarthy's lecture, a development officer for the Campbell Foundation privately asked the two most senior pediatric orthopaedic surgeons, "Is this how we do it here?" They somewhat reluctantly replied, "Not exactly." They acknowledged that the individual resources existed in Memphis, but coordination of care was somewhat lacking, as the specialists sometimes worked in 'silos.'

Pediatric Orthopaedic Surgeon William C. Warner, Jr., M.D. examines a child in the Center of Excellence for Cerebral Palsy Care and Research, while a parent and a physical therapist look on

Then, in another ripple, one month after Dr. McCarthy's presentation, a timely call came to the Campbell Foundation that would foster yet another connection. A member of the Board of the Children's Foundation of Memphis contacted the Campbell Foundation to share their intention to celebrate the centennial anniversary of the two organizations' shared legacy – their connection. A century earlier, women of Calvary Episcopal approached Willis C. Campbell, M.D., founder of Campbell Clinic, because they wanted to buy a wheelchair for a crippled child. He challenged them to dream big, and actually build a hospital for these kids. He pledged care from Campbell Clinic surgeons, and even gave a donation of $10,000 (over $200,000 in today's dollars) to kick off their fundraising drive. With their shared commitment to the cause, in only a few years, the Crippled Children's Hospital was born. The hospital had ongoing

The medical team uses bubbles to focus the attention of the child during an appointment in the Center of Excellence for Cerebral Palsy Care and Research

operations for more than sixty years. In the early 1980s, when the hospital was sold, the proceeds formed The Children's Foundation of Memphis.

After the Children's Foundation call in early 2017, the senior pediatric orthopaedic surgeons began to dream of building a multidisciplinary center for treatment of children with cerebral palsy similar to the one Dr. McCarthy described. One that would treat the whole child by bringing together the multiple medical professionals required. They dared to 'dream big,' and imagine a better solution for children with cerebral palsy; a solution that would be world-class. The plan was presented to the board of the Children's Foundation of Memphis in Spring 2017.

Inspired by the new vision, a million dollar grant celebrating their shared centennial was awarded from the Children's Foundation of Memphis to the Campbell Foundation for the development of a Center of Excellence in Cerebral Palsy Care and Research, which opened in January 2018.

"There are approximately 35,000 children in our tri-state region living with a diagnosis of cerebral palsy (CP) or other neuromuscular condition," said Dr. William Warner, Campbell Clinic pediatric orthopaedic surgeon. "The complex medical care these children require is daunting, extensive, and less coordinated than it could be — there's a gap," he said. "Children in our community with CP and other neuromuscular conditions deserve a chance to grow to their fullest potential and thrive. In some cases, independent living will be possible, and for others, pain free mobility and a full life is the goal. We knew we needed to close the 'gap' in our community."

"By assessing "best in class" cerebral palsy facilities across the U.S., we identified key factors for success," added Dr. David Spence, another of the Campbell Clinic pediatric orthopaedic surgeons directing the center. "We plan for our center to be one of the leading clinics in the nation. By bringing all of the healthcare providers together in this Center, these kids and their families will have a much better chance at a good outcome. We want to surround the families with the care, resources and support they need to allow their child to develop to his or her greatest potential."

The medical team uses bubbles to focus the attention of the child during an appointment in the Center of Excellence for Cerebral Palsy Care and Research

Since opening the Center, the team has conducted more than 500 multidisciplinary patient visits – providing children with cerebral palsy and their families with comprehensive, coordinated care plans, and with hope.

All because of a ripple.

It is amazing to see, in hindsight, how connected we truly are. These connections are powerful, and when combined with a big vision, amazing things can happen. We only have to look for the opportunity.

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CAMPBELL CLINIC

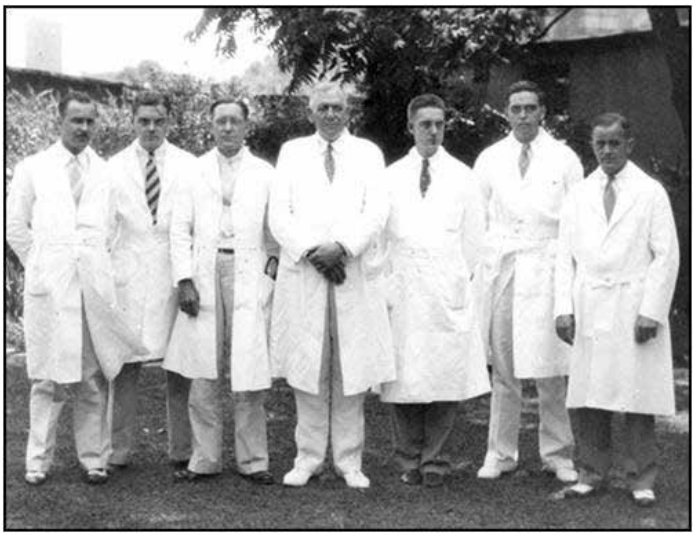
History of a Man, a Book, a Building and More

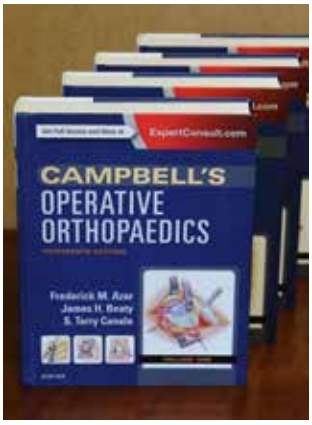
S. TERRY CANALE, M.D.

Dr. Willis C. Campbell began the practice of orthopaedic surgery in Memphis, TN in 1909. Dr. Campbell's flagship clinic was conveniently located at 869 Madison Avenue, across from the John Gaston Hospital, in the heart of the city and near the University of Tennessee Medical School, now known as the University of Tennessee Health Science Center (UTHSC). Campbell Clinic operated from that location until 1998, with satellite offices at various times throughout the city.

In the early twentieth century, the specialty of orthopaedics was in its infancy and very small. Everybody knew each other. Dr. Campbell realized that and successfully recruited the top prospects in orthopaedics. Suddenly, it was no longer Campbell's Clinic (a one-man operation) but "The Campbell Clinic".

Dr. Campbell, along with six other colleagues, was instrumental in the formation of the American Academy of Orthopaedic Surgeons (AAOS), a fledgling academy with a simple purpose to facilitate sharing of orthopaedic knowledge without exception. Dr. Campbell served as the first elected president in 1933. The AAOS now has more than 39,000 members – called Fellows – from across the globe, and is the largest medical association of musculoskeletal specialists in the world. Many of Campbell Clinic's early staff followed Dr. Campbell's example of leadership and service to the profession. Six other Campbell Clinic surgeons and one alumnus of the training program have served as AAOS President since Dr. Campbell – more than any other institution in the United States. The clinic staff have been honored to serve as presidents or chairmen of other associations such as the American Orthopaedic Association (AOA), the Orthopaedic Research & Education Foundation (OREF), the American Board of Orthopaedic Surgery (ABOS), the Journal of Bone & Joint Surgery (JBJS), and numerous other orthopaedic specialty societies.





Dr. Campbell extended his commitment to surgeon education with the genesis of a textbook dedicated to describing every relevant orthopaedic surgical procedure known. The resulting work, *Campbell's Operative Orthopaedics*, was first published in 1939, and was distributed to every U.S. field hospital during World War II, and thus became known as the "Bible" of orthopaedic surgery. Now in its 14th edition, *Campbell's Operative Orthopaedics* has been translated into eight different languages and remains the number one selling orthopaedic textbook in the world. A special thanks to Kay Daugherty and Linda Jones, Associate Editors, who are responsible for organizing the effort, providing brevity and clarity to the surgeons' words, and generally "herding the cats" to remain on task and on time. Dr. Alvin J. Ingram, former Campbell Clinic Chief of Staff, used to say that "the Book is what sets us apart from just another large orthopaedic clinic."

As the orthopaedic specialty grew, the reputation of Campbell Clinic did as well. In the '50s and '60s, many big names in orthopaedics wore the "Campbell tartan" green and treated patients in the tall brick building at 869 Madison. Names like Speed, Hamilton, Boyd, Smith,

Ingram, Stewart, Calandruccio, Sage, Milford, Tooms, and Edmonson were the pioneers of Orthopaedics, not only in Memphis, but also throughout the country.

Stories from the early days at 869 Madison have become legendary – not only due to the orthopaedic advances within – but also the day-to-day routines and traditions from the original clinic building. Tales of being stuck in the rickety elevators combine with special memories from the cafeteria including the purple sheen on the roast beef and the "fat pills" dripping in deep-fried grease – so unhealthy but devoured by staff and trainees alike. Some of the present surgical staff who grew up at Campbell Clinic as children of Campbell Clinic partners have admitted that, as very young children, they thought Campbell Clinic was a restaurant until they learned what else happened in that grand building.

After Dr. Campbell's death in 1941, his clinic partners founded the Campbell Foundation in 1946, and donated the clinic building at 869 Madison to the Campbell Foundation. The mission of the Foundation is to enhance the quality of life through the science of orthopaedic medicine, and remains dedicated to surgeon education, orthopaedic research, and community outreach healthcare – all hallmarks of Dr. Campbell's legacy.

By the late '80s and 90's, the clinic was getting national and international referrals and seeing many grateful patients. It became apparent that a large portion of the population of Memphis was rapidly moving east, and the clinic was at risk of losing market share despite the international reputation. Campbell Clinic opened satellite offices in Mississippi and even an office at the University of Tennessee, but the reality was that Campbell Clinic's base of operations had to "go east, young man, and move from 869 Madison."

In 1992, clinic leaders purchased a 10-acre parcel of land in Germantown, then a modest suburb on the eastern border of Memphis. Thanks to lots of hard working staff, a new sparkling and luxurious "bone palace" rose up at 1400 S. Germantown Road, a street that was home to little else besides gas stations and video rental shops. At the time, it was a risky move, since the clinic was all alone in that portion of the county. However, the ambitious vision of the leaders of the Clinic was proven to be wise, as Campbell Clinic now anchors a large medical corridor on the eastern edge of Memphis. The original clinic at 869 Madison closed its doors in 1998. The former clinic site is now home to a UTHSC parking garage, but bears a large granite marker on its southwest corner commemorating the original Campbell Clinic location.

Since the Germantown clinic opened, four other satellite locations in Tennessee and Mississippi followed, and Campbell Clinic's market share grew by a whopping 25%. As outpatient surgery and MRI grew, and because of the extra land, Campbell Clinic added a freestanding ambulatory surgery center and imaging capabilities to the Germantown base of operations.

Drs. Ingram, Sage, Edmonson, and Tooms were among my mentors in orthopaedics. Also, in my opinion, they gave the Campbell Foundation the start it needed to become a viable entity as a philanthropic organization, now under the lay leadership of Jack Blair.

What about the twenty-first century? Much has changed in addition to a new building. Campbell Clinic now has more than 50 staff members, has trained over 600 residents, and has one-year fellowships in numerous orthopaedic subspecialties.

Campbell Clinic operates outpatient clinics at four locations throughout the Memphis region, including one just south of the state line in Mississippi. All locations include diagnostic and physical therapy capabilities, and Campbell Clinic operates a second magnet (MRI) and purchased an additional ambulatory surgery center in the midtown area of Memphis. Our flagship hospital affiliations include Methodist, Baptist, Le Bonheur, and the Regional One Trauma Center ("The Med").

Campbell Clinic is credited with starting the first emergent "After Hours" clinic followed later by a no-appointment-needed "walk-in" clinic.

Our former partners, just as Dr. Campbell, had brilliant forethought to secure extra land at our German-

town location for future expansion. When the medical staff size grew in excess of 50, to compliment the original Germantown location, a new 120,000 square foot facility was constructed adjacent to the Germantown Campbell Clinic. Opened in December 2019, the new Campbell Clinic, located at 4887 Wolf River Road (immediately to the east of the 1400 Germantown Road facility), includes state-of-the-art outpatient and therapy facilities with a full complement of diagnostic capabilities. Also in the building is an expansive ambulatory surgery center with eight, large operating rooms with observation suites capable of projecting images from the surgeries to remote locations for training purposes. Also, I'm delighted that the facility includes a 15,000 square foot best-in-class performance and wellness facility, named in honor of my family.

Even though the original Campbell Clinic building at 869 Madison no longer stands, the legacy begun by the man in the building remains robust, thanks to a group of dedicated doctors, employees and a special book. Goodbye 869 Madison. We won't forget you because it reminded us of the old Campbell Clinic saying "when you see a turtle on top of a fencepost you know he had some help getting there." – Thanks Dr. Campbell and 869 Madison.

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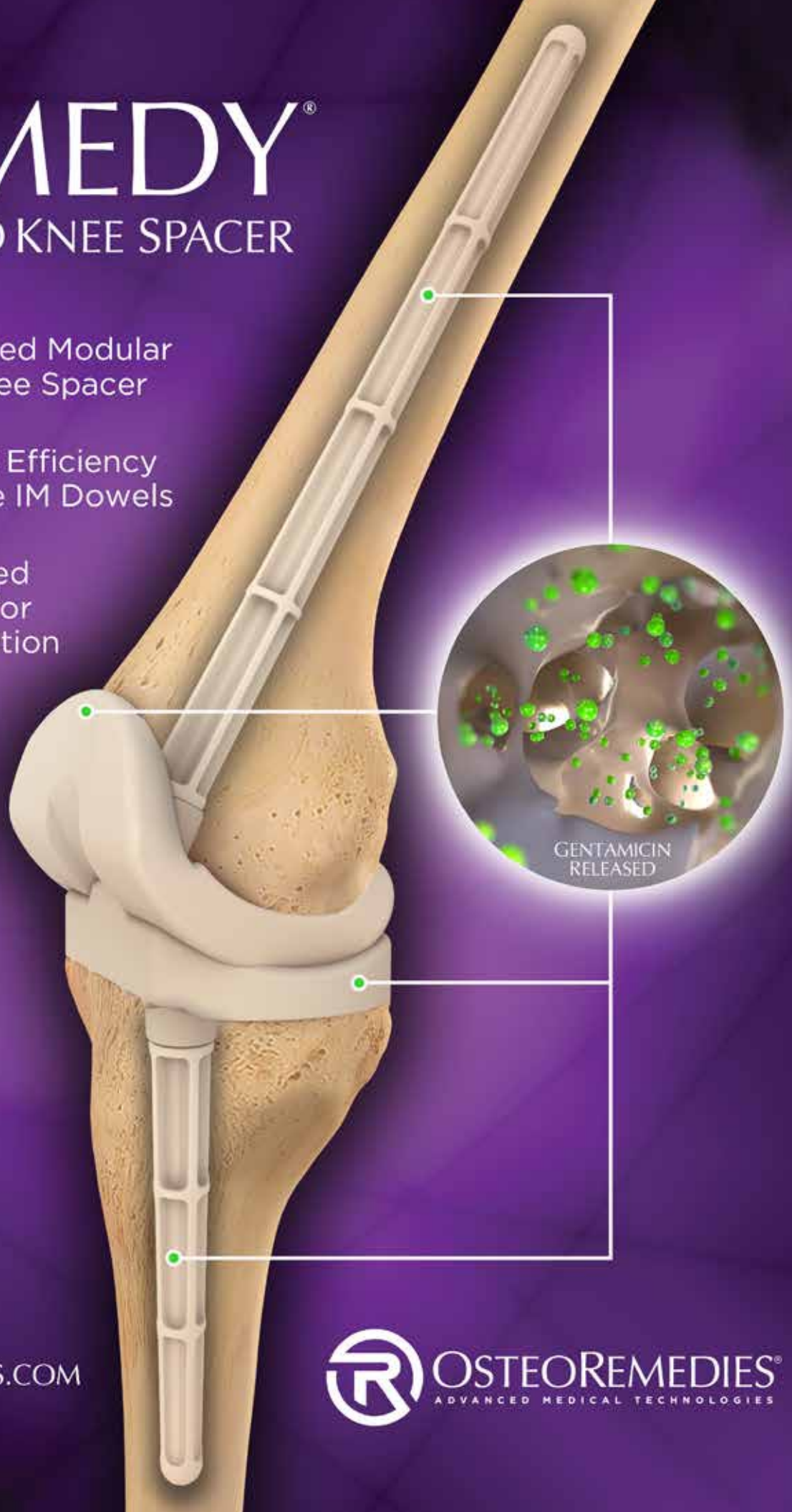

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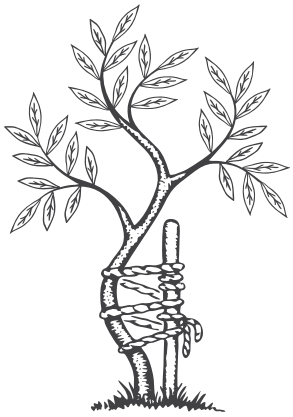

CLASS OF 2020 RESIDENT RESEARCH

The Learning Curve in Fully-Endoscopic Discectomy

ABSTRACT

Purpose: The purpose of this study was to investigate the learning curve for the first 90 elective fully-endoscopic discectomy (FED) procedures performed in an outpatient setting by a single surgeon.

Study Design/Setting: This study is a prospective comparison of patients treated in an ambulatory surgery center.

Patient Sample: The first 90 patients from our FED registry treated by the senior author (RJG) in an ambulatory surgery center were reviewed. Cases were divided by approach, transforaminal (46) or interlaminar (44).

Outcome Measures: Patient-reported outcome measures (visual analog score [VAS] and Oswestry Disability Index [ODI]) were recorded preoperatively and at 2 weeks, 6 weeks, 3 months, and 6 months postoperatively. Operative times, complications, time to discharge from post-anesthesia care unit (PACU), postoperative narcotic use, return to work, and re-operations were recorded and used to analyze the learning curve of FED.

Methods: Operative times were plotted as a moving average, in groups of 10. Non-linear regression was used to identify a trendline and the inflection point in the trendline was thought to be indicative of completion of the "learning curve."

Results: The mean operative time steadily decreased over the first 50 procedures to approximately 60% of the initial times, where it plateaued for both the transforaminal and interlaminar approaches (mean time 65 minutes). Mean operative times were 62 minutes with the interlaminar approach and 75 minutes with transforaminal approaches ($p=0.03$). Mean time to discharge from PACU was 87 minutes for the interlaminar approach and 61 minutes for the transforaminal approach ($p<0.001$). Preoperative mean VAS score (7) was significantly improved to a median score of 0 at discharge from PACU. The mean VAS and ODI scores at 6 weeks and 6 months postoperatively were statistically and clinically improved from preoperative values. The frequency and duration of postoperative narcotic use both significantly decreased during the learning curve. There were no differences in reoperation rates, complications, return to work, or postoperative narcotic use between the interlaminar and transforaminal groups. There was no difference in the frequency of reoperation over the length of the learning curve.

Conclusions: Endoscopic discectomy in the outpatient setting is a safe and effective treatment for symptomatic disc herniations. Mean operative time decreased to approximately 60% of initial times over the first 50 procedures, suggesting this is the minimal number of cases needed to become proficient with this technique. There does appear to be a secondary learning curve, but a larger patient series is needed to clarify this.

Key Words: endoscopic discectomy, symptomatic disc herniation, learning curve, ambulatory surgery center, number of cases, patient-reported outcomes, re-operations, complications, interlaminar approach, transforaminal approach

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Mood Disorders are Associated with Inferior Outcomes of Anatomic Total Shoulder Arthroplasty*

ABSTRACT

Background: Mood disorders (MD) have been associated with inferior outcomes after orthopaedic procedures, but little is known about their effect on total shoulder arthroplasty (TSA).

Methods: In patients with primary TSA and a minimum of 2 year clinical and radiographic follow-up, documentation of depression, anxiety, and/or use of a prescription mood-stabilizing drug indicated MD. Prolonged narcotic use was patient-reported consumption at most recent follow-up or filled narcotic prescription within 3 months in a statewide database.

Results: Chronic pain syndromes were more frequent in 24 patients with MD (76%) than in 63 without (1.6%), and narcotic use was higher (54% vs. 13%, respectively). There were no significant differences in range of motion, strength, complications, reoperations, or radiographic complications and none in the amount of improvement for any of the functional parameters.

Conclusions: Patients with MD were four times more likely to require narcotics for pain control, although function improved by an amount similar to the control group.

Level of evidence: Level III, retrospective comparison study.

Key Words: total shoulder arthroplasty, mood disorders, outcomes, narcotic use, pain control, anxiety, depression

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The Frequency of Mediastinal Injury in Acute Posterior Sternoclavicular Dislocations: A Multicenter Study

ABSTRACT

Background: Acute posterior sternoclavicular dislocations (APSCD) are rare injuries that historically have prompted concern for injury to the great vessels and other mediastinal structures from initial trauma or subsequent treatment, resulting in the recommendation that a thoracic or vascular surgeon be present or available during operative treatment. The purpose of this study was to determine the frequency and characteristics of vascular injury with APSCD in a large multicenter cohort.

Methods: Following IRB approval, records of consecutive patients under 25 years of age treated for APSCD were collected from each participating center **(Figure 1)**. Only acute injuries (sustained fewer than 10 days before presentation) were included. Patient demographics, injury mechanism, associated mediastinal injuries, and need for thoracic/vascular surgery were recorded. Mediastinal structures injured or compressed by mass effect were specifically characterized by review of pre-operative computed tomography (CT) **(Table 1, Figure 2)**.

Results: Review identified 125 patients with a mean age of 14.7 years; 88% were male. APSCD most commonly resulted from a sporting injury (74%) followed by falls from standing height (10%) and high-energy motor vehicle trauma (10%). The most common finding on cross-sectional imaging was compression of the ipsilateral brachiocephalic vein (50%) **(Table 2)**. Eleven patients had successful closed reduction, and 114 (90%) had open reduction and internal fixation, with 25 failed or unstable closed reductions preceding open treatment. There were no vascular or mediastinal injuries during reduction or fixation that required intervention.

Conclusion: In this multicenter series of 125 APSCDs, no injuries to the great vessels/mediastinal structures requiring intervention were identified. Although more than half of patients had evidence of extrinsic vascular compression at the time of injury, careful open reduction of acute injuries can be safely performed, minimizing the risk of late intervention and longer-term complications. Although vascular injuries following APSCD appear to be quite rare, vascular complications can be catastrophic. Treating providers should consider these data and their own institutional resources to maximize patient safety during the treatment of APSCD.

Level of Evidence: Level III, therapeutic case-control study

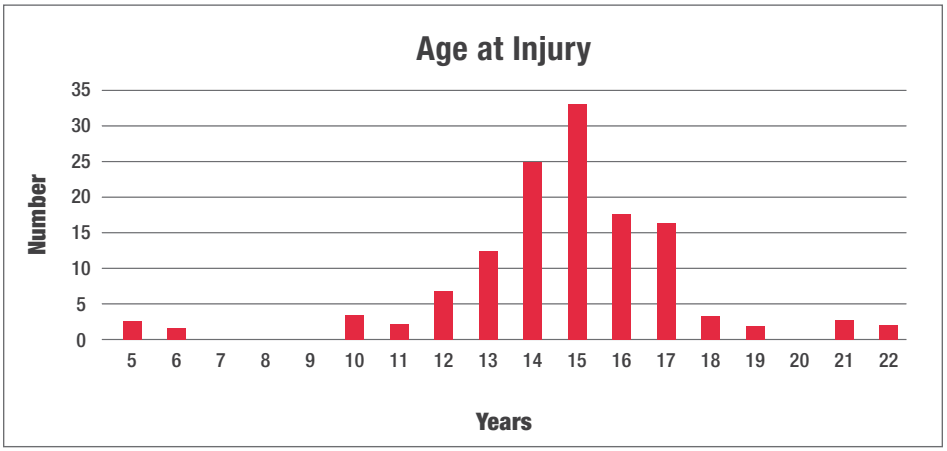

Figure 1: Age at injury

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		CT Compression	CT No Compression	Total	P
Symptom of any kind	Yes	20	14	34	0.55
	No	55	30	85	
Vascular congestion	Yes	0	0	0	N/A
	No	75	44	119	
Dysphagia	Yes	13	8	21	0.91
	No	62	36	98	
Dysphonia	Yes	2	1	3	0.89
	No	73	43	116	
Dyspnea	Yes	8	5	13	0.91
	No	67	39	106	
Paresthesia	Yes	2	4	6	0.12
	No	73	40	113	

Table 1: Symptoms and CT correlation

Compressed Structure	N	% of patients with
Ipsilateral Brachiocephalic Vein	38	50
Ipsilateral Subclavian Vein	10	13.1
Ipsilateral Carotid Artery	9	11.8
Superior Vena Cava	9	11.8
Trachea	9	11.8
Ipsilateral Brachiocephalic Artery	8	10.5
Ipsilateral Jugular Vein	6	7.9
Contralateral Brachiocephalic Vein	5	6.6
Ipsilateral Subclavian Artery	4	5.3
Thyroid	1	1.3
Aorta	1	1.3
Total	**100**	

Table 2: Mediastinal Structures Affected

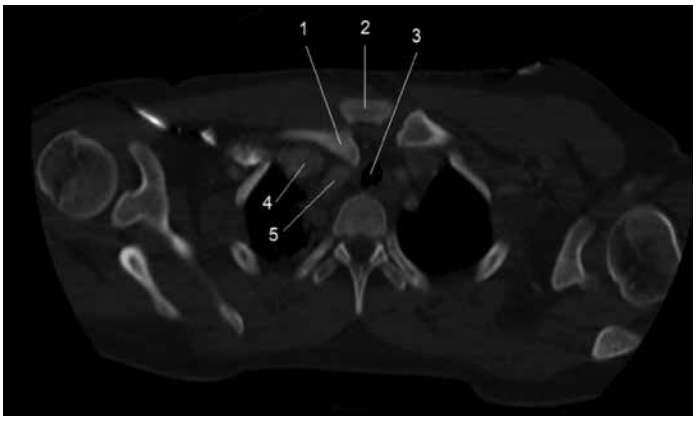

Figure 2: A selected axial image obtained from a supine patient prior to treatment. 1: Dislocated clavicle, 2: Sternum, 3: Trache 4: Right brachiocephalic vein 5: Right brachiocephalic artery

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Reliability Testing of the Mayo Elbow Performance Score in Postoperative Patients

ABSTRACT

Background: To test the intra-observer reliability of the Mayo Elbow Performance Score (MEPS) and the inter-observer reliability as compared to the validated Oxford Elbow Score (OES) elbow scoring system in a population of patients who are a minimum of 2 years removed from a surgical procedure on their dysfunctional elbow.

Methods: A total of 42 patients who were at least 2 years removed from a surgical procedure on their dysfunctional elbow formed the study cohort. Patients who received any substantive treatment (injection, surgery, etc.) or had any interval change between initial and follow-up evaluation were excluded. The others completed an initial MEPS questionnaire over phone interview; at a second phone interview 2 to 3 weeks later, they completed another MEPS questionnaire and were also administered the OES questionnaire. Intraclass correlation coefficients (ICC) and Pearson correlation coefficients (PCC) with 95% confidence intervals were calculated to test the intra-observer reliability of the MEPS and the inter-observer reliability of the MEPS compared to OES, respectively. ICC and PCC greater than 0.75 were considered acceptable.

Results: The average MEPS score at the initial interview was 78 (range 5-100, SD 22.4). At the second interview, the average MEPS score was 77 (range 5-100, SD 21.5) and the average standardized OES score was 79 (range 17-100). The ICC for MEPS scores at the two time points was 0.90 and the Pearson coefficient between the MEPS and OES scores was 0.87, both indicating strong agreement.

Conclusion: In patients having undergone a surgical procedure on their dysfunctional elbow, the MEPS has strong reliability at different time points and when compared with a validated post-operative elbow outcomes instrument.

Clinical Relevance: The MEPS is a reliable method of assessing elbow conditions and function in the postoperative elbow patient.

Keywords: Outcomes instrument, elbow pathology, MEPS, reliability and accuracy, validation.

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MRI Lag Times for Knee Pathology Increased After Implementation of the Affordable Care Act

ABSTRACT

Introduction: The Patient Protection and Affordable Care Act (ACA) ushered in a new era of healthcare policy in the United States. Passed in 2010, its more impactful resolutions took effect on January 1, 2014. The ACA's clinical and economic impact is widely experienced by orthopedic surgeons, yet not well quantified. We proposed to evaluate the impact of the ACA on the timing of magnetic resonance imaging (MRI) for knee pathology before and after implementation of the legislation.

Methods : We performed a retrospective analysis of all knee MRIs performed at our institution from 2011 to 2016 (three years before and after ACA implementation). The MRI lag time was calculated by comparing the dates of initial clinical evaluation and MRI completion. The groups were subdivided based on insurance payer status (Medicare, Medicaid, commercial payers). The cohorts were compared to determine differences in average lag time and completion rates at time intervals from initial clinic visit before and after ACA implementation.

Results: A total of 5543 knee MRIs were included; 3157 (57%) scans were performed before ACA implementation, while 2386 (43%) were performed after. There was a 5.6% increase in Medicaid cohort representation after ACA implementation. Patients waited 14 days longer for MRI scans after ACA implementation (116 days vs. 102 days). There were increased lag times for patients in the commercial payer (113 days vs. 100 days) and Medicaid (131 days vs. 96 days) groups. Fewer patients had received MRI scans after ACA implementation within 2 weeks, 6 weeks, and 12 weeks of their initial clinic visits.

Conclusions: The lag time between initial clinical evaluation and MRI scan completion for knee pathology significantly increased after ACA implementation, particularly in the commercial payer and Medicaid cohorts. Longer wait times could lead to diminished patient satisfaction, delayed treatment, and increased morbidity, while fewer MRI scans performed could reduce overall healthcare costs. As healthcare policy changes continue, their effects on orthopedic patients and providers should be closely scrutinized.

Level of Evidence: Level III- Retrospective cohort study

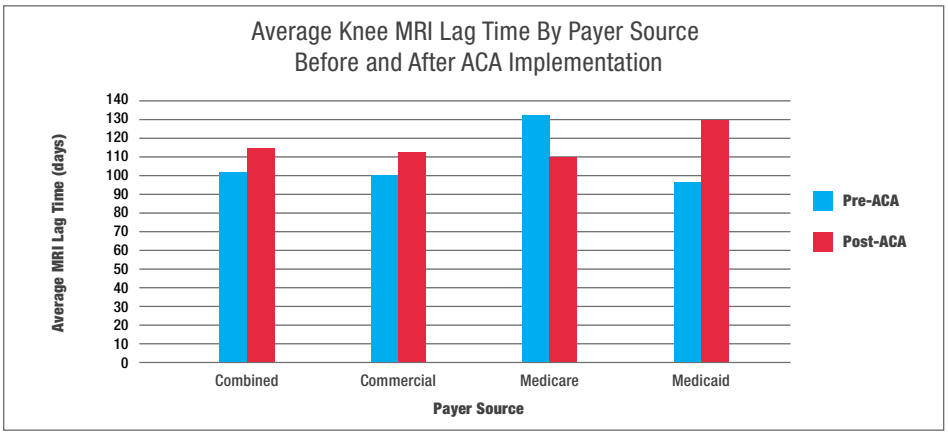

Figure 1: Graphical representation of average knee MRI lag time for combined cohort and payer source subgroups, before and after ACA implementation.

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The Effect of Under-Dosing Prophylactic Antibiotics in the Care of Open Tibial Fractures*

ABSTRACT

Objectives: To determine the frequency and effect of under-dosing prophylactic weight-based antibiotics in patients with open tibial fractures. We hypothesized that patients who did not receive appropriate weight-based dosing of prophylactic antibiotics would have higher rates of infection.

Design: Retrospective cohort study.

Setting: Level 1 Trauma Center.

Patients/Participants: Patients 18 years of age or older with high-grade (Gustilo-Anderson type IIIA or IIIB) open extraarticular tibial fractures over a 5-year period.

Main Outcome: The primary outcome was deep infection within one year of initial injury. Appropriate weight-based dosing of cefazolin was defined as: at least 1 g for patients < 80 kg, 2 g for patients between 80 and 120 kg, and 3 g for patients > 120 kg.

Results: Sixty-three patients met the inclusion criteria; 21 (33%) were under-dosed with cefazolin at the time of initial presentation. Among the 20 patients who subsequently developed deep infection, only 55% were appropriately dosed with cefazolin; of the patients who did not develop deep infection, 72% were appropriately dosed with cefazolin ($P = 0.18$). Univariate analysis revealed that hypertension was associated with infection ($P = 0.049$). Multivariable logistic regression analysis of infection due to all organisms did not reveal a statistically significant reduction in the odds of infection with appropriate weight-based dosing of cefazolin [Odds ratio = 0.42 (95% confidence interval, 0.12–1.48), P = 0.177]. Five of 7 (71%) of the gram positive, non-methicillin-resistant *Staphylococcus aureus*, infections occurred in patients who were under-dosed with cefazolin. Five (23.8%) of 21 patients who were under-dosed with cefazolin had gram-positive, non-methicillin-resistant S. aureus infections, compared to 2 (4.8%) of 42 patients who were appropriately dosed ($P = 0.036$).

Conclusions: Under-dosing of weight-based antibiotics in the treatment of open fractures is common. Appropriate weight-based dosing of cefazolin for prophylaxis in high-grade open tibial fractures reduces the frequency of infection due to cefazolin-sensitive organisms. Interestingly, organisms not susceptible to cefazolin were responsible for the majority of infections. The effect of under-dosing of cefazolin and other weight-based antibiotics deserves further investigation in larger studies.

Key Words: open tibial fractures, infection, antibiotic dosing

Level of Evidence: Therapeutic Level III. See Instructions for Authors for a complete description of levels of evidence.

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Outpatient Hip Safety in an Ambulatory Surgery Center is Independent of Approach

ABSTRACT

Background: There are few data comparing the direct anterior approach (DAA) and posterior approach (PA) for total hip arthroplasty (THA) in the outpatient setting. The purpose of this study was to compare 90-day complications between the two approaches. We hypothesized that they would be equally safe and effective.

Methods: Retrospective review identified 432 THAs (346 DAA, 86 PA) performed at a single ambulatory surgery center (ASC). Outcomes compared included demographics, comorbidities, pre-operative and discharge pain scores (VAS), overall time spent in the ASC, overnight stay, emergency room visits, admission, re-operation, and complications within a 90-day period **(Table 1)**.

Results: There were no differences in mean pre-operative VAS (DAA 4.7, PA 4.5), mean discharge VAS (DAA 0.8, PA 0.7), overall time spent in the ASC (DAA 9.0 hours, PA 9.3 hours), total number of overnight stays (DAA 0.9%, PA 1.2%), emergency room visits (DAA 1.7%, PA 1.2%), admissions (DAA 1.4%, PA 1.2%), re-operations (DAA 1.4%, PA 1.2%), or complications (DAA 3.5%, PA 2.3%) **(Table 2)**.

Conclusion: There were no differences in the safety outcomes, and overall there were few complications in the 90-day period, regardless of the surgeon's preferred approach. This study indicates both DAA and PA are equally safe for THA in the outpatient setting, and the choice of surgical approach should be based on patient and surgeon preference.

Key words: hip arthroplasty, safety, outpatient, ambulatory surgery center, surgical approach

Brief title: Safety in outpatient total hip arthroplasty

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THA Approach			
Demographics and Comorbities	**DAA (n=346)**	**PA (n=86)**	***P value***
Age (mean years)	56±0.45 (57±0.88)*	53±0.96	*0.004* *(0.001)**
Gender			
Male	195 (56%)	55 (64%)	*0.202*
Female	151 (44%)	31 (36%)	
Other	7 (2%)	2 (2%)	
Race			
Caucasian	278 (82%)	59 (70%)	*0.056*
African American	61(18%)	25 (30%)	
BMI (mean, kg/m2)	30.1±0.27 30.9±0.59*	28.7±0.44	*0.021* *0.003**
CAD	23 (7%)	0 (0%)	*0.014*
CHF	12 (3%)	0 (0%)	*0.080*
COPD	6 (2%)	1 (1%)	*0.707*
HTN	182 (53%)	38 (44%)	*0.162*
Diabetes	28 (8%)	2 (2%)	*0.060*
OSA	38 (11%)	4 (5%)	*0.306*
CVA	2 (1%)	1 (1%)	*0.559*
DVT	7 (2%)	3 (3%)	*0.419*
Mood disorder	50 (14%)	11 (13%)	*0.692*
Renal disease	19 (5%)	1 (1%)	*0.087*
ETOH	5(1%)	2 (2%)	*0.563*
Tobacco use	30 (9%)	14 (16%)	*0.037*

*Sample size adjusted, THA, total hip arthroplasty; CAD, coronary artery disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; HTN, hypertension; OSA, obstructive sleep apnea; CVA, cerebrovascular accident; DVT, deep venous thrombosis; ETOH, ethyl alcohol. Statistical difference indicated in bold when p <0.05.

Table 1: Demographics and Comorbidities

THA Approach			
Outcomes	**DAA (n=346)**	**PA (n=86)**	***P value***
VAS (mean)			
Pre-op	4.7±0.16 4.6±0.34*	4.5±0.34	*0.576* *0.808**
Discharge	0.8±0.09 0.7±0.13*	0.7±0.14	*0.858* *0.629**
Time in ASC (hours)	8.7±0.11 9.0±0.22*	9.3±0.23	*0.019* *0.447**
Admission	5(1.4%)	1(1.2%)	*0.070*
Re-Operation	5(1.4%)	1(1.2%)	*0.841*
Overnight Stay	3(0.9%)	1(1.2%)	*0.798*
ER Visit	6(1.7%)	1(1.2%)	*0.841*
Complication	12(3.5%)	2(2.3%)	*0.592*

*Sample size adjusted, THA, total hip arthroplasty; VAS, visual analog scale; ASC, ambulatory surgery center; ER, emergency room. Statistical significance indicated in bold when p <0.05.

Table 2: Outcomes comparison between DAA and PA for outpatient THA.

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Firearms Can Be Safely Used Following Shoulder Arthroplasty

ABSTRACT

Introduction: Many patients with shoulder arthroplasty enjoy hobbies that require the use of firearms; however, there is a paucity of literature regarding firearm use after arthroplasty. The purpose of this study was to determine if patients can safely engage in shooting sports and/or hunting after shoulder replacement.

Methods: Retrospective review identified 473 patients with anatomic or reverse shoulder arthroplasty with a minimum of 2-year follow-up. Patients were contacted to complete a survey to assess their participation in hunting and/or shooting sports: shoulder-mounted or handgun firearm type, frequency of firearm use, purposes for which firearms were used, pain level, limitations during firearm use, and shooting-related complications with the shoulder replacement. Medical records were reviewed to correlate any reported complications due to firearm use.

Results: Of the 473 patients identified, 245 (52%) completed the firearm survey; 61 (25%) resumed firearm use after surgery, 42 using shoulder-mounted firearms (27 on the operative extremity) and 53 using handguns. Recreational shooting (69%) and hunting (54%) were the primary reasons for firearm use. Eleven patients reported shooting over 500 rounds per year after surgery, with no increased limitations or pain with greater frequency of firearm use. Fifty-two patients reported no or mild pain when shooting, and 49 patients reported no limitations in their ability to shoot. There were no complications related to firearm use reported by patients or in the medical record.

Conclusion: Patients can safely engage in the use of a variety of firearms after shoulder arthroplasty without pain or limitations or shooting-related arthroplasty complications.

Keywords: shoulder arthroplasty; firearms use; frequency; pain; limitations; complications

Level of evidence: Level IV, case series

		n		n		n
Shooting level						
	Recreational	42	Competitive	5		
Shooting volume						
	<100 rounds/year	32	100-500 rounds/year	14	>500 rounds/year	11
Hunting types						
	Hunting	33				
	Deer	25	Waterfowl	11	Turkey	9
	Upland Bird	10	Squirrel	11	Other	17
Patient-rated shooting ability						
	Better	7	Same	45	Worse	8
Shooting VAS score						
	0	40	1	4	2	5
	3	1	4	2	5	2
	6	2	7	0	8	2
	9	0	10	1		

Table 1: Shooting Activities and Performance

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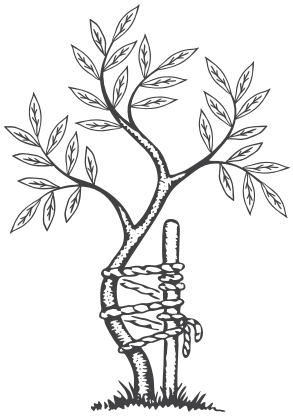

CAMPBELL CLINIC STAFF RESEARCH

TKA in the Ambulatory Surgery Center: 90-Day Outcomes in Patients 65 Years of Age and Older Versus Younger Patients

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ABSTRACT

Introduction: Prior to January 2018, Total Knee Arthroplasty (TKA) was on the Center for Medicare and Medicaid Services (CMS) inpatient-only list, meaning that the procedure would be reimbursed by CMS only if it was done on an inpatient basis. CMS removed TKA from the inpatient-only list and now allows reimbursement of TKAs in the hospital outpatient department (HOPD). Additionally, CMS has solicited public comment regarding potential future expansion of Medicare reimbursement for TKA procedures done in ambulatory surgery centers (ASC). Cost containment may be a motivator of these actions because of the increasing TKA volume and price, as both the HOPD and the ASC are surgical sites of care with considerably lower costs than hospital inpatient procedures, and CMS reimbursement to ASCs is 53% of reimbursement to HOPDs, on average, for the same procedures.

Of concern, however, for older patients are the risks of morbidity, mortality, surgical complications; potentially slower recovery; and pain associated with surgery, all of which may increase with increasing age. Other concerns may be associated with same-day discharge and recovery at home or other venue when TKAs are performed in the HOPD or ASC, which are away from the hospital without immediate emergency care if needed. Moreover, additional risk might be assumed for free-standing ASCs because of the lack of immediate proximity to hospital infrastructure should an adverse event or complication arise during the surgical procedure that would necessitate immediate hospital-based emergency care.

The primary study objective was to compare preoperative cohort characteristics and perioperative and post-operative clinical outcomes for patients 65 years of age and older to those in patients younger than 65 years. Pre-operative characteristics included gender, ethnicity, BMI, American Society of Anesthesia (ASA) score, insurance status, and left/right side surgery. Perioperative and post-operative outcomes included rates of occurrence of (1) surgical complications, transfers to the hospital, and post-operative patient adverse events at the ASC; (2) 90-day post-surgical complications and complications requiring surgical/medical interventions; and (3) 90-day post-surgical healthcare resource utilization; and (4) patient satisfaction.

Methods: A retrospective chart review identified patients who had primary TKA between January 1, 2014, and January 1, 2019, in two free-standing ASCs. Inclusion criteria included patients age 18 to 70 years and procedure performed by one of eight orthopaedic surgeons identified before the study as adhering to similar multimodal pain management pathways:

- Peripheral nerve blocks (bupivacaine with epinephrine) that do not inhibit motor function while controlling pain
- Liposomal bupivacaine (via pericapsular injection), which delivers approximately 72 hours of localized anesthesia
- Spinal anesthesia
- Nonsteroidal anti-inflammatory drugs (NSAIDs): 15 mg Mobic daily, 400 mg Celebrex 2 days before surgery and for 2 weeks after surgery

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- Gabapentin: 300 mg daily twice a day before surgery and for 2 weeks after surgery
- Tramadol: 100 mg every 6 hours as needed after surgery
- Oxycodone: 5 mg, 2-1 every 6 hours as needed after surgery
- Tylenol: 1000 mg day of surgery

Patients had a spinal block and regional adductor canal block (unless contraindicated) in combination with general or monitored anesthesia care. All patients received pre-operative intravenous antibiotics. An intraoperative pericapsular injection of liposomal bupivacaine was administered to all patients. Intravenous tranexamic acid (TXA) was given intraoperatively unless contraindicated; topical TXA was used in patients with contraindications for intravenous use.

Results: Of the 439 procedures meeting inclusion criteria, 66 (15%) were performed in patients 65 years of age and older and 373 (85%) were performed in patients under 65 years of age. The average age of the >65 group was 10 years older than the younger group (67 years vs 57 years). BMI was significantly lower in the older group (31.9) than in the younger group (34.3) (p=0.0017). Aside from these patient characteristics, the older and younger groups were similar in terms of gender, ethnicity, ASA class, insurance type, and left vs. right side TKA procedures.

Older patients had a slightly longer average overall time in the ASC (+15 minutes), longer average operative time, and longer average PACU time, but shorter preoperative time and time to ambulation than younger patients. Although average pain scores at discharge were low for the entire cohort (1.3), scores for older patients were numerically lower than those for younger patients.

There were 3 hospital admissions and 4 ED visits in the entire cohort within the 90-day global episode, and these occurred only among the younger age group. This difference was not statistically significant because of the small numbers overall; 90-day adverse events, surgeries related to the index surgery, and patients with unplanned clinic visits also were not statistically different between the older and younger groups. At the 90-day follow-up visit, 10 patients (3.8%) in the entire cohort with known patient satisfaction data (n=267) reported complications or pain associated with the procedure, all of whom were in the younger age group.

Conclusions: No statistically significant differences in TKA outcomes were observed at the ASC or within the 90-day post-surgical episode of care for patients 65 years and over compared to younger patients. In the older age group, length of surgery, total length of stay in the ASC, and pain scores at discharge were not statistically different from younger patients, and there were no surgical complications in this group. Furthermore, for older patients, through the 90-day surgical episode of care, there were no ED visits, hospital admissions, or patient reports of complications or pain. TKA surgical outcomes at the ASC and through the 90-day surgical episode for older patients were equivalent to or better than the same outcomes for younger patients. TKA in the ASC is appropriate for selected patients ≥ 65 years of age, with safety and satisfaction outcomes similar to those in younger patients.

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Isolated Absence of Multiple Carpal Bones in a Child with Traumatic Fingertip Amputation: An Incidental Finding and Review of the Literature

ABSTRACT

INTRODUCTION: Congenital absence of the carpus is a rare entity typically associated with concomitant forearm anomalies.[1] Few case reports have documented isolated carpal absences without respective radial-sided or ulnar-sided defects.[2,3] We have found no published cases documenting asymptomatic, isolated, and incidentally discovered absences of more than one carpal bone in a pediatric patient.

CASE REPORT: A 10-year-old, left-hand-dominant male was lifting a volleyball pole when he sustained crush injuries to the distal aspects of the left long and ring fingers. He was subsequently evaluated and treated at a local pediatric hospital by an orthopaedic surgeon. The patient had no history of trauma, wrist pain, or other congenital abnormalities, but there was a family history of upper extremity abnormalities in his father and paternal grandmother. All other medical history and review of systems were noncontributory.

Physical examination. Examination of the patient's left upper extremity revealed traumatic amputations of the middle and ring fingers at the level of the proximal distal phalanx **(Figure 1)**. He had a transversely-oriented wound without gross contamination or exposed bone and was able to perform full proximal interphalangeal and metacarpophalangeal joint range of motion. Distal interphalangeal joint range of motion was moderately irritable. He had brisk capillary refill in all uninjured digits, and all appeared normal in size. He had 90 degrees of wrist extension and 130 degrees of flexion **(Figure 2)**.

Figure 1

Imaging evaluation. Initial radiographic imaging consisting of three views of the left hand and wrist showed traumatic amputation of the distal phalanges of the left long and ring fingers, as well as absence of the scaphoid, lunate, triquetrum, trapezoid, and trapezium **(Figure 3)**. The hamate and capitate were dysplastic, and the pisiform did not appear to articulate with the hamate.

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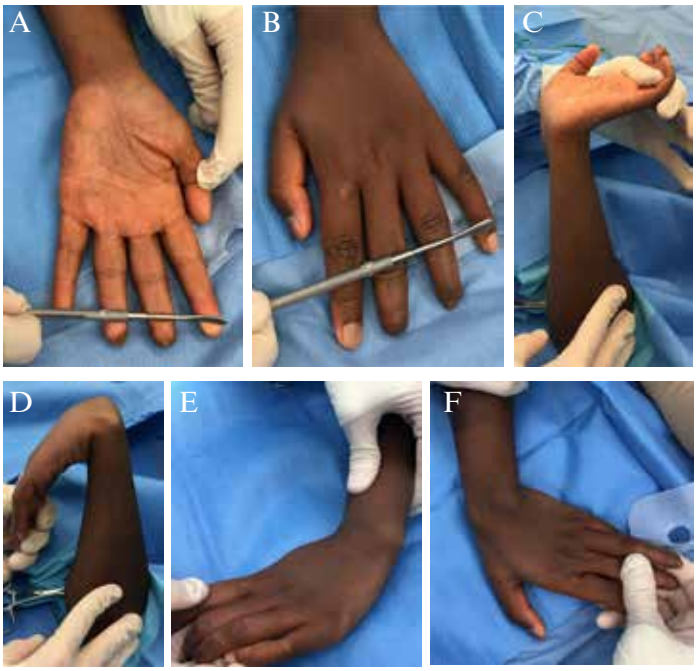

Figure 2

Treatment and outcome. The patient had a 6-week course of local wound care and physical therapy and ultimately developed a long-finger hook nail. His traumatic long-finger amputation was revised 85 days after injury. The postoperative course was uneventful.

DISCUSSION: Isolated absence of multiple carpal bones without associated anomalies is rare. To our knowledge, this is the first case report of multiple radial and ulnar carpal deficiencies without additional skeletal anomalies. Furthermore, the discovery of the patient's carpal anomalies was incidental, secondary to his traumatic fingertip amputations, making his presentation unique due to its asymptomatic nature and the lack of an obvious deformity.

A literature search (consisting of PubMed and Google Scholar searches) to identify studies involving patients with absent carpal bones found 16 reports involving 18 patients: six had one or more carpal absences with concomitant upper extremity abnormalities but no other known abnormalities,[4-8] seven had absent carpal bones as well as other organ system anomalies,[8-14] three had isolated absence of the scaphoid,[2,15,16] two had isolated absence of the triquetrum,[3,17] and one had an isolated absence of the lunate,[18] which was ultimately attributed to a septic staphylococcal infection sustained as an infant. Of the 18 patients described, only 3 had no associated anomalies, two with absence of the scaphoid and one with absence of the triquetrum.

Concomitant anomalies of the upper extremity have been documented in all case reports of absence of more than one carpal bone. Clinically, these congenital defects can be subtle, as in Postacchini and Ippolito's[5] description of a 38-year-old woman with a normal appearing right hand with the exception of a single palmar crease. This patient presented with tendonitis of extensor pollicis longus and abductor pollicis brevis in her right wrist; the scaphoid, lunate, and trapezoid were absent and the distal carpal row was fused, as were the ipsilateral second and third metacarpals. Most reported patients presented as a result of their clinically abnormal appearance or because of another complaint related to their genetic syndrome but without a history of trauma. The patient in this case had no obvious gross deformity nor any other clinical complaints that would have led to the discovery of his missing carpal bones.

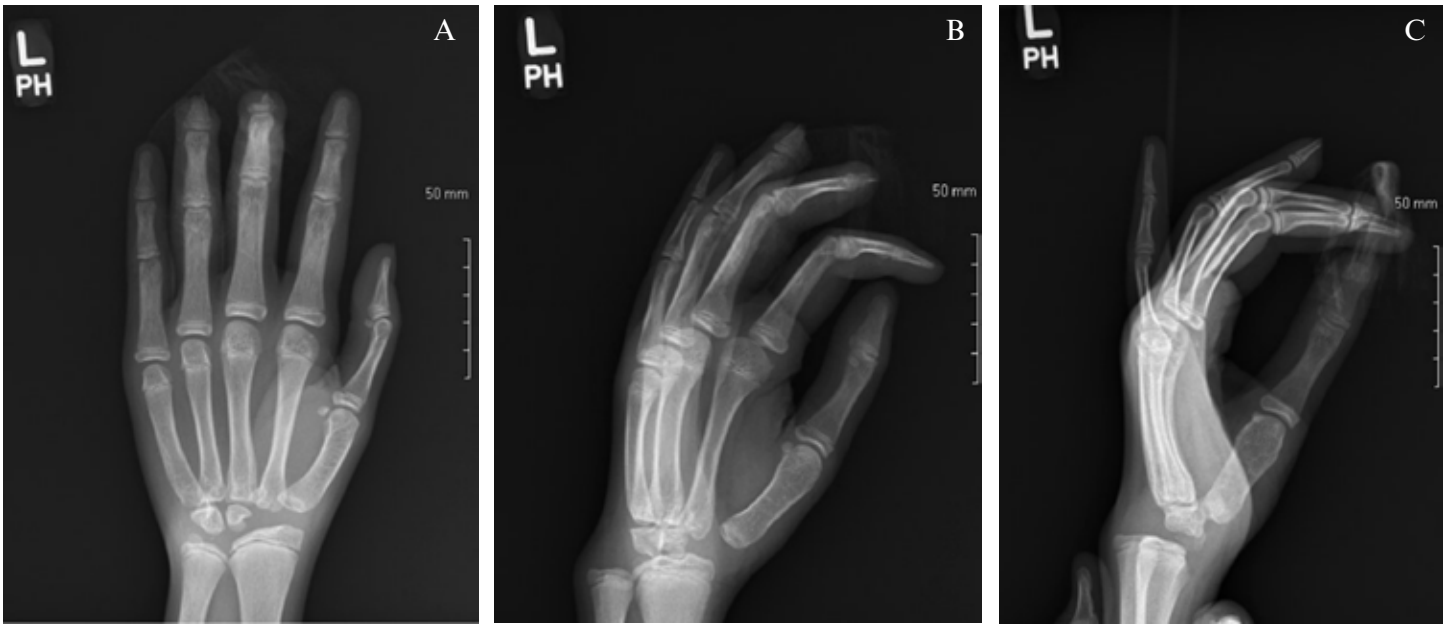

Figure 3

Several case reports have described isolated absences of the scaphoid[2,15,16] and triquetrum[3,17] without other upper extremity anomalies, and some reported hypoplastic counterparts in the contralateral extremities. In the description by Kuz and Smith[2] of an 18-year-old male with an absent right scaphoid, the contralateral side had a hypoplastic scaphoid. Interestingly, most patients with isolated carpal bone absences presented with hand or wrist symptoms after sustaining a low-energy trauma to the hand or wrist.[14-16]

Diagnosing congenital absence of the carpal bones relies primarily on radiographs. There is a possibility that the subject in our study had other carpal bones with failed or even delayed ossification, but his parents refused an MRI that could have provided additional information regarding the patient's osseous and ligamentous carpal anatomy.

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Identifying Appropriate Candidates for Ambulatory Outpatient Shoulder Arthroplasty: Validation of a Patient Selection Algorithm*

ABSTRACT

Background: Outpatient total shoulder arthroplasty (TSA) is increasing in frequency, but the selection of patients who are appropriate outpatient joint candidates remains challenging. We propose an algorithm for selecting outpatient TSA candidates, with validation by a cohort of patients from an ambulatory surgery center (ASC).

Methods: We identified 61 patients who had primary anatomic and reverse TSA. The selection algorithm, which stratifies patients referable to their age and cardiopulmonary comorbidities, was used to choose patients for outpatient surgery. Complications, including cardiopulmonary, thromboembolic, and postoperative wound problems, were recorded.

Results: All 61 patients were discharged from the ASC on the day of surgery. There were no cardiopulmonary events requiring intervention or hospital admission. One patient (2%) required a secondary operation, 3 patients (5%) experienced acute surgical complications, 3 patients (5%) had transient postoperative nausea, and 4 patients (7%) had additional complications within the 90-day episode of care.

Conclusions: This study is the first to propose a patient selection method for outpatient TSA. Using this algorithm for patient selection produced a low rate of perioperative complications and no hospital admissions. We suggest this algorithm provides an evidence-based method for the standardization of outpatient TSA candidate selection.

Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Total shoulder arthroplasty; outpatient; patient selection; complications; algorithm; validation

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Bundled Payment Plans Are Associated With Notable Cost Savings for Ambulatory Outpatient Total Shoulder Arthroplasty*

ABSTRACT

Introduction: Bundling of services, typically into a 90-day episode of care, is intended to facilitate cost reduction. The purpose of this study was to determine the impact of a private insurance bundling program on the costs of outpatient total shoulder arthroplasty (TSA) at a freestanding ambulatory surgery center.

Methods: A cost minimization analysis was done of patients who had anatomic TSA by a single surgeon at a single freestanding ambulatory surgery center, including line-by-line comparisons of demographic and comorbidity factors for all patients treated within the 90-day episode of care.

Results: Seventy-six primary anatomic TSAs were included, 39 in the bundled group and 37 outside of the program. The bundled group was on average older (58 years) than the unbundled group (54 years, $P = 0.021$), but the groups were otherwise similar in demographics. The average total implant charges were significantly less for the bundled group ($24,822.43 versus $28,405.51, $P = 0.014$). Average total surgery supply charges and anesthesia supply charges were similar ($P > 0.05$). Mean total outpatient surgical day charges (implants, surgical, and anesthesia equipment) were significantly less for the bundled group ($29,782.43 versus $33,238.68, $P = 0.022$), as were average operating room staffing costs ($135.37 versus $162.55, $P = 0.015$). During the 90-day postoperative period, charges were similar.

Conclusions: Primary anatomic TSA using a bundled care program in an outpatient setting coincides with markedly lower charges. The primary driver of this reduction is implant pricing, which is negotiated as part of the bundle. Surgeons must carefully analyze their unique practices in the changing economic health care environment when creating an outpatient TSA and/or bundling program.

Level of evidence: Level III economic analysis

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A Retrospective Comparative Study of Patient Satisfaction Following Ambulatory Outpatient and Inpatient Total Shoulder Arthroplasty*

ABSTRACT

Background: Little is known about patient perceptions of outpatient total shoulder arthroplasty (TSA). We evaluated patient-reported satisfaction with TSA in a freestanding ambulatory surgery center (ASC) and an inpatient (INPT) setting.

Methods: Patients were mailed a survey regarding hospital admission, surgical site infections, and medical problems after surgery, as well as their satisfaction with the surgery and location. Patients were asked if, given the opportunity, they would change the location of their surgery.

Results: Thirty-five patients with ASC surgery and 46 with INPT surgery completed the survey. Satisfaction regarding location and outcomes of surgery was similar, with no differences in readmission rates, need for medical care after surgery, or surgical site infections. A high percentage of patients in the INPT group would have changed their surgery location to an ASC setting.

Conclusions: Patients were very satisfied with TSA, as well as the environment of their surgery (ASC or INPT). If given a choice, however, the ASC group preferred having their surgery in the ASC setting, while a high percentage of patients in the INPT group would have preferred to change to an ASC setting.

Level of Evidence: Level III. Retrospective comparative study.

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Morphologic Variants of Posterolateral Tibial Plateau Impaction Fractures in the Setting of Primary Anterior Cruciate Ligament Tear*

ABSTRACT

Background: Impaction fractures of the posterolateral tibial plateau commonly occur in the setting of anterior cruciate ligament (ACL) tears, with considerable variability found in fracture size and morphologic features.

Purpose: The primary objective was to characterize different morphologic variants of posterolateral tibial plateau impaction fractures. The secondary objective was to investigate the association between these impaction fracture variants and concomitant meniscal and ligamentous injuries.

Study Design: Cross-sectional study; Level of evidence 3.

Methods: Patients treated for primary ACL tears and having magnetic resonance imaging available were included in this study, and magnetic resonance images were reviewed with denotation of displaced posterolateral tibial impaction fractures. A classification system was created based on morphologic variants of impaction fractures; associations were evaluated through use of independent chi-square testing.

Results: There were 825 knees meeting the inclusion criteria, with displaced posterolateral tibial plateau impaction fractures present in 407 knees (49.3%). We observed 3 distinct morphologic variants of lateral tibial plateau impaction fractures: (I) posterior cortical buckle not involving the articular surface; (II) posterior impaction fracture involving the articular surface, with sub-types based on (A) tibial plateau depth bone loss < 10% and (B) bone loss > 10%; and (III) displaced osteochondral fragment, with subtypes for (A) shear or (B) depressed fragment. Type IIIA impaction fractures were associated with an increased incidence of lateral meniscus posterior root tears (33.3% vs 12.4%; $P = .009$) and an increased incidence of lateral meniscal tears (83.3% vs 56.7%; $P = .024$) compared with all knees without type IIIA impaction fracture. An increased incidence of medial collateral ligament (MCL) tears was noted in patients with type IIIA impaction fractures compared with those who had no fracture or had another fracture type (61.1% vs 20.1%; $P < .001$). Type IIIB impaction fractures were associated with an increased incidence of lateral meniscal tears (80.0% vs 56.2%; $P = .005$).

Conclusion: A high prevalence of displaced posterolateral tibial plateau impaction fractures occur in the setting of ACL tears, and they can be classified into distinct morphologic subtypes. Posterolateral tibial plateau impaction fractures with displaced depressed or shear fragments were both associated with an increased incidence of lateral meniscal tears, whereas impaction fractures with a shear fragment were associated with an increased incidence of lateral meniscus posterior root tears and MCL tears.

Keywords: tibial plateau; impaction fracture; classification; ACL tear

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Impaction fractures of the posterolateral aspect of the tibial plateau have previously been recognized as being associated with anterior cruciate ligament (ACL) tears.[4,6,10-12] A generalized classification system for cartilage and bone injuries of the knee has been described with major categories for bone bruises, stress fractures, tibial fractures, femoral fractures, and osteochondral fractures[6,12] and further subcategories within those major categories; however, no specific classification for posterolateral tibial plateau impaction fractures occurring in the setting of an ACL tear has been described.

Much of the recent literature regarding posterolateral tibial plateau injury in the setting of an ACL tear has focused on bone bruises, sometimes described as occult or nondisplaced impaction fractures.[1,3,8,9,15,16] Bone bruising in the setting of ACL tear has a reported incidence of approximately 80%.[1,13] When bone bruising is present, it suggests a higher energy pivoting injury, as full or high-grade partial ACL tears are more frequently associated with bone bruising compared with low-grade partial tears.[17] Bone bruises of the lateral tibial plateau and lateral femoral condyle have also been shown to be associated with concomitant medial and lateral meniscal tears as well as medial collateral ligament (MCL) tears in the setting of ACL tear.[1,16] Impaction fractures in which displacement of the articular surface or cortical bone is present have received little discussion. These displaced impaction fractures appear to represent an impaction injury of increased severity compared with isolated bone contusions and warrant further investigation to determine whether they are of consequence to operative management or postoperative outcomes in the setting of ACL reconstruction.

On review of a cohort of patients with primary ACL

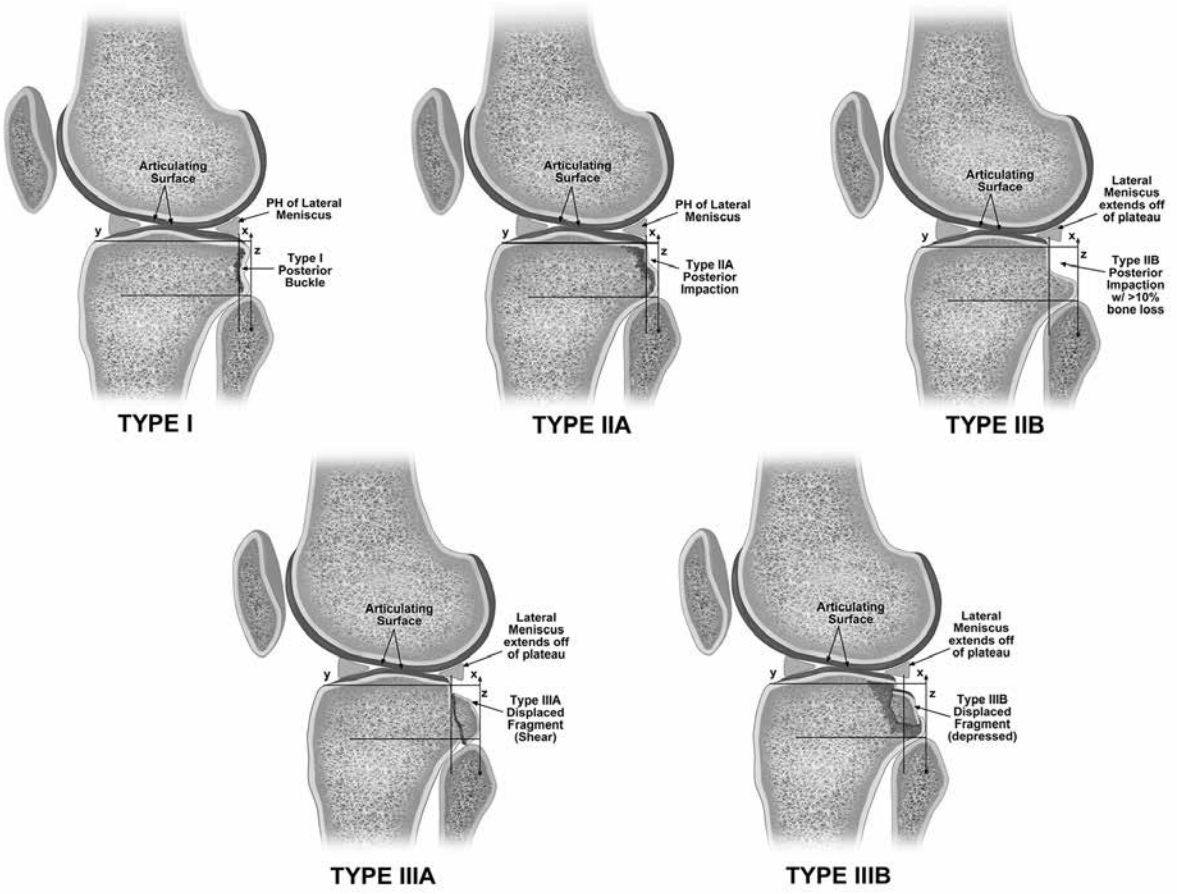

Figure 1: Sagittal illustrations depicting a classification system for posterolateral tibial plateau impaction fracture. Type I impaction fractures are defined as posterior cortical impaction without involvement of the articular surface. Type II fractures are those in which there is a posterior impaction that involves the articular surface, with type IIA resulting in less than 10% tibial plateau depth bone loss and type IIB with greater than 10% bone loss. Type III fractures are defined as depressed osteochondral fractures, with type IIIA being a shear fragment and type IIIB being a depressed fragment. PH, posterior horn.

tears, we identified displaced posterolateral impaction fractures to be a common associated injury on magnetic resonance imaging (MRI) scans. We observed different morphologic variants in that portion of the study. Thus, the primary objective of this study was to provide a classification system to characterize these different morphologic variants of posterolateral tibial plateau impaction fractures. The secondary objective was to investigate the association between these impaction fracture variants and concomitant meniscal and ligament injuries. We hypothesized that posterolateral tibial plateau fractures occurring in the setting of primary ACL tear could be classified according to morphologic characteristics and that there would be increased incidence of concomitant meniscal or ligamentous injuries as the severity of the morphologic changes progressed.

METHODS

Study Design

This study was approved following review from an institutional review board (Vail Health, #2019-10). The inclusion criteria for this study were all patients with primary ACL tears treated by a single board-certified orthopaedic surgeon (R.F.L.) between April 2010 and March 2019. Inclusion criteria also required patients to have available MRI scans. Patients without MRI scans available were excluded from this study (n = 81). Of the 825 total knees meeting inclusion criteria, 805 underwent ACL reconstruction surgery whereas 20 did not. Demographic information and clinical information were recorded for all patients, and data from operative reports were recorded for all patients who underwent surgery. Diagnosis of meniscal tears in this study required arthroscopic confirmation.

Preoperative MRI scans were reviewed for the presence of displaced lateral tibial plateau fractures. First, a binary grouping system was used to categorize all patients based on whether they had a posterolateral tibial plateau impaction fracture. MRI signal change at the posterolateral tibial plateau was classified as an impaction fracture only if there was displacement of subchondral or cortical bone at the posterolateral tibial plateau rim visible on sagittal MRI T1-weighted images. Nondisplaced fractures or impaction injuries with bony contusion only were not considered an impaction fracture in this study. After all patients' MRI scans had been reviewed, those patients with posterolateral tibial plateau fractures were again reviewed, and a classification system was developed based on observed morphologic variants. There were 3 major categories of posterolateral tibial plateau impaction fractures observed, with an additional subcategory created for each of the latter 2 categories. Type I fractures were defined as posterior buckles of the proximal posterior cortex of the lateral tibial plateau, characterized by a superior to inferior deformity with no involvement of the articular surface **(Figures 1 and 2)**. Type II fractures were defined as posterior impaction fractures with involvement of the articular surface, resulting in a decreased lateral tibial plateau depth. These fractures demonstrate a rectangular or trapezoidal shaped bone void in the transition zone between the articular line (line *y*) and the line tangential to the posterior aspect of the lateral tibial plateau (line *z*), instead of a triangular shape in the transition zone between these lines in either a normal knee or a type I impaction fracture **(Figure 3)**. Type II fractures were further differentiated into 2 subcategories based on the amount of bone loss present, with type IIA fractures having less than

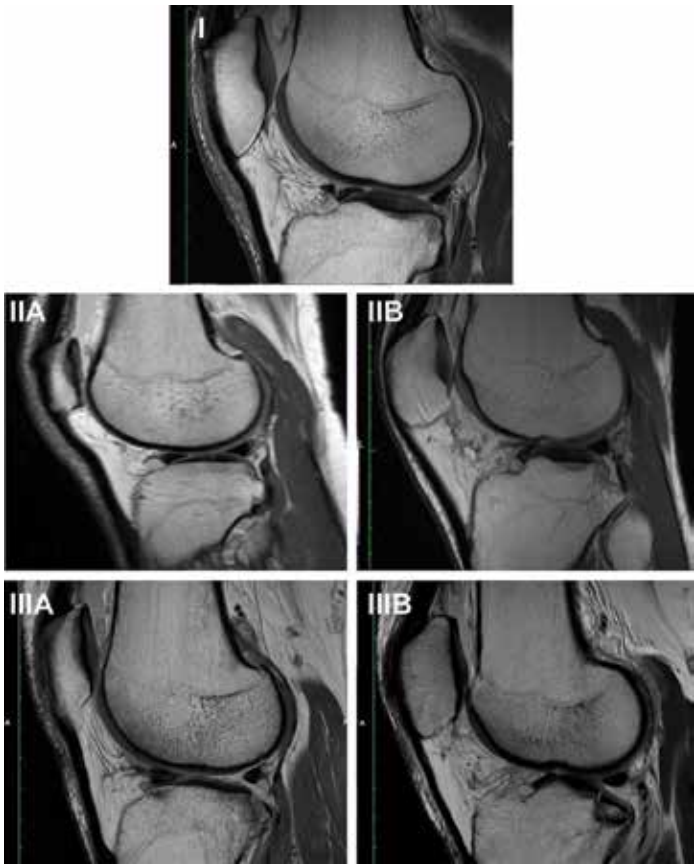

Figure 2: Sagittal magnetic resonance images showing sample posterolateral tibial plateau impaction fractures based on the classification system. See Figure 1 for fracture type definitions.

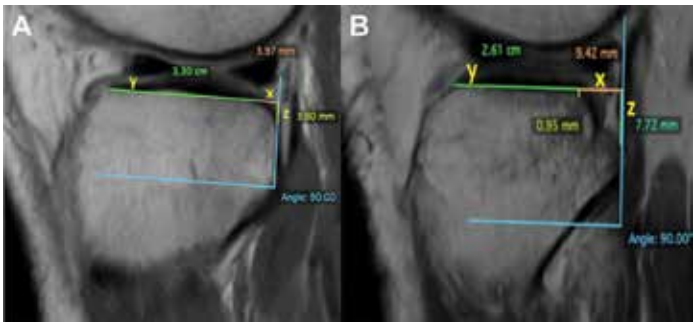

Figure 3: Measurement technique for tibial plateau impaction fracture in **(A)** a normal knee and **(B)** a knee with posterolateral tibial plateau impaction fracture. A sagittal magnetic resonance image demonstrates tibial plateau depth measurements in a control knee without an impaction fracture. Line y is drawn first along the subchondral bone from the anterior to posterior aspect of the articular surface. Next, line *x*, the posterior articular marginal distance, is drawn extending from the posterior extent of the articular surface to a line perpendicular to line *y* and placed as a tangent line along the posterior-most aspect of the proximal lateral tibia. Line *z*, the posterior height, is measured from the level of the articular surface to the level where bone is first contacted along the posterior tangent line. Posterior articular marginal percentage is calculated as $x/(x + y)$.

10% tibial plateau depth bone loss and type IIB having greater than 10% **(Figures 1 and 2)**. When we measured the amount of sagittal bone loss in all patients with tibial plateau impaction fractures, the mean percentage of corrected bone loss was 5.2% with a standard deviation of 5.1%. We chose 10% as a threshold as this represents 1 SD over the mean sagittal bone loss. Type III fractures were defined as impaction fractures resulting in a displaced bony fragment. Type III fractures were also further differentiated into 2 subcategories: shear fragments (IIIA) and depressed fragments (IIIB) **(Figures 1 and 2)**. All posterolateral tibial plateau fractures were classified according to this classification system by 2 orthopaedic surgeons (D.L.B., W.J.G.).

To differentiated type IIA and type IIB fractures, 2 fellowship-trained orthopaedic surgeons (D.L.B., M.D.C.) measured the amount of tibial plateau depth bone loss for all patients with type II posterolateral tibial plateau impaction fractures. This measurement was performed on the sagittal view of the MRI at the center of the lateral tibial plateau (eg, 50% of the calculated width) **(Figure 3)**. A modified Amis and Jakob line was drawn along the subchondral bone of the lateral tibial plateau from the anterior to posterior extents of the articular surface (line *y*). A line perpendicular to this line was then drawn vertically, lying tangent to the posterior aspect of the proximal lateral tibia (line *z*). The distance from the posterior-most aspect of line *y* to line z was represented by line *x* and was termed the posterior articular marginal distance. The posterior articular marginal

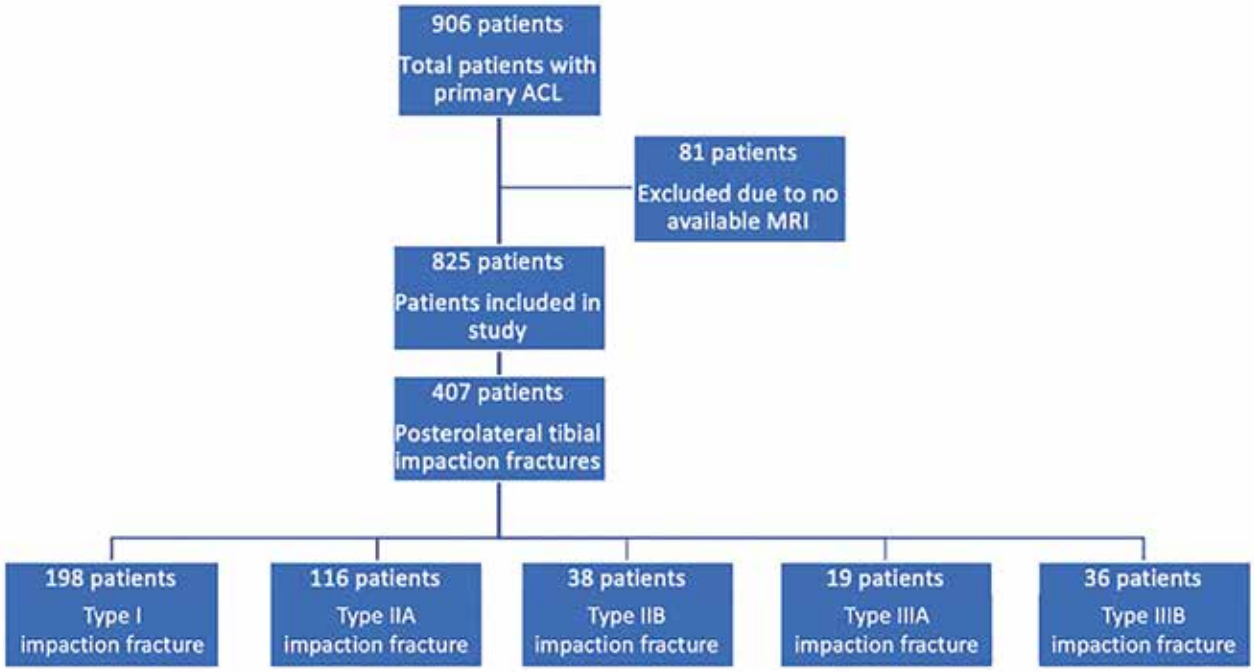

Figure 4: Flowchart demonstrating the number of patients meeting inclusion and exclusion criteria as well as the number of patients with posterolateral tibial impaction fractures and each specific fracture type. ACL, anterior cruciate ligament; MRI, magnetic resonance imaging.

		Age, y		
	n (%)	Mean ± SD	Minimum	Maximum
No fracture	418 (50.7)	30.5 ± 12.9	12.0	72.9
Type I	198 (24.0)	35.4 ± 13.0	12.9	73.4
Type IIA	116 (13.1)	43.2 ± 11.5	14.2	67.2
Type IIB	38 (4.6)	52.1 ± 9.6	33.8	72.0
Type IIIA	19 (2.3)	41.6 ± 14.4	18.3	73.6
Type IIIB	36 (4.4)	47.4 ± 14.2	17.6	72.4
Total	825	35.4 ± 14.2	11.2	73.6

Table 1: Number and Age of Patients With Different Types of Posterolateral Tibial Plateau Impaction Fractures

percentage was then calculated by dividing the posterior articular marginal distance by the sum of line *y* and line *x*. Tibial plateau depth bone loss was then calculated by subtracting the average posterior articular marginal percentage calculated in a subset of patients without posterolateral tibial impaction fractures from the calculated posterior articular marginal percentageineachpatient with an impaction fracture.

Statistical Analysis

Descriptive statistics were performed to determine the incidence of each type of posterolateral tibial plateau fracture based on our classification system. Clinical characteristics for patients with each type of posterolateral tibial plateau impaction fracture were analyzed to assess for correlations with meniscal tears, other ligament tears in addition to ACL tear, mechanism of injury, sex, and body mass index (BMI) through use of chi-square testing and analysis of variance with post hoc Tukey test to analyze associations with age and BMI. Given the differences in patient age by impaction fracture type, a binary logistic regression was performed with impaction fracture classification, age, and sex as the covariates and with specific types of meniscal tears and knee ligament injuries as the dependent variables. Odds ratios (ORs) with corresponding 95% CIs were calculated for significant associations determined by logistic regression. Measurement reliability between 2 raters was assessed via interrater correlation coefficients (ICCs) for the classification of posterolateral tibial plateau impaction fractures. Power analysis to determine sample size needed to detect an ICC of 0.6 for 2 observers with 80% power yielded a minimum of 15 patients needed. All statistical analysis was performed with IBM SPSS Statistical Suite, version 25, and the alpha level was set for statistical significance at $P < .05$.

	Female	Male	*P*
No fracture	181/418 (43.7)	237/418 (56.7)	**.007**
Type I	101/198 (51.0)	97/198 (48.9)	.28
Type IIA	71/116 (61.2)	45/116 (38.8)	**.002**
Type IIB	20/37 (54.0)	17/37 (46.0)	.45
Type IIIA	5/19 (26.3)	14/19 (73.7)	.06
Type IIIB	17/36 (47.2)	19/36 (52.8)	.93
Total	395/824 (48.0)	429/824 (52.0)	

[a]Values are expressed as n/N (%). Boldface indicates statistical significance.

Table 2: Independent Chi-Square Associations Between Sex and Posterolateral Tibial Plateau Impaction Fracture Type[a]

RESULTS

Of the 825 knees (814 patients) with primary ACL tears and available MRI scans, displaced posterolateral tibial plateau impaction fractures were identified in 407 knees (49.3%). After reviewing MRI scans of these knees, we classified 198 impaction fractures as type I (48.6%), 116 as type IIA (28.5%), 38 as type IIB (9.3%), 19 as type IIIA (4.7%), and 36 as type IIIB (8.8%). Interrater reliability was calculated for a subset of 60 impac-

	Contact	Noncontact	*P*
No fracture	108/410 (26.3)	302/410 (73.7)	**.001**
Type I	21/194 (10.8)	173/194 (89.2)	**.001**
Type IIA	13/111 (11.7)	98/111 (82.3)	**.02**
Type IIB	7/36 (19.4)	29/36 (80.6)	.95
Type IIIA	7/18 (38.9)	11/18 (61.1)	**.04**
Type IIIB	3/35 (8.6)	32/35 (91.4)	.09
Total[b]	160/805 (19.9)	645/805 (80.1)	

[a]Values are expressed as n/N (%). Boldface indicates statistical significance.

[b]Mechanism of injury data were not available for 20 patients; thus, these patients with missing data were excluded from the independent analysis.

Table 3: Independent Chi-Square Associations Between Mechanism of Injury and Posterolateral Tibial Plateau Impaction Fracture Type[a]

	Lateral Meniscal Tear		Lateral Meniscus Posterior Root Tear		Medial Meniscal Tear		Medial Meniscal Ramp Lesion		Medial Meniscus Posterior Root Tear	
	Incidence	*P*	Incidence	*P*	Incidence	*P*	Incidence	*P*	Incidence	*P*
No fracture	221/409 (54.0)	.06	51/406 (12.6)	.82	191/411 (46.5)	.28	66/410 (16.1)	**.05**	16/411 (3.9)	.65
Type I	110/194 (56.7)	.86	21/194 (10.8)	.34	90/194 (46.4)	.54	42/194 (21.6)	.23	2/194 (1.0)	.10
Type IIA	65/111 (58.6)	.77	13/112 (11.6)	.68	59/111 (53.2)	.27	22/111 (19.8)	.75	6/111 (5.4)	.27
Type IIB	22/37 (59.5)	.78	7/37 (18.9)	.26	19/37 (51.4)	.71	7/37 (18.9)	.98	3/36 (8.3)	.12
Type IIIA	15/18 (83.3)	**.02**	6/18 (33.3)	**.009**	9/18 (50.0)	.89	4/18 (22.2)	.70	0/18 (0)	.41
Type IIIB	28/35 (80.0)	**.005**	5/35 (14.2)	.79	21/35 (60.0)	.16	9/35 (25.7)	.28	1/35 (2.9)	.88

[a]Incidence is expressed as n/N (%). Boldface indicates statistical significance.

Table 4: Chi-Square Associations Between Posterolateral Tibial Plateau Impaction Fracture Type and Various Meniscal Injuries[a]

tion fractures classified by 2 different orthopaedic surgeons and demonstrated good agreement (ICC = 0.83) **(Figure 4)**.

Patients with posterolateral tibial plateau impaction fractures of all classification types were significantly older than patients without an impaction fracture ($P < .001$) **(Table 1)**. Furthermore, patients with either type IIB or type IIIB fractures were significantly older than patients with type I fractures ($P < .001$). No difference in the BMI was found between any impaction fracture group or patients without fracture ($P = .95$). Significant positive associations were seen between male sex and no impaction fracture and female sex and type IIA impaction fractures **(Table 2)**. Patients with any type of tibial impaction fracture were more likely to have a noncontact mechanism of injury compared with patients without impaction fracture ($P < .001$), and more specifically, patients with type I and type IIA fractures showed a higher incidence of non-contact mechanism ($P = .001$ and .02, respectively), whereas patients with type IIIA fractures showed a relatively higher incidence of contact mechanism compared to the other subgroups ($P = .04$) **(Table 3)**.

Significant associations were found between posterolateral tibial plateau impaction fracture type and certain meniscal injuries identified **(Table 4)**. No associations were found between type I or II impaction fractures and meniscal tears. Type IIIA impaction fractures showed an increased incidence of lateral meniscus posterior root tears (33.3% vs 12.4%; OR, 3.5; 95% CI, 1.3-9.7; $P = .009$) and an increased incidence of lateral meniscal tears (83.3% vs 56.7%; OR, 3.8; 95% CI, 1.1-13.3; $P = .024$) compared with knees without type IIIA impaction fracture. Type IIIB impaction fractures were associated with an increased incidence of lateral meniscal tears (80.0% vs 56.2%; OR, 3.1; 95% CI, 1.3-7.2; $P = .005$) compared with knees without type IIIB impaction fracture. We observed a decreased incidence of medial meniscal ramp lesions in patients without impaction fracture compared with all patients with impaction fractures (16.1% vs 21.5%; OR, 0.7; 95% CI, 0.40-1.0; $P = .05$). Given the statistically significant associations between age and sex with certain types of impaction fractures, a binary logistic regression was performed to compare meniscal tear type with impaction fracture classification, sex, and age. This showed significant associations between lateral meniscal tears and type IIIA (OR,4.1; 95% CI,1.2-14.5; $P = .03$) and type IIIB (OR, 3.7; 95% CI, 1.5-8.9; $P = .003$) impaction fractures in addition to male sex (OR, 1.7; 95% CI, 1.3-2.0; $P = .001$). For lateral meniscus posterior root tears, regression showed an association with type IIIA fractures (OR, 3.2; 95% CI, 1.1-8.9; $P = .03$).

Significant associations were found between posterolateral tibial plateau impaction fracture types and ligament tears in addition to the ACL **(Table 5)**. An increased incidence of MCL tears was seen in patients with type IIIA impaction fractures compared with those with no fracture or with other fracture type (61.1% vs 20.1%; OR, 5.9; 95% CI, 2.2-15.4; $P < .001$). Both type I and IIA fracture types showed decreased incidence of posterolateral corner (PLC) tears (1.5% vs 6.8%; $P = .005$, and 0.9% vs 6.3%; $P = .023$, respectively) compared with knees without type I and IIA impaction fracture, whereas type IIB showed a decreased incidence of fibular collateral ligament (FCL) tears (13.5% vs 29.4%; $P = .037$) compared with knees without type IIB impaction fracture. Binary logistic regression was performed to compare concomitant ligament tears with impaction fracture classification, sex, and age. This showed a significant association between type IIIA impaction frac-

	Medial Collateral Ligament Injury		Fibular Collateral Ligament Injury		Posterolateral Corner Injury		Posterior Cruciate Ligament InjuryW	
	Incidence	*P*	Incidence	*P*	Incidence	*P*	Incidence	*P*
No fracture	86/418 (20.6)	.31	135/418 (32.3)	**.02**	37/418 (8.9)	**.001**	37/418 (8.9)	**.001**
Type I	40/194 (20.6)	.59	51/194 (26.3)	.40	3/194 (1.5)	**.005**	6/194 (3.1)	**.05**
Type IIA	24/110 (21.8)	.96	31/110 (28.2)	.91	1/110 (0.9)	**.02**	2/110 (1.8)	**.05**
Type IIB	7/37 (18.9)	.64	5/37 (13.5)	**.04**	2/37 (5.4)	.97	1/37 (2.7)	.38
Type IIIA	11/18 (61.1)	**.001**	3/18 (16.7)	.26	0/18 (0)	.30	1/18 (5.6)	.93
Type IIIB	10/35 (28.6)	.34	8/35 (22.9)	.44	2/35 (5.7)	.96	2/35 (5.7)	.94

[a]Incidence is expressed as n/N (%). Boldface indicates statistical significance.

Table 5: Chi-Square Associations Between Posterolateral Tibial Plateau Impaction Fracture Type and Various Ligamentous Injuries[a]

ture and male sex and MCL tears (OR, 5.1; 95% CI, 1.9-14.0; $P = .001$, and OR, 1.6; 95% CI, 1.1-2.2; $P = .01$, respectively). A decreased correlation of type I and IIA impaction fractures was noted with both PLC tears (OR, 0.16; 95% CI, 0.05-0.53; $P = .003$, and OR, 0.09; 95% CI, 0.01-0.69; $P = .02$, respectively) and posterior cruciate ligament (PCL) tears (OR, 0.31; 95% CI, 0.13-0.75; $P = .01$, and OR, 0.17; 95% CI, 0.04-0.72; $P = .02$, respectively), while male sex showed increased association with PCL tear (OR, 2.2; 95% CI, 1.2-4.3; $P = .01$). No significant associations were seen with impaction fracture type, age, or sex with FCL tears ($P > .05$).

DISCUSSION

The main finding of this study was that distinct morphologic variants of posterolateral tibial plateau impaction fractures occur in the setting of ACL tears and that the type III variants (depressed osteochondral fractures) were both associated with an increased incidence of lateral meniscal tears in the setting of primary ACL tears. In particular, we found that both displaced shear (IIIA) and depressed fragment (IIIB) types of impaction fractures were associated with an increased incidence of lateral meniscal tears, with displaced shear fragment impaction fractures also associated with an increased incidence of lateral meniscus posterior root tears. Furthermore, when a grade III MCL tear is noted on clinical examination, there should be a heightened suspicion (5 times increased odds) for a posterolateral tibial plateau impaction fracture (type IIIA) on MRI.

The classification system established in this study has potential clinical utility because it demonstrates associations between certain posterolateral tibial impaction fracture types with concomitant meniscal and ligamentous injuries. Patients with type IIIA and IIIB fractures of the lateral tibial plateau had greater than 3 times increased chance of having a complete lateral meniscal tear compared with knees without type IIIA and IIIB impaction fracture. Type IIIA, depressed shear, osteochondral fractures also had a 3-fold increased odds of having a lateral meniscus posterior root tear compared with knees without type IIIA impaction fracture. As a result, when these fractures are identified on MRI, there should be a heightened clinical suspicion for lateral meniscal injury. This may be helpful in regard to clinical diagnosis, given the relatively high rate of missed lateral meniscal tears on MRI[2] and the difficulty with diagnosis of lateral meniscal root tears on MRI, as detection of these tears has a sensitivity of 60% on MRI.[5] Furthermore, when a type IIIA fracture is appreciated on MRI, the clinical suspicion for an MCL tear should be heightened, because we noted a 5 times increase in odds of complete grade III MCL tears in knees with type IIIA fractures. This classification system may also provide insight into the potential injury mechanism for some of the impaction fracture subtypes. We observed an increased incidence of a contact mechanism in patients with type IIIA fractures compared with other impaction fracture types, suggesting that this particular type of impaction fracture may occur less frequently with the typical pivot-shift mechanism compared with other impaction fracture types.

We did not find that type IIB fractures, posterior impaction fractures with greater than 10% bone loss, were associated with an increased incidence of any particular type of meniscal tear or concomitant ligament tearincomparisonwithpatients without these fractures. This does not necessarily mean that increasing bone loss associated with posterolateral tibial plateau impaction fractures is not of clinical significance. Previous studies have reported that lateral tibial plateau geometry af-

fects the stability of the knee. One study showed that decreased tibial plateau articular depth was associated with ACL tears, while another showed that a decreased medial to lateral width of the lateral plateau was associated with greater instability on pivot-shift testing.[7,14] Because our study does not include postoperative outcome data, we are unable to determine the potential effect that the increased tibial plateau bone loss seen in group IIB may have on postoperative stability or ACL graft failure, and further research is required to fully understand this potential effect.

This study has some limitations. This study was conducted with use of MRI rather than computed tomography (CT) scan. The use of CT scans could have afforded better detail of the fracture morphologic features and aided in characterizing fractures according to the proposed classification system. Nonetheless, our results demonstrated good interrater reliability with the proposed classification system using MRI, which also provides a more clinically applicable method for classification, as MRI is often the standard of care for evaluating ACL tears. Another limitation is that only 1 rater evaluated all MRI scans to identify the presence of an impaction fracture before development of the classification system, but establishment of criteria for fracture classification and detection of impaction fractures were done in consultation with the senior author (R.F.L.). Additionally, this study included only radiographic and operative data, which prevented us from being able to analyze the effect of different morphologic variants of posterolateral tibial plateau fractures on postoperative outcomes. As a result, this limits our ability to determine a more complete assessment of the clinical relevance of these posterolateral tibial plateau impaction fractures and whether additional measures should be considered to address these lesions when present. Future studies are needed to evaluate the biomechanical implications for such lesions on knee joint forces and stability in ACL-deficient and ACL-reconstructed knees.

CONCLUSION

We found a 49% prevalence of displaced posterolateral tibial plateau impaction fractures that occur in the setting of ACL tears and can be classified into distinct morphologic subtypes. Posterolateral tibial plateau impaction fractures with displaced depressed or shear fragments were both associated with an increased incidence of lateral meniscal tears, whereas impaction fractures with a shear fragment were associated with an increased incidence of lateral meniscus posterior root tears and MCL tears.

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Biomechanical Comparison of Docking Ulnar Collateral Ligament Reconstruction With and Without an Internal Brace*

ABSTRACT

Background: Current ulnar collateral ligament (UCL) reconstruction techniques are substantially less stiff and demonstrate lower load to failure compared with the native UCL. UCL repair with the addition of an internal brace has demonstrated superior biomechanical performance compared with docking UCL reconstruction, but internal bracing has not yet been used in UCL reconstruction.

Hypothesis/Purpose: To evaluate the time-zero biomechanical performance of a UCL docking technique reconstruction with and without an internal brace compared with native UCL properties. Methods: Twelve matched pairs of cadaveric elbows were dissected and fixed at 90° for biomechanical testing. A cyclic valgus torque protocol was used to test the anterior band of the UCL in native specimens. After native specimens were failed, palmaris grafts were used for a docking reconstruction with or without internal brace and were subjected to the same valgus torque test protocol. Torsional stiffness, ultimate failure torque, and ulnohumeral gapping were determined.

Results: Stiffness in UCL reconstructions using a standard docking technique (3.0 ± 0.4 N m/deg) were significantly less stiff ($P < .001$) than native UCL (4.0 ± 0.8 N m/deg), whereas reconstructions using an internal brace (3.6 ± 0.6 N m/deg) were not different ($P = .120$) compared with native. Ultimate failure torque for standard docking (18.3 ± 4.1 N m) was significantly lower ($P < .001$) than native UCL (36.9 ± 10.1 N m), whereas the internal brace samples (35.3 ± 9.8 N m) were not different ($P = .772$) than native.

Conclusion: UCL reconstruction with an internal brace augmentation provides superior stiffness and time-zero failure strength when compared with the standard docking technique.

Level of evidence: Basic Science Study; Biomechanics

Keywords: Elbow; UCL reconstruction; internal brace

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The following is a list of publications from our researchers from 2019.

FOOT AND ANKLE

- **Beahrs TR, Reagan J, Bettin CC, Grear BJ, Murphy GA, Richardson DR.** Smoking Effects in Foot and Ankle Surgery: An Evidence Based Review. Foot Ankle Int. 2019 Oct;40(10):1226-1232. doi: 10.1177/1071100719867942. Epub 2019 Aug 18. PMID: 31423824
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JOINT REPLACEMENT

- **Arnholt BC, Lowell JA, Perkins MR, Mihalko WM, Kurtz SM.** Postmortem Retrieval Analysis of Metallosis and Periprosthetic Tissue Metal Concentrations in Total Knee Arthroplasty. J Arthroplasty. 2019 Aug 19. pii:S0883-5403(19)30769-7. PMID: 31699531
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Thank you, Campbell Alumni

The Campbell Foundation wishes to thank the Alumni who supported our mission in 2019.

Thank you for making an impact!

Report from Alumni

Randy Davidson, M.D.

Campbell Club President

May, 2020

Dear Campbell Alumni,

Thank you for your continued support of the Campbell Foundation and sustaining its mission of resident education, orthopaedic research, and community healthcare outreach. Your gifts are vital and make the research activity that fills this issue of the Campbell Orthopaedic Journal a reality.

My, what an interesting few months that we have all experienced. During a typical March, we would have reconnected at Academy and celebrated old and new friendships at our Willis C. Campbell Club reception, but due to the pandemic our time together was cancelled. All of our practices across the country have been impacted, and certainly the future of orthopaedics will undergo changes in response to this experience.

On a positive note, as for the residency class of 2025, the Campbell Clinic has fully matched again this year. I'm excited to learn more about the 8 future WCC residents and see the impact that training at Campbell Clinic will have on the lives of these young physicians and their families.

Today's residents will need an increasing amount of academic information and access to the very best educational materials and conferences to respond to the changing orthopaedic environment.

As Campbell Alumni, it is our responsibility to sustain the Campbell tradition - and the Campbell Foundation needs our support now more than ever. Please consider a gift of financial support to the Campbell Foundation so that the next generation of orthopedic surgeons has every opportunity to excel in the future.

Your gifts strengthen the residency program and help provide these young surgeons with the resources and innovative technology essential for their orthopaedic training. Thank you for your continued support.

Sincerely,
Randy Davidson '99
Campbell Club President

Campbell Club In Memoriam

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CHAD E. CAMPION, M.D.
Hometown: LongValley, New Jersey

Undergraduate Institution: Stevens Institute of Technology

Medical School: Rutgers-New Jersey Medical School

Dr. Campion is the third of four brothers. He followed in the footsteps of his father, a general surgeon, to pursue a career in medicine. As a child, he loved helping his dad suture his and his brothers' childhood injuries at the kitchen table and also rounding with his father on the weekends.

Dr. Campion is engaged to Mary-Katherine, an attorney, whom he met through mutual friends.

Dr. Campion was injured playing lacrosse in college and required surgery on his shoulder. It was after his surgery that he decided to pursue a career in orthopaedics.

Plans After Campbell: Dr. Campion will complete a Spine Fellowship at Leatherman Spine in Louisville, Kentucky. He will then return to Campbell Clinic as a spine surgeon.

Dr. Campion adds, *"Thank you to the staff for an amazing education. It has been an honor to be a resident with the specialists of the 2020 class."*

RYAN B. EADS, M.D.
Hometown: Marysville, Kentucky

Undergraduate Institution: University of Kentucky

Medical School: University of Kentucky College of Medicine

Dr. Eads is the older of two children. He is the first in his family to choose medicine as a career, which happened as a result of suffering, in middle school, an achilles tendon injury that was operatively fixed. Later, during his senior year in high school, he shadowed his surgeon in the OR and clinic, paving his way to chose orthopaedics as his specialty.

Ryan met his wife, Jordan, during undergrad at the University of Kentucky, and they married in 2015. They have an eleven-month old named Jameson.

Plans After Campbell: Dr. Eads will complete a Sports Medicine Fellowship at the University of Pittsburgh.

Dr. Eads adds, *"Thanks to all the staff who have taken time out of their busy practice to educate us and to all my co-residents who have gone through this together, helping each other along and making every day memorable no matter what we went through."*

MATTHEW N. FOURNIER, M.D.
Hometown: Cheyenne, Wyoming

Undergraduate Institution: University of Wyoming

Medical School: University of Wyoming School of Medicine

Dr. Fournier is an only child and is the first in his family to pursue a medical career. He married his high school sweetheart, Abigail, an attorney, in 2011. They have two children, eighteen month old twins, Wynn and Clara.

Dr. Fournier chose medicine as a career because it provided an excellent way to use his passion for science. When asked why he chose orthopaedics as a specialty, he said "*because few other specialties allow such immediate gratification for both the patient and the physician as orthopaedics. For example, a patient debilitated by osteoarthritis can walk the next day after a total joint replacement. Giving a patient back their way of life is an incredible job.*"

Plans After Campbell: Dr. Fournier will complete a Sports medicine fellowship, then join a general practice in Laramie, Wyoming.

Dr. Fournier adds, "*To my fellow residents, thank you for the support, laughs and good times over the last five years. I wouldn't have made it through without you. To the staff, thank you for teaching me both the techniques of orthopaedic surgery and the art of taking care of patients. The Campbell Clinic provides a truly unique atmosphere in which to learn orthopaedics. To Mom and Dad: Thank you for your unwavering support through every step of this process. And to Abby: Thank you for being the rock that holds our family together.*"

PETER R. HENNING, M.D.
Hometown: Colgate, Wisconsin

Undergraduate Institution: Marquette University, Milwaukee, Wisconsin

Medical School: Medical College of Wisconsin, Milwaukee, Wisconsin

Dr. Henning is the older of two children. He follows in the footsteps of his mother, an occupational therapist, in choosing a career in medicine.

Dr. Henning is engaged to Sarah, a dietician at Regional One Health, and they planned to wed in May of this year. Unfortunately, due to COVID-19, they have postponed their ceremony until a later time. Dr. Henning does not yet have children, but he does consider his two dogs - Oliver and Darby - as well as two horses - Baloo and Smidgeon - as his family.

When asked why he chose medicine as a career: "*My mother got me interested in medicine. I originally planned to be a physical therapist, but she got me connected with an orthopaedic surgeon she worked with and it immediately clicked with me.*"

And why he chose orthopaedics as a specialty: "*As above. I began shadowing an excellent orthopaedic trauma surgeon in high school. I continued working with him up until 3rd year of medical school when he relocated. Working with him showed me what a positive impact I could have on people's lives by improving their musculoskeletal ailments.*"

Plans After Campbell: Dr. Henning will complete a Hand Fellowship at Indiana Hand to Shoulder Center in Indianapolis, Indiana.

Dr. Henning adds, *"I will be forever grateful for the people I have met here including faculty, staff, residents and fellows. You all have done more than just teach me how to be an orthopaedic surgeon, but you have given me a second home"*.

ANDREW M. HOLT, M.D.
Hometown: Knoxville, Tennessee

Undergraduate Institution: University of Tennessee

Medical School: Baylor College of Medicine

Dr. Holt is the oldest of three children and joins his sister, a nurse practitioner, in choosing a career in medicine. With a specialty in orthopaedics, he follows in the footsteps of his father, Dr. Michael Holt, an orthopaedic surgeon who graduated from Campbell Clinic residency in 1989.

Dr. Holt met his wife, Hilarie, an optometrist, in Memphis and they married in 2019

When asked why he made medicine his career choice, he said, "*Medicine is an ideal marriage of science, interpersonal skills, and technical prowess. I was drawn to the nature of the work and the opportunity to provide a service to my community. Seeing my father truly love his work only reinforced my decision.*" When asked about orthopaedics in particular, he responded, "*I immediately loved the physical and intuitive nature of orthopaedic surgery. The wide variety of patients and pathology kept work challenging. I especially enjoyed the opportunity to care for athletes and active individuals.*"

Plans After Campbell: Dr. Holt will complete a Sports Medicine Fellowship at Mississippi Sports Medicine & Orthopaedic Center and then join the sports medicine staff at Knoxville Orthopaedic Clinic.

Dr. Holt adds, "*Thank you to the Campbell Clinic family for the instruction, support, and friendship over the past five years. I consider myself immeasurably blessed to learn orthopaedics from such leaders in the field. To my fellow residents, thank you for your friendship during this journey. You always made work 'fun' and constantly pushed me to seek excellence in work and life.*"

CATHERINE R. OLINGER, M.D.
Hometown: Estes Park, Colorado

Undergraduate Institution: Creighton University

Medical School: Creighton University School of Medicine

When asked why she chose medicine as a career, Dr. Olinger explained, "*Since I was young, I dreamed of becoming a doctor. I have always had a passion to serve others and to heal. Medicine provides an opportunity for me to leave a lasting outcome that I can be proud of. The lifetime of learning, problem solving, patient interactions- these are all aspects that make Medicine incredibly fulfilling.*"

And why she chose orthopaedics: Orthopedics has given me an unforgettable experience of patient care that is unlike any other specialty. Treating broad aspects of healthcare such as private practice, service to uninsured populations, and management of patients from diverse backgrounds has been incredibly rewarding. My orthopedic education has empowered me to care for patients as a whole and to be mindful of all aspects of patient care. It is a profession that is surgically oriented, but at the same time provides the capacity to work and interact on a personal level with patients in the clinic. In the operating room, I experience an overwhelming rush of excitement for every procedure. Additionally, seeing the vast improvement in patients' conditions through follow-up is incredibly rewarding.

Plans After Campbell: Dr. Olinger will complete an Orthopedic Spine Fellowship at Harborview Medical Center in Seattle, Washington.

Dr. Olinger adds, "*Thank you to all the faculty and staff that have been critical to our education at the clinic. I especially want to thank everyone who has personally helped me during residency. Without the support of the Campbell Clinic staff, I would not have survived residency. Thank you to all the faculty who have shared their patients with us and for their understanding during our growth in becoming practicing surgeons. Thank you to the foundation staff who have made residency very rewarding and whom without I would not have been successful. Thank you to all my fellow residents who have been my brothers and sisters during our 5 years together. Thank you all for being there for Eddie and Husband Chad; especially teaching Eddie to hunt, spit, and live life like a good Tennessee boy should. I will always remember you all and cannot wait to continue to share stories for years to come.*"

ZACHARY K. PHARR, M.D.
Hometown: Nashville, Tennessee

Undergraduate Institution: Lipscomb University

Medical School: University of Tennessee Health Science Center

According to Dr. Pharr, he is the youngest and the wisest, of five children. He is also the first in his family to choose medicine as a career. He married his wife Kayla in 2011. They have two children, John Luke (3, going on 13), and Jane (1).

When asked why he chose to become a physician, he explained "*It was my hope to have a meaningful impact on people's lives combined with a natural inclination towards the sciences ultimately led me to pursue medicine.*"

When asked about orthopaedics in particular: "*Orthopaedics is incredible in that it allows one to use the skill of their hands to be a source of healing for patients with concrete pathology. It provides pain relief, deformity correction, and a pathway back to an active lifestyle.*"

Plans After Campbell: Dr. Pharr will complete a Sports Medicine Fellowship at American Sports Medicine Institute in Birmingham, AL and then join Mid-Tennessee Bone & Joint Clinic

Dr. Pharr adds, "*To the faculty, thank you for your patience, teaching, and willingness to allow me to assist in treating your patients. It has been an invaluable experience, and I owe you a great debt. To the residents, I wish you the best of luck. Continue to strive towards excellence in Orthopaedic care. Always guard your empathy and maintain a high standard for your patients. God bless.*"

CARSON M. RIDER, M.D.
Hometown: McKenzie, Tennessee

Undergraduate Institution: Union University at Jackson, Tennessee

Medical School: University of Tennessee Health Science Center

Dr. Rider is the oldest of four brothers. He was the first in his family to choose medicine as a career, however his brother Alex followed suit and is currently completing a residency in ophthalmology.

Dr. Rider met his wife, Jesse, a Women's Health Nurse Practitioner, when he was one of the "first responders" after she sustained a bad crush injury to her hand during college. They became friends shortly thereafter and married in 2014. They have two children, Hank and Ann Tipton.

When asked why he chose a medical career: "*I had originally planned to pursue a career in professional clay target shooting. For me, shooting was a very self-gratifying sport that came with tons of trophies, lots of traveling, and unfortunately significant hearing loss. I decided that I wanted a career that would allow me to make a greater impact on the lives of others. Medicine was a much more desirable field since it would allow me to devote my time and efforts into helping people in need.*"

And why he chose orthopaedics: "*Growing up in rural West Tennessee, I was always building things, taking them apart, and putting them back together again. As a very hands-on surgical subspecialty, Orthopaedic Surgery allows me to reconstruct and restore human anatomy to provide generally quick and satisfactory results to patients. The power tools are just the icing on the cake.*"

Plans After Campbell: Dr. Rider will complete a fellowship in Foot and Ankle Surgery at Hospital for Special Surgery in New York City. After fellowship, he will return to Memphis to join the Campbell Clinic foot team.

Dr. Rider adds: "*To my attending surgeons: I cannot thank you enough for all the of the time, patience, and teaching that you have poured into us. Our training at this program is top notch and it would not be the same without the outstanding staff surgeons that are truly devoted to resident education. I have learned so much from all of you, not only about Orthopaedics, but also about life. Thank you very much for all that you do for us and for your patients.*"

"I want to give a special thanks to the foot and ankle staff for guiding and mentoring me as I begin my career as a foot and ankle surgeon. I am excited to come back and work with such a phenomenal group of surgeons."

To my classmates: *"I could not have asked for a better residency class. We came from all over this great country, but we have become a close Memphis family over the last 5 years. I wouldn't trade anything for the times we have spent together. Thank y'all for always being there for me and I will miss each and every one of you.*"

To the Campbell Clinic Residents: "*The relationships that we have developed and the memories that we have made will last a lifetime. I have thoroughly enjoyed this journey with you and hopefully y'all have learned as a much from me as I have from you. Thank y'all for all of your hard work. Remember Dr. Azar's mantra: Faith, Family, Campbell Clinic. If you live this out as you progress through residency, you will be successful.*"

To my parents: *"I am where I am today because of you. Thank you for teaching me the importance of hard work and putting others first. I really appreciate all of your love and support.*"

To my wife: "*You are the real MVP. You have been extremely understanding and have sacrificed so much during my medical school and residency training. From the meals you make for us at the Med to the time you spend simply listening and talking after a long work day, you have been an outstanding life partner through all of this. Thank you for being there for me during the highs and the lows. There is no way I could have done this without you.*"

MICHAEL J. FLORACK, M.D.
Hometown: Gastonia, North Carolina

Undergraduate Institution: University of Notre Dame, South Bend, Indiana

Medical School: Tulane University School of Medicine, New Orleans, Louisiana

Orthopaedic Residency: Allegheny Health Network, Pittsburgh, Pennsylvania

Dr. Florack is the second eldest - and only male - of five children. He met his wife Katie while playing frisbee in college and they married in 2014. They have two children, Teresa (3) and Julie (1).

Dr. Florack's decision to choose medicine as a career came naturally as his father is an orthopaedic surgeon and his paternal grandfather is an OBGYN.

On why he chose medicine: "*I enjoy the application of science to real world function. I like the focus on helping individuals through team based dynamics."*

And orthopaedics in particular: "*Because I like to fix broken things with a capacity to heal. I want to restore function to people in a meaningful way. Post-op x-rays offer the opportunity to look at my work in a way I find personally rewarding."*

Plans After Campbell: Dr. Florack will join a community practice specializing in a mix of trauma and arthroplasty.

Dr. Florack adds, "*Thanks to Drs. Weinlein, Rudloff, and Beebe for their excellent mentorship this year, and to all of the CC residents for their tireless and diligent patient care at the Med.*"

ELIZABETH M. FRIEDMANN, M.D.
Hometown: Frederick, Maryland

Undergraduate Institution: University of Georgia, Athens, Georgia

Medical School: Virginia Tech Carilion School of Medicine, Roanoke, Virginia

Orthopaedic Residency: University of Maryland Medical Center, Baltimore, Maryland

Dr. Friedmann has an older sister and is the first in her family to pursue a career in medicine.

When asked about her decision to choose medicine as a career, she replied, "*I wanted to be in a field that was continually challenging, and one where I would be of service to my community.*"

And orthopaedics in particular: "*I have always enjoyed building and home improvement projects. I loved the physicality of orthopaedics and that we are able to create a measureable change for patients in the operating room."*

Plans After Campbell: Dr. Friedmann will join a practice in Annapolis, MD. as a foot & ankle specialist.

Dr. Florack adds, "*I am so grateful to have had the opportunity to work with great surgeons and mentors who are also fantastic people.*"

KARIM K. MAHMOUD, M.D.
Hometown: Alexandria, Egypt

Undergraduate Institution: Alexandria University, Alexandria, Egypt

Medical School: Alexandria College of Medicine, Alexandria, Egypt

Orthopaedic Residency: Hamad Medical Corporation, affiliated with Weill Cornell College of Medicine in Doha, Qatar

Dr. Mahmoud has one brother, and is the first in his family to choose medicine as a career. His wife, Youssra, is a physician and they met through mutual friends during the Alexandria-Egyptian Revolution. They married in 2012 and have a seven-year-old child, Yahia.

When asked why he chose a career in medicine, he explained, "*Once I had finished high school, I decided that I wanted to pursue studying medicine. I was interested in learning more about how I could save lives and help people feel better.*"

And about orthopaedics in particular, he said "*I had to join the Egyptian army for one year obligatory service, and that was one of the most important turning points in my life. I started my year with the eruption of the Egyptian revolution and I was dealing daily with a lot of emergency cases and severe injuries.*"

Plans After Campbell: Dr. Mahmoud will complete a Foot and Ankle Fellowship at Emory University.

Dr. Mahmoud adds, "*Thanks to all of the Campbell Clinic family for the wonderful year.*"

SIERRA G. PHILLIPS, M.D.
Hometown: Kennesaw, Georgia

Undergraduate Institution: University of Georgia, Athens, Georgia

Medical School: Medical College of Georgia, Augusta, Georgia

Orthopaedic Residency: University of Alabama at Birmingham, Birmingham, Alabama

Dr. Phillips is the second of three children and is the first in her family to choose medicine as a career. She met her husband Joel, a pharmacist, while playing soccer in high school and they married in 2014. They have a nine-month-old son, Andrew Delaney.

When asked why she chose a career in medicine, she replied, "*I remember accompanying my family members to doctor's visits when I was younger, and I was fascinated with how doctors could help make their patients better.*"

And when asked why she chose orthopaedics in particular, Dr. Phillips explained, "*It is fairly cliche, but I was an athlete and had several injuries in my youth requiring the attention of orthopaedic surgeons. My doctors became my mentors.*"

Plans After Campbell: Dr. Phillips has signed with orthopaedic group OrthoAtlanta in her hometown.

Dr. Phillips adds, "*Thank you to the faculty who have taken the time to teach and allowed me the privilege of working with them and their patients. Thank you to the staff for being so supportive! Thank you to residents and other fellows for being friendly and helpful both at work and outside of work.*"

MICHAEL L. SIMS, M.D.
Hometown: Columbus, Georgia

Undergraduate Institution: LaGrange College, LaGrange, Georgia

Medical School: Mercer University School of Medicine, Macon, Georgia

Orthopaedic Residency: Greenville Health System, Greenville, South Carolina

Dr. Sims is the oldest of three children and follows his father, a family practice physician, with a career in medicine. He met his wife Misty at church and they married in 2012. They have two children - Asa (6) and Vivian (3).

When asked why he chose a career in medicine, Dr. Sims explained, "*I enjoy talking with people, the personal interaction, and performing a job that is valued by my patients.*"

And when asked why he chose orthopaedics in particular, he replied "*I enjoy seeing people walk again.*"

Plans After Campbell: Dr. Sims is joining a practice as a Foot & Ankle specialist in Greenville, South Carolina.

Dr. Sims adds, "*Thank you to Drs. Richardson, Bettin, Murphy, and Grear for their patience with and confidence in me.*"

JESSICA M. WELTER, M.D.
Hometown: Longmont, Colorado

Undergraduate Institution: Colorado State University, Fort Collins, Colorado

Medical School: Touro University Nevada, Henderson, Nevada

Orthopaedic Residency: University Hospitals, Cleveland, Ohio

Dr. Welter is an only child and the first in her family to pursue a career as a physician. She met her husband Scott, a Production Control Manager, at Crossfit and they were just recently married. They have a daughter, Mia (1).

When asked why she chose a career in medicine, Dr. Welter replied, "*As long as I can remember I've wanted to be a doctor, I never saw myself as anything else.*"

And when asked why she chose orthopaedics in particular she explained, "*As orthopedists, we offer solutions and focus on improving quality of life for our patients. I think that is a cool and unique feature that separates us from many other specialties. Not to mention, it's fun!*"

Plans After Campbell: Dr. Welter will join a practice in Washington, MO, outside of St. Louis.

Dr. Phillips adds, "*This has been a great year, Campbell Clinic is an amazing institution with wonderful people at all levels. I can't thank my attendings and staff enough for the education and experience I've had this year. Overall, I'm very blessed to be here and thank you all for giving me this opportunity.*"

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Current Orthopaedic Residents

INTERNS

Tyler E. Calkins, M.D.
Undergraduate: West Virginia University
Medical School: West Virginia University School of Medicine

David W. Cooper, M.D.
Undergraduate: Tusculum College
Medical School: East Tennessee State University James H. Quillen College of Medicine

Zachary R. Diltz, M.D.
Undergraduate: The University of Alabama
Medical School: Ohio State University College of Medicine

Ilya M. Gutman, M.D.
Undergraduate: The University of Alabama
Medical School: University of Alabama School of Medicine

Claire E. Hays, M.D.
Undergraduate: Louisiana State University
Medical School: Louisiana State University School of Medicine

W. Colby Skinner, M.D.
Undergraduate: University of Georgia
Medical School: Medical College of Georgia at Augusta University

Carson J. Smith, M.D.
Undergraduate: University of Miami
Medical School: USF Health Morsani College of Medicine

Clayton W. Wing, M.D.
Undergraduate: University of Georgia
Medical School: Medical College of Georgia at Augusta University

CLINICAL YEAR 2

Seth R. Cope, M.D.
Undergraduate: Brigham Young University
Medical School: University of Texas School of Medicine at San Antonio

Austin Hardaway, M.D.
Undergraduate: The University of Alabama
Medical School: University of Tennessee Health Science Center College of Medicine

Hayden S. Holbrook, M.D.
Undergraduate: Wake Forest University
Medical School: Wake Forest School of Medicine

Caleb A. Jones, M.D.
Undergraduate: Tyler Junior College
Medical School: University of Texas School of Medicine at San Antonio

Anthony J. Marois, M.D.
Undergraduate: Wake Forest University
Medical School: Wake Forest School of Medicine

Zachary A. Mosher, M.D.
Undergraduate: Auburn University
Medical School: University of Alabama School of Medicine – Huntsville

Daniel J. Smigielski, M.D.
Undergraduate: University of Alabama
Medical School: University of Tennessee Health Science Center College of Medicine

Eric D. Villereal, M.D.
Undergraduate: University of Mississippi
Medical School: University of Tennessee Health Science Center College of Medicine

Current Orthopaedic Residents

CLINICAL YEAR 3

Nathaniel B. Alexander, M.D.
Undergraduate: University of Arkansas
Medical School: University of Arkansas for Medical Sciences College of Medicine

Stephanie N. Chen, M.D.
Undergraduate: Case Western Reserve University
Medical School: University of Toledo College of Medicine

Travis B. Eason, M.D.
Undergraduate: North Carolina State University
Medical School: Brody School of Medicine at East Carolina University

Richard A. Hillesheim, M.D.
Undergraduate: Washington University in St. Louis
Medical School: Sidney Kimmel Medical College at Thomas Jefferson University

Austin B. Murphy, M.D.
Undergraduate: Samford University
Medical School: University of Alabama School of Medicine

David L. Parker, M.D.
Undergraduate: Brigham Young University
Medical School: University of North Dakota School of Medicine and Health Sciences

Naveen Pattisapu, M.D.
Undergraduate: University of Texas at Austin
Medical School: Baylor College of Medicine

Devon Tobey, M.D.
Undergraduate: University of Georgia
Medical School: Mercer University School of Medicine

CLINICAL YEAR 4

J. Stephen Chambers, M.D.
Undergraduate: Georgia Institute of Technology
Medical School: Mercer University School of Medicine-Savannah

Joseph T. Cline, M.D.
Undergraduate: Davidson College
Medical School: University of North Carolina at Chapel Hill School of Medicine

Parker P. Duncan, M.D.
Undergraduate: University of Memphis
Medical School: University of Tennessee Health Science Center College of Medicine

Charles T. Fryberger, III, M.D.
Undergraduate: Auburn University
Medical School: University of Alabama School of Medicine

Matt 'Jejo' Mathew, M.D.
Undergraduate: University of Kansas
Medical School: University of Kansas School of Medicine

S. Gray McClatchy, M.D.
Undergraduate: Mississippi State University
Medical School: University of Arkansas for Medical Sciences College of Medicine

Trenton T. Stevens, M.D.
Undergraduate: University of North Carolina at Chapel Hill
Medical School: University of Tennessee Health Science Center College of Medicine

Carson D. Strickland, M.D.
Undergraduate: University of Georgia
Medical School: Mercer University School of Medicine-Savannah

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The most common adverse events related to EUFLEXXA injections reported in 12- and 26-week clinical studies were arthralgia, back pain, pain in extremity, musculoskeletal pain, and joint swelling. In an open-label extension of the 26-week clinical study with repeat series of injections, the most common adverse events related to EUFLEXXA at Week 52 were arthralgia and joint swelling.

Please see Brief Summary of full Prescribing Information on adjacent column.

REFERENCES: 1. EUFLEXXA [package insert]. Parsippany, NJ: Ferring Pharmaceuticals Inc. **2.** Kirchner M, Marshall D. A double-blind randomized controlled trial comparing alternate forms of high molecular weight hyaluronan for the treatment of osteoarthritis of the knee. Osteoarthritis Cartilage. 2006;14(2):154-162. **3.** Altman RD, Rosen JE, Bloch DA, et al. A double-blind, randomized, saline-controlled study of the efficacy and safety of EUFLEXXA for treatment of painful osteoarthritis of the knee, with an open-label safety extension (the FLEXX Trial). Semin Arthritis Rheum. 2009;39(1):I-9.

BRIEF SUMMARY Please consult package insert for full Prescribing Information.

INDICATION
EUFLEXXA® (1% sodium hyaluronate) is indicated for the treatment of pain in osteoarthritis (OA) of the knee in patients who have failed to respond adequately to conservative non-pharmacologic therapy and simple analgesics (e.g., acetaminophen).

CONTRAINDICATIONS
- Do not use EUFLEXXA® to treat patients who have a known hypersensitivity to hyaluronan preparations.
- Do not use EUFLEXXA® to treat patients with knee joint infections, infections or skin disease in the area of the injection site.

WARNINGS
- Mixing of quaternary ammonium salts such as benzalkonium chloride with hyaluronan solutions results in formation of a precipitate.

  EUFLEXXA® should not be administered through a needle previously used with medical solutions containing benzalkonium chloride. Do not use disinfectants for skin preparation that contain quaternary ammonium salts.
- Do not inject intravascularly because intravascular injection may cause systemic adverse events.

PRECAUTIONS

General
- Patients having repeated exposure to EUFLEXXA® have the potential for an immune response; however, this has not been assessed in humans.
- Safety and effectiveness of injection in conjunction with other intra-articular injectables, or into joints other than the knee has not been established.
- Remove any joint effusion before injecting.
- Transient pain or swelling of the injected joint may occur after intra-articular injection with EUFLEXXA®.
- Do not use after expiration date.
- Protect from light.
- Do not re-use—dispose of the syringe after use.
- Do not use if the blister package is opened or damaged.

Information for Patients
- Transient pain and/or swelling of the injected joint may occur after intra-articular injection of EUFLEXXA®.
- As with any invasive joint procedure, it is recommended that the patient avoid any strenuous activities or prolonged (i.e., more than 1 hour) weight-bearing activities such as jogging or tennis within 48 hours following intra-articular injection.
- The safety of repeated treatment cycles of EUFLEXXA® has been established up to 1 year.

Use in Specific Populations
- **Pregnancy:** The safety and effectiveness of EUFLEXXA® have not been established in pregnant women.
- **Nursing Mothers:** It is not known if EUFLEXXA® is excreted in human milk. The safety and effectiveness of EUFLEXXA® have not been established in lactating women.
- **Children:** The safety and effectiveness of EUFLEXXA® have not been demonstrated in children.

ADVERSE REACTIONS
Adverse event information regarding the use of EUFLEXXA® as a treatment for pain in OA of the knee was available from two sources; a 12 week multicenter clinical trial conducted in Germany, and a 26 week multicenter trial conducted in the U.S.

Report Device-Related Adverse Events
The most common adverse events related to EUFLEXXA® injections reported in the clinical studies are arthralgia, back pain, pain in extremity, musculoskeletal pain and joint swelling.

Potential Adverse Events
Potential adverse events that may occur in association with intra-articular injections are arthralgia, joint swelling, joint effusion, injection site pain and arthritis.

12 Week Multicenter Clinical Study
In a prospective randomized, double blinded, active control (commercially available hyaluronan product) study conducted at 10 centers. Three hundred twenty-one patients were randomized into groups of equal size to receive either EUFLEXXA® (n=160) or the active control (n=161). A total of 119 patients reported 196 adverse events; this number represents 54 (33.8%) of the EUFLEXXA® group and 65 (44.4%) of the active control group. There were no deaths reported during the study. Incidences of each event were similar for both groups, except for knee joint effusion, which was reported by 9 patients in the active control group and one patient in the EUFLEXXA® treatment group. A total of 160 patients received 478 injections of EUFLEXXA®. There were 27 reported adverse events considered to be related to EUFLEXXA® injections: arthralgia – 11 (6.9%); back pain – 1 (0.63%); blood pressure increase – 3 (1.88%); joint effusion – 1 (0.63%); joint swelling – 3 (1.88%); nausea – 1 (0.63%); paresthesia – 2 (1.25%); feeling of sickness of injection – 3 (1.88%); skin irritation – 1 (0.63%); tenderness in study knee – 1 (0.63%). Four adverse events were reported for the EUFLEXXA® group that the relationship to treatment was considered to be unknown: fatigue – 3 (1.88%); nausea – 1 (0.63%).

26 Week Multicenter Study
In a multicenter, randomized, double-blind trial evaluating the efficacy and safety of EUFLEXXA® as compared with saline, in subjects with chronic osteoarthritis of the knee followed by an open labeled safety extension study. The intervention consisted of three (3) weekly injections of study device into the target knee, with scheduled follow-up evaluations during the 26 weeks following the first injection. In the extension phase subjects received three (3) weekly injections of EUFLEXXA® into the target knee with follow-up evaluation up to 52 weeks. Twenty-three serious TEAEs were reported in 19 (3.2%) subjects during the study: 10 (3.4%) subjects in the EUFLEXXA® group and 9 (3.1%) subjects in the saline group. One of these events was considered related to the study device (increased redness of the left knee joint in the EUFLEXXA® group). Eight (1.4%) subjects had 9 TEAEs leading to discontinuation: 3 (1.0%) subjects in the EUFLEXXA® group and 5 (1.7%) subjects in the saline group. Twelve (2.8%) subjects reported 20 TEAEs during the extension phase. Six of these subjects had received EUFLEXXA® during the core study. None of these serious TEAEs was considered related to the study device, and all resolved. Two (0.5%) subjects has TEAEs leading to discontinuation from the study, one of whom received EUFLEXXA® during the core study; both subjects had events that were considered unrelated to study device.

This product is not made with natural rubber latex.

See EUFLEXXA® DIRECTIONS FOR USE

For more information, go to www.euflexxa.com.

To report SUSPECTED ADVERSE REACTIONS, contact FERRING PHARMACEUTICALS Inc. at 1-888-FERRING (1-888-337-7464) or FDA at 1-800-FDA-1088 or www.fda.gov/medwatch.

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Summary of Indications for Use for DUROLANE: is indicated for the treatment of pain in osteoarthritis (OA) of the knee in patients who have failed to respond adequately to conservative non-pharmacological therapy or simple analgesics, e.g. acetaminophen.

Do not inject DUROLANE in patients with knee joint infections, skin diseases, or other infections in the area of the injection site. Do not administer to patients with known hypersensitivity or allergy to sodium hyaluronate preparations. Risks can include transient pain or swelling at the injection site.

DUROLANE has not been tested in pregnant or lactating women, or children. Full prescribing information can be found in product labeling, at www.DUROLANE.com, or by contacting Bioventus Customer Service at 800-836-4080.

Summary of Indications for Use for GELSYN-3: is indicated for the treatment of pain in osteoarthritis (OA) of the knee in patients who have failed to respond adequately to conservative non-pharmacologic therapy and simple analgesics (e.g., acetaminophen). Do not administer to patients with known hypersensitivity (allergy) to sodium hyaluronate preparations. Do not inject GELSYN-3 into the knees of patients having knee joint infections or skin diseases or infections in the area of the injection site.

GELSYN-3 is not approved for pregnant or nursing women, or children. Risks can include general knee pain, warmth and redness or pain at the injection site. Full prescribing information can be found in product labeling, at www.GELSYN3.com or by contacting Customer Service at 800-836-4080.

Summary of Indications for Use for SUPARTZ FX: is indicated for treatment of pain in osteoarthritis (OA) of the knee in patients who have failed to respond adequately to conservative non-pharmacologic therapy and simple analgesics, e.g., acetaminophen. You should not use SUPARTZ FX if you have infections or skin diseases at the injection site or allergies to poultry products. SUPARTZ FX is not approved for pregnant or nursing women, or children. Risks can include general knee pain, warmth and redness or pain at the injection site.

Full prescribing information can be found at www.SupartzFX.com or by contacting Customer Service at 800-836-4080.

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