



**Department of Orthopaedic Surgery and
Rehabilitation**

Wake Forest School of Medicine

**33rd Annual Gary Poehling, MD
Resident Research Day**

**4th Beth Smith, PhD and Tom Smith, PhD
Visiting Professor**

Bruce A. Levy, MD

June 28, 2024



Atrium Health
Wake Forest Baptist



Wake Forest University
School of Medicine

The Department of Orthopaedic Surgery Resident Research Day and Visiting Professor is a yearly event where PGY5, PGY3, PGY2 Podiatry, and Physician Scientists highlight their research through podium presentations. Monetary awards are given to the top basic science, top clinical, and top podiatry research projects. Recipients are selected based on the overall evaluation of their research project and scored by the Visiting Professor.

The Visiting Professor highlights the event with presentations that provide insight on the technical aspects of their research and advising residents on how to transition from residency to fellowships to a faculty position. The Visiting Professor is an esteemed colleague in an orthopaedic specialty. This year's Visiting Professor is an expert in Sports Medicine and invited by Dr. Brian Waterman Professor of Orthopaedic Surgery.

Bruce A. Levy, MD

4th Beth Smith, PhD and Tom Smith, PhD Visiting Professor



Dr. Bruce A. Levy was born and raised in Montreal, Quebec, Canada and received his medical degree from the University of Montreal. He then completed his Orthopedic Surgery Residency at the Mayo Clinic in Rochester, Minnesota and an Orthopedic Sports Medicine Fellowship at the Minneapolis Sports Medicine Center in Minnesota. Dr. Levy spent most of his surgical career at the Mayo Clinic in Rochester, Minnesota where he held the rank of Professor of Orthopedic Surgery and was the past Program Director for the Mayo Clinic Orthopedic Sports Medicine Fellowship. He recently joined the Orlando Health Jewett Orthopedic Institute where he now serves as the Academic Chief of Sports Medicine and Director of the Sports Medicine Surgical Fellowship. Since completing his training in 1999, Dr. Levy's clinical and research interests have focused largely on complex knee trauma with a particular emphasis on knee dislocation and multi-ligament knee reconstruction.

Dr. Levy is an investigator in several multi-center trials funded by the NIH and Department of Defense. He is on the editorial board for several journals, served on the Board of Trustees for the Journal Arthroscopy and was the Sports Medicine Deputy Editor for Clinical Orthopaedics and Related Research. Dr. Levy is a member of the Herodicus Society, a consultant for the NBA and NHL Players Associations and has served as a team physician for the US Snowboard Team. Dr. Levy has published over 300 peer-reviewed papers in scientific literature.

Gary G. Poehling, M.D.

Dr. Gary G. Poehling received a B.S. degree from Marquette University in 1964 and his M.D. degree from Marquette School of Medicine in 1968. He completed an internship and residency in general and thoracic surgery at Duke Medical Center from 1968-1970. He served in the United States Air Force from 1970-1972 at the 655th Tactical Hospital in Tachikawa, Japan. After fulfilling his military duty, Dr. Poehling completed his orthopaedic residency at Duke Medical Center from 1972-1976, serving as Chief Resident his final year. He subsequently joined the faculty of Bowman Gray School of Medicine, now Wake Forest University School of Medicine, and Department of Orthopaedic Surgery as an Assistant Professor. Dr. Poehling served as Interim Chair of the Department in January 1989 and was formally appointed as Chair in October 1989 and served in that capacity for 18 years and served as Editor in Chief for the Journal of Arthroscopy for 24 years.



Dr. Poehling has over 43 years of experience as an orthopaedic surgeon. He pioneered the use of arthroscopy and was influential in defining various procedures that can be performed arthroscopically. Together with James Roth, MD and Terry Whipple, MD, Dr. Poehling pioneered the use of wrist arthroscopy in 1985. Dr. Poehling also was one of the first orthopaedic surgeons to use arthroscopic operative techniques in the elbow. Dr. Poehling has also served as a proponent for the development and use of minimally invasive surgical techniques. As an academic surgeon he has promoted the application of computer technology for training residents and medical students. He has championed the importance of orthopaedic outcome studies and evidence-based medicine.



Beth Smith, PhD and Thomas Smith, PhD

Beth Smith earned her PhD in Toxicology from Texas A&M in 1974. She completed post-doctoral work at Wake Forest School of Medicine in 1978 with Richard St. Clair, PhD. Dr. Smith began her career at Wake Forest School of Medicine in 1987 in the Department of Orthopaedic Surgery as a Research Assistant. Her research interests were botulinum toxin to treat cerebral palsy. Her work using intramuscular toxin injections to manage muscle spasticity changed the management of pediatric patients with cerebral palsy worldwide. Dr. Smith published journal articles, book chapters, and books throughout her career. During her tenure, she was the Director of the Orthopaedic Research Lab, Coordinator of the Spasticity Management Workshops, served as Chair of the Division of Surgical Sciences Research Day from 1993-1997, and Chair of the Department of Orthopaedic Surgery Resident Research Day from 1991 until her retirement in 2018.

Thomas Smith earned his PhD in Physiology from Bowman Gray School of Medicine in 1979. He completed post-doctoral work at the University of Mississippi School of Medicine with Thomas Coleman, PhD and Arthur C. Guyton, PhD. Dr. Smith served as an Assistant Professor in the Department of Physiology and Biophysics at the University of Mississippi School of Medicine from 1980-1982. He began his career at Wake Forest School of Medicine as an Instructor in the Department of Physiology and Pharmacology in 1978, achieving the rank of Assistant Professor in 1982. Dr. Smith joined the Department of Orthopaedic Surgery in 1996 working diligently to improve orthopaedic research until his retirement in 2020. He is an expert in small animal models and microsurgery training. The models he developed are now a resource for the IACUC and multiple collaborators across the institution. His expertise in cardiovascular physiology and applications for orthopaedic research helped establish the Extremity Lab, advanced techniques for re-implantation, and assessment of compartment syndrome. He collaborated with Walt Curl, MD, and Nicole Deal to determine the action mechanism of cold therapy for treatment of contusions. Dr. Smith published journal articles, book chapters, and books throughout her career.

Beth Smith, PhD, and Tom Smith, PhD, have many collaborative accomplishments during their tenure in the Department of Orthopaedic Surgery at Wake Forest University. They were responsible for the growth of industry and grant funding for the lab. With this additional funding, the lab was able to grow the support personnel to facilitate the research interests of the department's faculty and residents. Current personnel comprise 4 research faculty, 3 management level staff, and 10 grants, lab, and project coordinator staff members. The Smiths were instrumental in the establishment and success of the Physician Scientists program starting in 1999. The program has resulted in patents, publications, Physician Scientist training, numerous awards, and the establishment of an orthopaedic research lab at Wake Forest School of Medicine that continues to thrive and grow.

- Patents: 3 awarded; 3 pending
- Book Chapters: 38
- Peer reviewed journal articles: 240
- Grant Funding (PI or Co-I): \$19,150,068

Physician Scientists:

- 10 have completed their PhD at Wake Forest University; 12 currently serves as faculty at Medical Schools
- 5 Pending PhDs

Awards

- Koman L, Smith B, Li Z, Smith T. Kappa Delta Award for Clinical Research in Microvascular Physiology. Orthopaedic Research and Education Foundation. American Association of Orthopaedic Surgeons. 1999.
- Koman L, Smith B, Smith T. Kappa Delta Award for Clinical Research in Translational Uses of Botulinum Toxins. Orthopaedic Research and Education Foundation. American Association of Orthopaedic Surgeons. 2019
- Co-authors for 3rd, 4th, and 7th most frequently cited article from the Journal of Pediatric Orthopaedics
- Co-authors for top 100 classic papers of pediatric orthopaedic Surgery in JBJS (19th, 21st, and 30th most frequently cited)

**Thirty-Third Annual Gary Poehling, M.D. Resident Research Day
June 28, 2024**

Fourth Annual Beth Smith, PhD and Tom Smith, PhD Visiting Professor

Bruce A. Levy, MD
Chief, Academic Sports Medicine
Director, Sports Medicine Surgical Fellowship
Orlando Health Jewett Orthopedic Institute
Orlando, FL

- 8:00 Welcome
Cynthia Emory, MD
Professor and Chair of Orthopaedic Surgery and Rehabilitation
- 8:05 Visiting Professor Introduction
Brian Waterman, MD
- 8:10 Multi-ligament Knee Injuries: How Evidence Based Medicine Guides Treatment
Bruce A. Levy, MD

Emcee: Ikey Gwam, MD (PGY4)

PGY3 – Orthopaedic Residents:

- 9:00 Kyle A. Lynch, MD
9:10 Edward Beck, MD, MPH
9:20 Jeffery St. Jeor, MD
9:30 Taylor Wood, MD
9:40 Jack Teasdall, MD

9:50 Discussion

10:00 **BREAK**

Physician Scientists:

- 10:15 Marcel Brown, MD
10:25 Ayobami Ogunsola, MBBS, MPH

10:35 Discussion

PGY2 - Podiatry Residents

- 10:45 Justin Waller, DPM
10:55 Jennifer Kipp, DPM
11:05 Devon Niewohner, DPM

11:15 Discussion

11:30 **Lunch**

- 12:30 Beyond Fellowship: Lessons Learned
Bruce A. Levy, MD

PGY5 – Orthopaedic Residents

- 1:30 Anirudh K. Gowd, MD
1:40 Nick Andring, MD
1:50 Evan Miller, MD
2:00 Matthew Akelman, MD
2:10 Sam Rosas, MD, PhD, MBA
- 2:20 Discussion
- 2:30 Podiatry Award Winner Presentation
- 2:40 **CONCLUSION OF RESIDENT RESEARCH DAY**

Analgesic Use in Ankle Fracture Reduction

Kyle Lynch, MD, Jeffery St. Jeor, MD, Caleb Puckett, Elizabeth Zieser-Misenheimer
Aaron Scott, MD

Introduction: Achieving adequate analgesia during orthopaedic procedures following an orthopaedic trauma remains a difficult task, with many modalities currently in use. One of the most common painful procedures performed acutely in the emergency department is the reduction of bimalleolar or trimalleolar ankle fractures. Frequently, reduction is performed under a hematoma analgesic block along with opioid or opioid analogue medications. Unfortunately, patients often report that these procedures are still painful despite these methods. There is also a significant number of patients who report symptoms of post-traumatic stress disorder owing to their orthopaedic injuries, which may also be related to an additional perceived trauma that occurs during their fracture reduction in the initial post-injury period. Recently, the use of ketamine, an NMDA receptor antagonist frequently used as a dissociative analgesic, has gained popularity when used in sub-sedative doses as it has been shown to be safe and effective and offers an adjunct to traditional opioid medications without the risks and healthcare burden of a procedural sedation. Interestingly, there is some evidence that the use of ketamine in combat settings as an analgesic lowers the incidence of PTSD in the first-year following a combat injury. To our knowledge, the psychological outcomes of ketamine use as an analgesic for fracture reduction have not been studied. Our objective is to report on the effect of ketamine in sub-sedative doses versus traditional opioid analgesia when used during ankle fracture reduction, as well as on baseline characteristics of analgesic use within our study cohort.

Methods: A retrospective chart review was conducted utilizing ICD9 and ICD10 codes for bimalleolar and trimalleolar ankle fractures treated at Atrium Health Wake Forest Baptist emergency department (ED) from 2021 – March 2024. Patients were included if they were older than 18, the orthopaedic surgery department was consulted in the ED, and a reduction was performed in the ED. Patients were excluded for: open injuries, ICU admission, other long bone fractures, intubated or otherwise sedated polytrauma patients. Chart review of demographics and information regarding the emergency department encounter was then performed. Included patients were then contacted via telephone and asked questions regarding their experience as well as screened for post-traumatic stress disorder (PTSD) using the PC-PTSD-5 screening tool. Statistical analysis was then performed.

Results: Following query of appropriate ICD9/ICD10 codes, a total of 437 patients were identified, of these, 28 met inclusion criteria for the study. Patients had a mean age of 54 years, 16 were female, 12 were male, the mean BMI was 30.8 (SD 9.2). 24 received a hematoma block, 4 did not. 11 were discharged from the ED and 17 were admitted inpatient. Three patients received ketamine in analgesic doses, ranging from 0.12mg/kg – 0.22 mg/kg. Regression analysis showed no significant correlation between sex, BMI, hematoma block, or discharge from the ED and the morphine milliequivalents (MME) each patient received during their care. Of the factors collected, only age was significantly correlated with MME amount, with older patients being likely to receive a lower dose ($R = -0.77$, $p = 0.003$). No patients showed adverse reactions to their analgesic regimen.

Conclusion: Age is correlated with the dose of opioid analgesic use during care encounters for ankle fracture reduction in the ED. More information is needed in order to adequately study the effect of alternative analgesics such as ketamine when used during orthopaedic procedural encounters.

Blood Flow Restriction Therapy Following Acute Shoulder Injury Patients: Assessment of Efficacy in Return to Activity

Edward C. Beck, MD, MPH

Committee Members: Tracy Criswell, PhD, Kerry Danelson, PhD, Kristen Nicholson, PhD, Brian Waterman, MD

Introduction: Upper extremity injuries are a detriment to the careers of athletes at all playing levels, particularly overhead throwing athletes. A common reason that both athletes non-athletes have difficulties returning to activity following treatment is due to atrophy in the affected limb. Recent studies have evaluated the effect of blood flow restriction (BFR) therapy on attenuating muscle atrophy, but most have evaluated its effects on rehabilitation of lower extremity injuries. Furthermore, the mechanism of action on muscle atrophy, as well as effect on pathologies proximal to the BFR tourniquet is largely unknown. As such, the purpose of this randomized control trial was to 1) determine whether patients with non-surgical rotator cuff and biceps tendinopathy undergoing BFR rehabilitation show increased improvements in shoulder function relative to patients undergoing routine therapy with a tourniquet that is not occluding arterial blood (i.e. sham BFR), and 2) determine whether trends in blood biomarker concentration differ between both groups throughout the rehabilitation protocol.

Methods: A total of 12 patients with non-surgical rotator cuff or biceps tendon pathology will be enrolled in a pilot study and randomly assigned to either the BFR or sham BFR group. Patients in both groups will undergo physical therapy for approximately 6 weeks. Prior to beginning rehabilitation, baseline muscle cross sectional area (CSA) of both supraspinatus and infraspinatus muscle bellies will be measured and internal/external rotation strength of the injured shoulder will be evaluated. Baseline functional scores, as well as blood draws will be performed prior to beginning therapy. Repeat blood draws and strength measurements will be performed halfway through therapy. Once the rehabilitation protocol is completed, muscle CSA, muscle strength, blood draws, and functional score assessment will be repeated. Blood biomarkers (GH, IL-6, IGF-1) at all 3 time points will be assessed using Eliza assays once all patients have been tested. Statistical analysis will be performed comparing the change in CSA, strength, biomarkers, and functional scores over time.

Results (Anticipated): A total of 12 patients in the pilot study will be assigned to either group. Based on the available literature, it is anticipated that patients in the BFR group will have an average of 20-30% improvement in muscle CSA compared to approximately 5% improvement in the sham BFR group. Additionally we anticipate that there will be an average improvement of 15-20% in strength in the BFR group versus 1-5% in the sham BFR group. While studies have demonstrated increases in IL-6, GH, and IGF-1 shortly after low weight exercises with BFR, none have evaluated trends over the duration of therapy. However, we anticipate higher concentrations of each over time in the BFR group as compared to the sham BFR group.

Conclusion: This study will determine whether BFR therapy can improve outcomes of injuries proximal to the tourniquet and provide greater understanding of mechanism. The results of this study may have an impact on rehab for overhead throwing athletes with shoulder injuries, as well as other subspecialties in orthopedic surgery, and other medical specialties (PM&R, ICU, geriatric medicine).

The Effect of Knee Rotation Angle on Patellofemoral Instability

Jeffery D. St. Jeor, MD
Nicholas A. Trasolini, MD

Introduction: A lateralized tibial tubercle, as often measured by tibial tubercle–trochlear groove (TT-TG) distance, is a risk factor for patellofemoral instability (PI) and influences surgical management. TT-TG has been shown to be a function of both tibial tubercle position and rotation of the tibia relative to the femur, or knee rotation angle (KRA). However, the role of KRA in PI, as well as its utility in surgical decision making, remains a topic of investigation. The purpose of this study was to determine if a threshold value of KRA could be identified as an independent risk factor for PI. The secondary aim of this study was to identify whether KRA is influenced by factors such as knee flexion angle (KFA).

Methods: A retrospective review was conducted of patients with PI who underwent medial patellofemoral ligament reconstruction (MPFLr) at a single institution between 2018 and 2023. A comparison group was patients who underwent isolated partial meniscectomy (IPM) during that same period. Parameters of interest were TT-TG, KRA, and KFA measured on MRI. Data analysis of patient factors and demographics, along with MRI measurements, was completed with SAS Viya (Cary, NC); significance was $\alpha < 0.05$.

Results: 122 patients who underwent MPFLr (73 female, 49 male; mean age 21.1 [± 9.8] years) and 96 patients who underwent IPM (47 female, 49 male; mean age 38 [± 17.6] years) were identified. The average TT-TG for MPFLr and IPM was found to be significantly different at 15.3mm (± 5.4) and 11.4mm (± 3.5) respectively ($p < 0.001$). The average KRA for MPFLr and IPM was also found to be significantly different at 5.9° (± 4.1) and 4.7° (± 2.8) respectively ($p = 0.018$). There was no significant difference seen in KFA between the MPFLr and IPM groups ($p = 0.39$). Examining the relationship of TT-TG and KRA, via linear regression, revealed a positive correlation. For every 1mm increase in TT-TG, KRA increased by 0.20° ($p = 0.034$). The relationship of KRA and KFA was also examined using linear regression but no significant correlation was seen ($p = 0.41$). When examining MPFLr vs IPM via logistic regression, both KRA and TT-TG were significantly associated with MPFLr ($p = 0.034$ and $p < 0.001$ respectively). Additionally, female gender was also significantly associated with MPFLr ($p = 0.009$). Age was significantly associated with MPFLr, for every one year decrease in patient age they were 0.1 times more likely to undergo MPFLr ($p < 0.001$). Further analysis, via decision tree, demonstrated that a $KRA > 8.07^\circ$ and $TT-TG > 15\text{mm}$ had a specificity of 76% and 85% respectively. Additionally, a binary analysis at these values was significantly correlated with MPFLr ($p = 0.001$ KRA and $p < 0.001$ TT-TG).

Conclusion: The results of the study demonstrated that KRA is associated with PI even when controlling for TT-TG. Additionally, $KRA > 8.07^\circ$ may be an independent risk factor for the development of instability. Furthermore, the KRA does not appear to be affected by KFA making it a reliable prognostic factor for PI.

Clinical Outcomes and Complications Comparing Closure of Common Hand Procedures with Nylon and Monocryl: A Retrospective Review

Taylor R. Wood, MD; Victor E. Greco, MD; Matthew St. John, MD; Elizabeth K. Zieser-Misenheimer, BS, MBA; Lauren D. Hostettler, BS; Emily Chang, BA; Garrett Bullock, PhD, DPT; Bowen Qiu, MD; Benjamin R. Graves, MD; Zhongyu Li, MD, PhD

Introduction: Wound dehiscence is the most common complication with common hand surgeries, occurring both with absorbable and non-absorbable suture. This study aimed to compare clinical outcomes of the use of monocryl versus nylon suture for closure in commonly performed hand procedures, focusing on post-operative infection and wound dehiscence requiring antibiotics or re-operation.

Methods: A retrospective review was performed for patients who underwent carpal tunnel release, trigger finger release, De Quervain's release, and cubital tunnel release from 2020-2023. Patients were excluded if they had previous surgery on the operative area or if they had procedures other than the above being performed simultaneously. Basic demographics were collected, including age, gender, BMI, smoking status, and diabetes, as well as any wound complications that resulted in dehiscence, antibiotic prescription, and re-operation at two and six weeks post-operatively.

Results: 1,927 procedures were performed on patients who met inclusion criteria. Average age was 59.1 years old, BMI 32.4, 64% female, 12% current smokers, and 30% diabetic. Prevalence and incidence of wound complications were calculated through the Clopper-Pearson method (prevalence monocryl: 5%, 95% CI: 3, 8; prevalence nylon: 7%, 95% CI: 6, 8; incidence monocryl at two weeks: 3%, 95% CI: 2, 5 and six weeks: 2%, 95% CI: 1, 5; incidence nylon at two weeks: 5%, 95% CI: 4, 7 and six weeks: 2%, 95% CI: 1, 3). There were no differences in risk of post operative complications between monocryl and nylon suture use (Risk Difference -0.02 (95% CI: -0.04, 0.01)).

Conclusion: There was no risk difference or differences in prevalence or incidence of post operative wound complications with the use of nylon versus monocryl for closure at two and six weeks post operatively following common hand procedures. Surgeon preference may continue to guide the use of absorbable versus nonabsorbable sutures for these procedures in the future.

Surgical Approach was Independently Associated with Size of Acetabular Cup Used

Robert J. Teasdall, MD, Samuel Rosas, MD, PhD, MBA, Matthew S. Gwilt, MS, Ayobami S. Ogunsoola, MD, MPH, Alexis M. Cooper, MD, Maxwell K. Langfitt, MD, Molly S. Hartzler, MD, John S. Shields, MD
John S. Shields, MD

Introduction: Revision hip arthroplasties are on the rise. Successful revision, among many variables, depends on adequate acetabular bone stock and bone preservation. This led our group to question whether surgical approach affected the amount of bone reamed in primary total hip arthroplasty (THA) with the diagnosis of primary hip osteoarthritis. The anterior approach (AA), compared with the posterior approach (PA), integrates fluoroscopy, allowing surgeons radiographic feedback on amount of bone reamed during cup placement. We hypothesized that this would lead to less reaming, and therefore a smaller cup size with more acetabular bone stock.

Methods: A retrospective review of THAs performed at our institution by three fellowship-trained arthroplasty surgeons beyond their first two years of practice was performed. We examined cup size, approach, demographics, and a cup-to-templated head size ratio with marker ball magnified x-rays. This later ratio was used as a proxy for bone reaming. Normality was first examined, and testing conducted with t-tests and Mann-Whitney U tests based on parametricity. Alpha was set at $p < 0.05$. Statistical analysis was performed by a different team member than the femoral head measuring team to avoid bias.

Results: Data from 2020-2023 included 78 posterior and 78 anterior THA patients. Demographics demonstrated no statistically significant difference in the age, gender, height, weight, BMI, Charlson Comorbidity Index, or femoral head size template ($p > 0.05$ for all) between either approach. Nonetheless, acetabular cups were bigger with the PA (mean 53.15 mm (SD 3.76) vs 51.03 mm (SD 2.65), $p < 0.001$) and there was a greater cup-to-head ratio, 1.15 vs 1.10 ($p < 0.001$). Multiple regression demonstrated that variables independently predictive of cup size utilized were approach used and femoral head size ($p < 0.001$ for both).

Conclusion: Surgical approach impacts implant size selection in THA, which correlates to amount of acetabular bone reamed, which may be greatly influenced by fluoroscopy use at the time of AA-THA. The average cup size for the AA was 2.12 mm smaller than cups used for the PA. The average cup size for the AA was 4.64 mm larger than the measured femoral head size compared to the PA which had an average cup size 6.73 mm larger. Patients who undergo PA-THA are more likely to receive larger acetabular cups and have a greater cup-to-head ratio compared to AA-THA, which correlates to more acetabular bone loss.

In-Vitro & Ex-Vivo Effects of Amniotic Fluid Stem Cell Conditioned Media for Treating Primary Knee OA

Marcel Brown, MD, Matthew Gwilt, BS, MS, Brianna Vaghela, Ila Kacker, Leslie Granados, BA, Xue Ma MD, PhD
Xue Ma MD, PhD

Introduction: Osteoarthritis (OA) of the knee is a chronic disease with limited treatment options and remains the most prevalent joint disorder in the United States. Amniotic Fluid Stem Cell Conditioned Media (AFSC-CM) is an acellular preparation that isolates the placental-derived cytokines and growth factors released into growth medium and can act as a biological treatment for OA.

Methods: Human knee articular cartilage samples (n=4) were collected following total knee arthroplasty. Porcine cartilage (n=4) was collected from same day pig necropsies. Human and porcine chondrocytes were cultured in 10% Fetal Bovine Serum (FBS) and once 20% confluent, were treated with a one-time dose of AFSC-CM with either low dose (LD=3mg/ml) or high dose (HD=10mg/ml) AFSC-CM. Articular cartilage explants (n=4 human, n=4 porcine) were collected and treated after 48 hours in 1% mini ITS with a one-time dose of AFSC-CM at LD and HD. Explants were then cultured for 6 days, with timed collection of media for assessment of glycosaminoglycan (GAG) release every 48 hours.

Results: Human chondrocytes showed increased proliferation in the HD treated group in comparison to control and IL-1 at every measured time point through day 6. Increased proliferation was appreciated in porcine cells with both LD and HD AFSC-CM treatment in comparison to control and IL-1 at day 4 and day 6. GAG release was decreased in both human and porcine cartilage when treated with AFSC-CM in comparison to IL-1 after 48 hours.

Conclusion: One-time treatment of human end-stage OA chondrocytes with AFSC-CM showed increased cell proliferation and viability over time, findings which were replicated in a similar dose-response manner in healthy control porcine samples. These anabolic effects of AFSC-CM on both diseased and healthy cartilage suggest that as a therapeutic, AFSC-CM can be effective both early and late in OA disease progression. Further, mitigation of GAG release with AFSC-CM treatment in chondrocyte explants suggests its possible role in preventing catabolic degradation of the extracellular matrix (ECM) in OA.

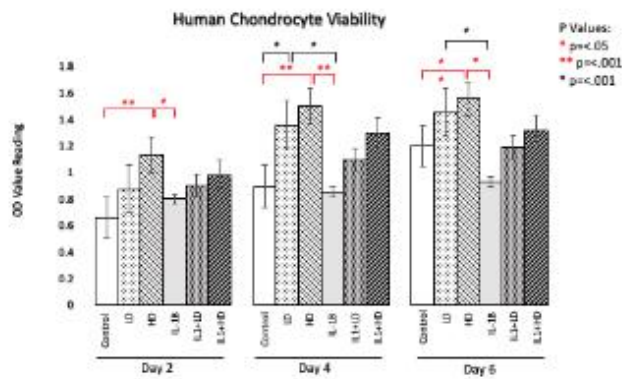


Figure 1: Human Chondrocyte proliferation post treatment (n=4). Seeded at density of 10,000 cells/well. Significance between treatment, IL-1 β , and control groups displayed by asterisk.

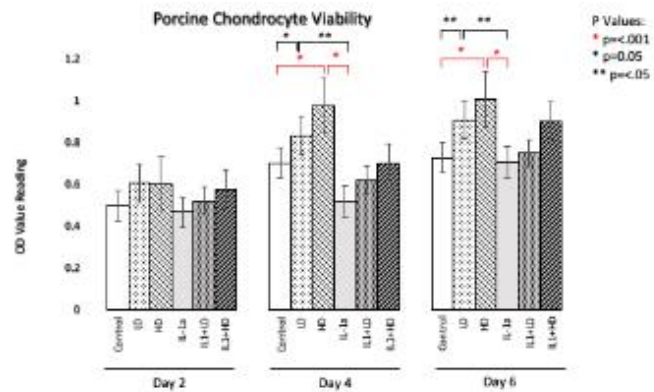


Figure 2: Porcine Chondrocyte proliferation post treatment (n=4). Seeded at density of 5,000 cells/well. Significance between treatment, IL-1, and control groups displayed by asterisk.

The Effect of Charlson Comorbidity Index, Race and Surgical Complications on Postoperative Knee Function after Total Knee Arthroplasty

Ayobami S. Ogunsola, MD, MPH; Marcel G. Brown, MD; and Davis Brady, BA
Xue Ma, PhD

Introduction: Osteoarthritis (OA) is a degenerative joint disease that affects approximately 240 million people worldwide with knee OA being the most predominant form. The prevalence of OA is increasing globally, representing an enormous health and economic burden. Total Knee Arthroplasty (TKA) is the definitive treatment; however, it is associated with complications, necessitating revision and frequent follow-up. The Knee Injury and Osteoarthritis Outcome Score (KOOS, JR) is a validated instrument for assessing knee function over time. This study aimed to evaluate the effect of TKA on knee functional outcomes, as measured by the KOOS, JR over time, to identify factors associated with changes.

Methods: This retrospective longitudinal study included patients who underwent TKA at an outpatient surgical center at Wake Forest University Medical Center Since 2021. Participant demographics, preoperative range of motion, and comorbidities were obtained. In addition, the KOOS scores were recorded before surgery, 4-6 months, and 1 year postoperatively. The Charlson Comorbidity Index (CCI) score was also recorded for each patient. Based on the CCI score, patients were stratified into low-(< 2), moderate (2-4), and high-risk (> 4) groups. Various postoperative complications were reported as an aggregate variable “Complications.” A generalized linear mixed effect model was fitted to the data, modeling KOOS, Jr scores as a function of time and other independent variables.

Results: The study sample size was 444, and the majority of subjects were females (n = 260; 58.76%) and non-Hispanic Whites (n = 364; 81.89%). Of the study participants, 78.83% had a moderate risk according to the CCI score category (CCI scores: 2 -4) while 6.31% were classified as having a high risk prior to TKA. Among the study participants, 22.52% developed one or more post-TKA complications. The fitted model showed significant time-dependent improvements in KOOS, Jr scores (Figure 1). Patients experienced an average increase of 18.12 points (95% CI: 16.42, 19.81) at 4-6 months postoperatively and 26.05 points (95% CI: 24.35, 27.75) at one year postoperatively relative to preoperative scores (p = 0.0001). Moreover, the presence of postoperative complications was associated with a statistically significant decrease in the KOOS, JR scores, with an average decline of 3.47 points. Conversely, patients who were at high risk prior to surgery had a significant increase in the KOOS scores by 6.40 points (p = 0.0207). African American experienced a significant decrease in KOOS, JR scores, with an average decline of 3.47 points (p = 0.0035).

Conclusion: This study found significant improvements in knee function after TKA, but the presence of complications negatively affected knee function. High-risk patients (CCI > 4) had better functional recovery, which may be due to better preoperative optimization and greater improvement relative to their baseline KOOS JR. score. This study shows that TKA can improve knee functional outcomes, as measured by KOOS, JR scores, and emphasizes the importance of pre-surgical optimization of patients with comorbidities for complication prevention. Further investigation is warranted to identify and address racial differences seen in knee functional outcome score post TKA.

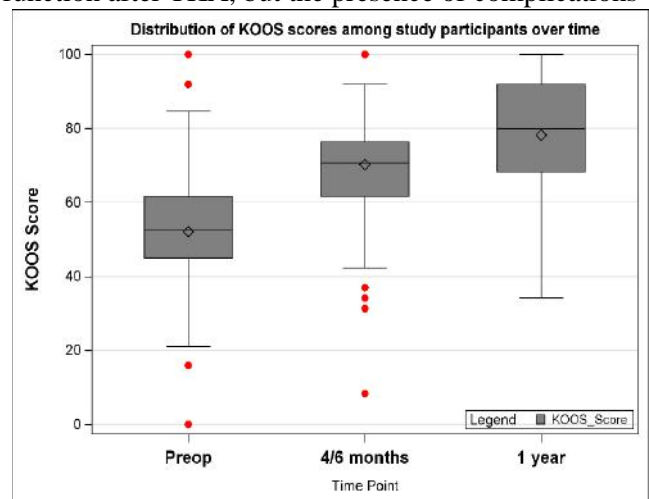


Figure 1: Distribution of KOOS, JR Scores among Study Participants

Comparison Analysis of Healing and Complication Outcomes Following Transmetatarsal Amputation with utilization of polypropylene, nylon, staple sutures.

Justin J. Waller, DPM, Alec Wroblewski, DPM
Paula Gangopadhyay, DPM

Introduction: Transmetatarsal amputations have been widely utilized as a limb salvage procedure for complications such as gangrene and diabetic foot infections. While this procedure can certainly provide patients with an opportunity for limb salvage, the literature regarding risks or benefits when undergoing direct comparison for this form of amputation has revealed limited data. We report a study that investigates rates of infection as well as wound dehiscence with use of nylon, prolene, and staples.

Methods: Retrospective study of patients that have undergone transmetatarsal amputations over a 9-year period from 2013-2022 at our institution; Atrium Wake Forest Baptist Medical Center. 230 patients were initially reviewed; however 135 patients were ultimately included. Medical records were reviewed in Epic EMR system to ascertain the various types of suture or closure materials that were utilized for the transmetatarsal amputation site. Imaging in the form of radiographic plain films were reviewed to confirm amputation level. P-values were calculated using a Fisher's Exact Test, t-tests, and Wilcoxon.

Results: Overall, 135 transmetatarsal (TMA) amputations were included in the study. A multitude of variables/comorbidities were reviewed in this study including BMI, diagnosis of peripheral arterial disease, diabetes. Patient medical records were also reviewed for presence of deep wound closure, which ultimately was not the focus of the study, and transition from TMA to a proximal limb amputation. In this study, we discovered that 71/135 (52%) went on to develop wound dehiscence to the amputation site. It was noted that 11/135 (8.14%) went on to develop wound infections. Of the 71 patients that developed wound dehiscence following initial surgery, 6 (8%) of patients were closed with prolene, 50 (70%) were closed with nylon, 13 (18%) were closed with staples. 11 patients total developed an infection (minor/major) which either resolved or went on to be converted into a proximal amputation. Of these patients, 1 (9%) of patients were closed with prolene, 6 (55%) were closed with nylon, 1 (9%) were closed with staples. The remaining patient population contained a combination of suture types. 21% of this total patient population went on to undergo proximal limb amputation. In regard to wound dehiscence and infection, logistic regression was performed for direct comparison between nylon, prolene, and staples to determine statistical significance as it pertains to rate of development of those respective variables. Wound dehiscence yielded an overall P-value of 0.36. Regarding infection, the p-value was 0.78.

Conclusion: We report a study that investigates the association of infection as well as wound dehiscence with use of nylon, prolene, and staples. When investigating wound dehiscence, it was determined that there is no statistically significant difference when using either nylon, prolene, or staples, as there was an overall P-value of 0.36. When investigating the development of infection, it was determined that there is no statistically significant difference when using either nylon, prolene, or staples as there was an overall p-value is 0.78. Therefore, we conclude that there are no significant differences regarding association with wound dehiscence or infection when using these 3 closure types for transmetatarsal amputation.

Diabetic Osteomyelitis: Oral vs Intravenous Antibiotics at a Single Level 1 Academic Medical Trauma Center

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Introduction: Residual osteomyelitis is a frequent problem following surgical intervention for diabetic foot infection. The current Infectious Disease Society of America guidelines recommend 4-6 weeks of initial intravenous antibiotics for treatment of residual osteomyelitis. However, recent literature suggests oral antibiotic therapy is not inferior to intravenous therapy.

Methods: The primary aim of this study was to evaluate treatment success in 128 patients receiving oral versus intravenous antibiotics for residual osteomyelitis in the diabetic foot after amputation at a Level 1 academic medical trauma center. Treatment success was defined as completion of at least 4 weeks of antibiotic therapy, complete surgical wound healing, and no residual infection requiring further debridement or amputation within one year of the initial surgery. Patients with peripheral arterial disease were excluded.

Results: A retrospective chart review was performed, and we found no statistically significant difference in treatment success between these two groups ($p=0.28$). Median time to healing for oral antibiotic treatment was 3.17 months compared to 4.06 months for intravenous treatment ($p=0.10$). Furthermore, there was no significant difference in group demographics or comorbidities, aside from more patients in the intravenous group having coronary artery disease ($p=0.04$). Type of closure and type of microbial infection was also not associated with a difference in outcomes between the two treatment arms.

Conclusion: The results of the present study suggest oral antibiotics for treatment of residual osteomyelitis are not inferior to intravenous therapy and may be more efficacious for certain patients regarding cost and ease of administration.

Soft Tissue Procedures for Hallux rigidus

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Introduction: Hallux rigidus and functional hallux limitus affect numerous people and contribute to limited motion of the first MTPJ and increased pain. Bony procedures, including cheilectomy and first MTPJ arthrodesis, have been the mainstay of treatment for this condition. These procedures can significantly limit the motion of the first MTPJ or lead to further surgeries in the future.

Methods: In this study, we sought to investigate the efficacy of soft tissue procedures in treating hallux rigidus. Specifically, we examined the changes in motion before and after the flexor hallucis longus (FHL) distal transection to the first MTPJ. This procedure was performed on 11 non-embalmed cadaveric specimens, and the range of motion was measured both before and after the transection.

Results: Data analysis showed a statistically significant (p-value of 0.0003) improvement of ROM from pre- and post-transection of the FHL distal to the first MTPJ. The average increase in ROM of the first MTPJ was 11.5 degrees.

Conclusion: The findings of this study underscore the potential of soft tissue procedures as a complementary approach to bony procedures, particularly for patients seeking alternatives to arthrodesis. Further exploration of more proximal soft tissue procedures could yield valuable insights into the extent of ROM changes.

Machine Learning Prediction of Health Care Admissions Costs Following Select Orthopedic Procedures

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Introduction: Supervised Machine Learning (SML) is becoming increasingly utilized within the field of Orthopedic Surgery for uses such as predictive modeling, image analysis, and outcomes research. With growing pressures to increase cost efficiency, SML may be used to help predict cost of admission and readmissions after orthopedic procedures.

Methods: The following orthopedic procedures were selected for study: anterior cervical discectomy and fusion (ACDF), open treatment of hip fractures, and total shoulder arthroplasty. The Nationwide Readmissions Database (NRD) was accessed in 2018. The database was queried for all primary procedures by International Classification of Diseases (ICD-9) codes. Costs were calculated by utilizing the total hospital charge and each hospital's cost-to-charge ratio. Unplanned readmissions within 90 days were calculated using unique patient identifiers. Hospital characteristics, including annual volume of procedures performed, size, region, and differences in wage were incorporated into the model in addition to patient demographics, diagnoses, and comorbidities. Training and testing data subsets were created for each procedure and model performance was determined by receiver operating characteristic, area under the curve (ROC-AUC). Machine learning algorithms were used to predict patients with immediate postoperative admission costs greater than the fourth quartile of total cost. Factors associated with high cost were determined.

Results: Within the combined dataset, 42,485 cases of ACDF, 63,494 cases of hip fractures, and 49,354 cases of TSA were separately studied. Total admissions costs were \$26,977 +/- 28,947, \$23,439.6 ± 19,250.4, and \$13,871 ± 14,301.06, respectively. SML models using logistic regression were top performing for TSA (AUC=0.83) and gradient boosting trees for ACDF (AUC=0.86) and hip fractures (AUC=0.88). Wage index, representative of regional differences in hospital workers' income, was the highest weighted variable in all three datasets. For ACDF, diagnosis severity, annual volume of procedures performed, and readmissions were the next weighted variables. For hip fractures, readmissions, age, and annual volume of procedures were the next weighted. Lastly, for TSA, annual volume of procedures, readmissions, and diagnosis severity were the next weighted.

Conclusion: SLM is successful in providing accurate models of healthcare expenditure for ACDF, open treatment of hip fracture, and TSA. Broadly, regional and patient health largely drive cost, but there is heavy influence on hospital volume and readmission rates.

Photodynamic Bone Stabilization For Geriatric Femur Fractures

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Introduction: The photodynamic bone stabilization device (PBSD) implant IlluminOss has gained attraction for the percutaneous and intramedullary application in geriatric fracture care. Early applications have mostly been in non-weight bearing upper extremity injuries with relative success, but minimal lower extremity applications have been described. In the current study we review our experience augmenting geriatric femur fractures using the PBSD implant.

Methods: This was a retrospective case series at a single level 1 academic trauma center. Patients were >65 years old sustaining periprosthetic or distal femur fractures treated with lateral locking plate and intramedullary PBSD augmentation with at least 6 months of radiographic follow up. Our main outcome measures were all cause reoperation rate, radiographic union scale of the tibia (RUST) extrapolated to femur fractures, and complications.

Results: Seventeen patients with an average age of 79.0 +/- 9.5 years with average follow up of 7.3 +/- 4.2 months were included. There were six interprosthetic, six distal periprosthetic, four proximal periprosthetic (Vancouver C), and one supracondylar femur fractures. Nine patients were immediately weight bearing versus eight who were non-weight bearing secondary to concomitant injuries, intra-articular extension, or other fracture characteristics. At three months the average RUST score was 7.8 +/- 2.3 which progressed to 10.7 +/- 2.2 at final follow up. There was one reoperation for a superficial hematoma.

Conclusion: PBSD augmented femur fractures have the potential for high union rate with low complication profile related to the PBSD implant. This study demonstrated PBSD augmentation to be an effective alternative option in difficult peri-implant geriatric femur fractures.

Late-week Multilevel Anterior Cervical Discectomy and Fusion Associated with Increased Length of Stay

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Introduction: Surgeries later in the week may result in longer LOS and higher costs for joint arthroplasty, yet this is unclear following spine surgery. Procedures performed later in the week may lead to weekend admissions when there are limited services that may contribute to an extended LOS. We attempt to identify associations between day of surgery and LOS, readmission, and complications following single- and multilevel ACDF. The objective of the present study was to assess the day of surgery during the week as a possible predictor of length of stay (LOS) following anterior cervical discectomy and fusion (ACDF).

Methods: Patients at a single institution undergoing ACDF by 7 primary surgeons in both orthopedic and neurosurgery spine departments between 2015 and 2019 were retrospectively reviewed. Patients were stratified by surgery day at either the beginning (Monday/Tuesday) or end (Thursday/Friday) of the week and by single- or multilevel ACDF. Surgery for trauma, infections, adjacent level disease, or revision were excluded. Patient demographics, Charlson Comorbidity Index (CCI), LOS, postoperative complications, and readmission rates were assessed.

Results: Six hundred fifty-two patients underwent ACDF. For single-level ACDF, 222 were reviewed, with 112 having surgery at the beginning and 110 at the end of the week. For multilevel ACDF, 431 were reviewed, with 192 having surgery at the beginning and 239 at the end of the week. No differences in pre- or postoperative variables were determined for single-level ACDF. Despite no differences in pre-operative variables, CCI, operative duration, or number of levels, late-week multilevel ACDF had longer average LOS (2.8 ± 3.0 days) compared to early-week surgery (2.0 ± 2.0 days) ($P=0.018$).

Conclusion: Late-week multilevel ACDF was associated with an increased LOS, as it may prove beneficial to surgical planning. This conflicts with previous reports that day of week was not associated with LOS following ACDF.

Radiocarpal Fracture Dislocations: A Retrospective Review on Operative Fixation and Post-Operative Range of Motion

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Faculty Mentor: John Li, MD

Introduction: Radiocarpal dislocation (RCD) and radiocarpal fracture dislocation (RCFD) are rare but severe injury patterns with multiple types of fixation techniques described. The purpose of this study was to determine the outcomes of RCD and RCDF treated at our institution.

Methods: Patients were identified using our institution's EMR between 2013 and 2022. Seventeen patients met criteria who suffered either RCD or RCFD. Patient charts were reviewed retrospectively with a focus on demographics, mechanism of injury, smoking status, open injury, direction of dislocation, Moneim and Dumontier classification, procedure, complications, final range of motion and subsequent surgeries.

Results: Seventeen patients met criteria with an average age of 38.5 years. Thirteen patients sustained dorsal dislocations while four sustained volar dislocations. Four were Dumontier type 1 and 13 were type 2. Twelve were Moneim type 1 and five were type 2. Fourteen of the 17 patients had at least six-month follow-up. The average flexion and extension at time of last follow-up was 33.6 degrees and 39.5 degrees, respectively. Average pronation and supination was 80.6 and 63.1 degrees, respectively. Fourteen patients underwent subsequent surgeries, mainly hardware removal. There was no significant difference in post operative range of motion, complications, or subsequent surgeries based on Moneim or Dumontier classification ($p > 0.11$).

Conclusion: RCD and RCFD are challenging and rare injuries with multiple patterns and variance. With proper fixation and recognition of associated injuries, patients with these injuries can expect to return to work and achieve functional range of motion.

Factors Associated with Insurance Denial of Preoperative CT scan for Robotic TKA
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Introduction: Robotic total knee arthroplasty (rTKA) requires preoperative imaging via CT scan. With the increased emphasis on cost containment, many ask how often these get denied by insurance companies. As such, the purpose of this study was to evaluate what factors were associated with insurance company preoperative CT scan denial in patients undergoing rTKA.

Methods: We retrospectively evaluated a single surgeon's records of patients undergoing rTKA from January 2020 to January 2023. IRB approval was obtained for the study. Investigation was performed for demographics, surgical history, primary and secondary insurance carrier, zip code, method of payment if denied, and surgical system used. Descriptive statistics were performed based on normality of data to evaluate predictive factors of preoperative CT scan denial.

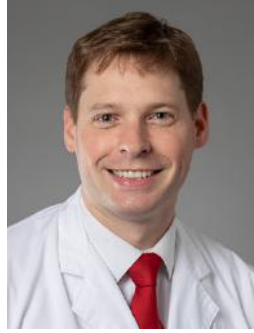
Results: Our records identified a total of 752 TKAs during the period with 649 Makos. Of these, 103 cases were manual, and preoperative CTs were denied on 22 cases. Of the denied cases, 14 were done manual and 8 later underwent CT before rTKA. Four of these 8 denials (50%) underwent rTKA after peer review, and 4 patients (50%) paid for the CT scan out of pocket. Of the CTs denied, 95% of patients held a single carrier commercial insurance and none were Medicare. Of the four patients that self-paid for their CT scan, three had commercial insurance alone, and one patient had a Medicare advantage plan. The patients whose insurance denied the CT were significantly younger with a mean age of 61 (SD 5.49) vs 66 (SD 9.235, $p=0.02$). The gender distribution was not significantly different ($p=0.341$), nor the average BMI ($p=0.129$).

Conclusion: Our study is the first to evaluate patient factors as predictors of preoperative CT scan denial for rTKA. Our findings demonstrate that commercial insurance appears to be the main risk factor for denial, but larger series are needed. Primary private insurance carriers appear to be sole factor which reliably allows surgeons to predict which patients are likely to get a denial for the preoperative CT. This data can help physicians increase their documentation at the time of ordering. Future studies are needed that quantify the burden these denials cause on patients, surgeons and the patient care teams.

Sports Medicine Faculty



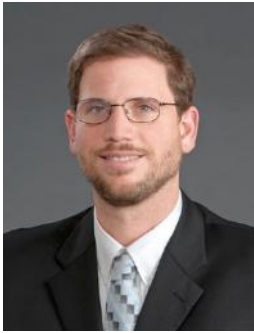
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