THIRTY-FIRST ANNUAL THESIS DAY

DEPARTMENT OF ORTHOPEDIC SURGERY
June 21, 2019

Department of Orthopedic Surgery
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RUSH

June 21, 2019

Welcome to the Department of Orthopedic Surgery's Thirty-First Annual Thesis Day. As you know, Thesis Day represents the culmination of the research efforts of our graduating residents and fellows and is a celebration of the accomplishments of these individuals.

We are grateful to all of the faculty members, research staff, and support staff all of whom have played an integral part in the education of these future leaders in orthopedic surgery. As mentors, we look forward to an ongoing relationship and look forward to following their careers. We wish them much success and fulfillment.

Thank you for participating in this day of scholarship and celebration!

Joshua J. Jacobs, M.D.
The William A. Hark, M.D.
Susanne G. Swift
Professor and Chairman
Department of Orthopedic Surgery

Mark S. Cohen, M.D.
2019 Thesis Day Program Chair
Professor and Director
Section of Hand and Elbow Surgery
Department of Orthopedic Surgery

William A. Hark, M.D.
1929-1981

Dr. William A. Hark attended the State University of Iowa for his Bachelor's degree and later received his Doctor of Medicine. At Iowa he was elected to Phi Beta Kappa and Alpha Omega Alpha. He was an outstanding swimmer and was captain of the university swim team.

After completing an internship at St. Luke's Hospital in Chicago, Dr. Hark spent two years in the United States Navy, completing his active service as Lieutenant Commander.

He undertook residency training at the Hines Veterans' Administration Hospital program in Chicago and completed it in December 1961. In 1962 he initiated his practice of orthopedic surgery in association with a most illustrious physician: his father, Dr. Fred Hark. In 1964 he was certified by the American Board of Orthopaedic Surgery. Since 1962 Dr. Hark had been associated with Rush-Presbyterian-St. Luke's Hospital. Dr. Hark was also Clinical Professor of Orthopaedics Surgery at the University of Illinois. During his professional career, Dr. Hark was active in many other institutions, including the Shriners' Hospital for Crippled Children in Chicago, the Hines Veterans' Administration Hospital, the Municipal Tuberculosis and State Tuberculosis Sanitarium, the Spaulding School for Handicapped Children, and the Admiral Retirement Home for Geriatrics.

Dr. Hark was a member of many distinguished professional organizations including The American Academy of Orthopaedic Surgeons and the Clinical Orthopaedic Society. He was also former President of the Chicago Orthopaedic Society and former Chairman of the Committee on Audiovisual Education of the American Academy of Orthopaedic Surgeons. He was to be the incoming President of the Chicago Committee on Trauma of the American College of Surgeons, where he had been extremely involved in educational activities for both medical and paramedical personnel.

Dr. Hark was greatly interested in residents' education. He was a staunch supporter of the residency program at Rush-Presbyterian-St. Luke's Medical Center. His cautious and well developed opinions and strategies always were welcomed at orthopedic grand round meetings. His quiet, measured voice often carried the final words that brought sense to decisions made by the staff when faced with difficult clinical problems.

Dr. Hark had many accomplishments as a physician and as an orthopedic surgeon. But more important than that, he left a legacy to those of us who were enriched by knowing him: a lesson in humility and a standard of excellence. He left us with an understanding of the meaning of compassion in medicine that will serve as a model for us, his peers, for his former residents, and for the many future orthopedic surgeons who will train among us. In that sense, William Hark's accomplishments are second to none.

Each year an outstanding, a world renowned, Orthopedic Surgeon is chosen to be The William A. Hark, M.D. Distinguished Visiting Professor. This year Peter J. Stern M.D. has the honor.

Return to Preoperative Level of Activity Following Hip Arthroscopy: Pilot Data from a Novel Smartphone-based Outcomes App

David Zhu, M.D., Shane Nho, M.D.

Introduction: We developed a novel smartphone outcomes app (rHip Recovery Tracker), which incorporates both patient-reported outcomes and fitness data from the smartphone. Patients download the app from the iTunes App Store onto their phone, and data is collected weekly. One of the data collected is the daily step count, averaged over the previous week, which is a direct measure of activity level.

Purpose: Based on data collected from the app, we developed a new outcome measure, the "breakeven point", defined as the time it takes for the patient's daily step count to return to preoperative levels. This represents an objective, quantitative measure of the patient's rate of recovery postoperatively, as well as a easily-understandable, concrete goal for patients. The goal of the present study is to analyze the pilot data collected for patterns and trends amongst patients.

Methodology: The cloud-based database of rHip Recovery Tracker was queried. All postoperative patients who underwent hip arthroscopy and had a minimum of 6 weeks' follow up using the app were included (n=11). The anonymized step count data, up to 12 weeks, were downloaded; step counts at each time point were normalized to the preoperative levels for each patient and plotted. The breakeven point for each patient was noted.

Results: Of the 11 patients, 7 reached the breakeven point within 12 weeks. The earliest breakeven point was at 6 weeks (4 patients). The other breakeven points occurred at 7, 9, and 10 weeks. Four patients had not yet reached the breakeven point, although their step counts were steadily increasing.

Conclusion: A smartphone-based outcomes collection app allows for more frequent collection of data at finer intervals. Thus, it is possible to track patient progress on a weekly, or even daily basis. This allows both the clinician and patient to receive real-time, subjective, quantitative results relating to postoperative recovery, such as the breakeven point. As we compile more data in the rHip database, it will be possible to apply machine-learning algorithms to analyze the data automatically, in order to predict outcomes and guide expectations.

DEPARTMENT OF ORTHOPEDIC SURGERY CLASS OF 2019

RUSH UNIVERSITY MEDICAL CENTER

Rush University Medical Center
Orthopaedic Surgery Residency Program
Class of 2019

Kevin Campbell, M.D., Timothy Luchetti, M.D., Allison Rao, M.D., Philip Louie, M.D., Joshua Bell, MD

Validation of a Novel Smartphone Patient-Reported Outcomes Survey App

David Zhu, M.D., Shane Nho, M.D.

Introduction:

Patient-reported outcomes surveys (PRO) play an ever-increasing role in determining hospitals' and physicians' ratings, rankings, and reimbursement. Collecting PRO data, however, remains burdensome for patients and office staff, especially for repeat or long-term follow-up. We developed a novel, downloadable, smartphone-based PRO capable of automatically notifying patients to respond as well as instantly calculating and transmitting scores. The PRO app also collects patients' activity data, including step count and distance walked, incorporating these data into its results.

Purpose: To validate a smartphone app-based *International Hip Outcomes Tool* patient-reported outcomes survey (IHOT-12). We hypothesize the app-based IHOT-12 will be valid compared to the original paper IHOT -12 and easier for patients and clinicians to use.

Methodology: 29 patients (ages 15-56) from hip arthroscopy clinic reporting hip pain completed paper and app-based IHOT-12s in randomized order. Scores from both versions were calculated and compared. Patients were timed for both versions, and also asked afterwards for their version preference

Results: Cronbach's alpha was 0.99, and Bland-Altman analysis showed no bias or clinically-significant difference between versions. There was no sequence bias. Accounting for completion order, app-based was faster for patients (p=0.02), with average completion time of 70s. Of 22 patients with a version preference, 19 (86%) chose app-based.

Conclusion: The app-based IHOT-12 is valid compared to paper and easier for patients. Combined with automatic notifications, and instant score calculation and transmission, the novel, downloadable app-based PRO may improve patient compliance, data availability, and office staff efficiency. With collection of multiple data points at finer intervals, patient outcomes can be trended over time to predict outcomes and adjust follow-up appointments if necessary. With the compilation of a database of patient results, machine-learning algorithms can also be applied to automatically predict patient outcomes.

Duration of Preoperative Symptoms Does Not Affect Clinical Outcome after Lumbar Arthrodesis

Arash J. Sayari MD, Jannat Khan BS, Bryce A. Basques MD, Philip K. Louie MD, Howard S. An MD

Introduction: Non-operative measures are generally employed and exhausted prior to consideration of surgical intervention for degenerative lumbar spine pathology. Patients can often experience symptoms for various lengths of time prior to surgical referral. It is unclear at what point in time surgical intervention may become less efficacious at relieving symptoms.

Purpose: To examine the effect of symptom duration on clinical outcomes after posterolateral lumbar fusion for degenerative and isthmic spondylolisthesis.

Materials and Methods: A retrospective cohort study was conducted of consecutive patients who underwent primary elective open PLF, excluding <18 years of age at the time of surgery or had a fusion to treat a lumbar fracture, tumor, or infection. Patient and operative data were collected, and duration of symptoms measured in months and was dichotomized at the 50th percentile, which was 24 months. Preoperative and final postoperative Visual Analog Scale (VAS) back pain, VAS-leg pain, Oswestry Disability Index were collected, including achievement of minimally clinically important difference (MCID). Sagittal parameters were assessed on radiographs. Postoperative complications were collected. Binary outcome variables were compared between groups with multivariate logistic regression, and continuous outcome variables were compared using multivariate linear regression. Multivariate analyses controlled for baseline patient and operative characteristics.

Results and Conclusions: A total of 850 patients were reviewed and separated into 2 groups based on symptom duration (group 1: <12 months of pain, group 2: > or equal to 12 months of pain). 247 patients were included in group 1, while 650 patients were included in group 2. Baseline demographics and operative characteristics were similar between the two groups, while group 2 was more likely to have undergone a prior lumbar fusion at a different level (p=0.02, Table 1). Both groups had similar changes in sagittal parameters and had no significant difference in clinical outcome measures (Table 2). The two groups also had no difference in rates of dural tear, discharge to rehabilitation facility, re-operation, early adjacent segment degeneration, or any post-operative complication. Despite differences in symptom duration, patients who have had pain for more than or equal to 12 months appear to show similar improvement after posterolateral lumbar arthrodesis than those who have had pain for less than 12 months. Extended effort of conservative treatments or delay of operative intervention do not appear to negatively impact the eventual outcome of surgery.

2019 GRADUATING FELLOWS CLASS

ADULT RECONSTRUCTION
Kevin Bigart, M.D.
Brian Fuller, M.D.
James Gholson, M.D.
Nathanael Heckmann, M.D.
Edward Sutter, M.D.
Robert Tracey, M.D.

SPINE
Joseph Ferguson, M.D.
Steven Fineberg, M.D.
Tyler Kreitz, M.D.

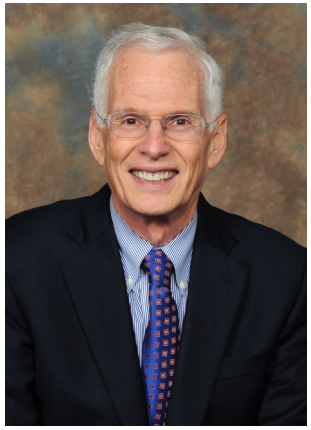
SPORTS MEDICINE
Jourdan Cancienne, M.D.
Jorge Chahla, M.D.
Ian Dempsey, M.D.
Benedict Nwachukwu, M.D.
Kelechi Okoroha, M.D.

SHOULDER & ELBOW
Robert Stephen Otte, M.D.

FOOT AND ANKLE FELLOWSHIP
Stephen Jacobsen, M.D.

HAND, UPPER EXTREMITY AND MICROVASCULAR
Maj. David Wilson, M.D.

PRIMARY CARE SPORTS MEDICINE
Shannon Powers, M.D.



THE WILLIAM A. HARK , M.D.

VISITING PROFESSOR

PETER STERN, M.D.

Peter Stern M.D., Peter J. Stern, M.D graduated from Williams College and received his medical degree from Washington University School of Medicine. He completed his Orthopaedic residency at the Harvard Combined Orthopaedic Program followed by a hand surgery fellowship in Louisville with Harold Kleinert. He is the Hill Professor of the Department of Orthopaedic surgery at the University of Cincinnati and he served as Department Chairman from 1992-2013.

Dr. Stern Is a past President of the American Society for Surgery of the Hand, the American Board of Orthopaedic Surgery and the American Orthopaedic Association. He is a past Trustee of the Orthopaedic Research and Education Foundation, and a past Chairman of the Orthopaedic RRC. He is a former Deputy Editor of both the *Journal of Bone and Joint Surgery and the Journal of Hand Surgery.* He now serves on *JBJS* Board of Trustees. He has served as a visiting professor at over 70 institutions, has given 49 Endowed Lectureships and has over 190 peer review publications. He has educated 71 fellows and over 160 orthopaedic residents.

A Novel Cost-Effective Training And Assessment Simulator For Spine Surgery

Arash J. Sayari MD, Philip K. Louie MD, Jannat Khan BS, Kyle Kunze BS, Bryce A. Basques MD, Howard S. An MD, Gregory D. Lopez MD

Introduction: Increasing complexity in spine surgery techniques has created a niche for improved surgical training. Currently, spine surgery simulation current includes synthetic bone activities, cadaver laboratories, and virtual reality simulators that are costly and often unaffordable for residency programs, or are not replicable.

Purpose: To introduce a novel simulator for spine surgery that is feasible, easily reproducible at any institution, and applicable in a clinical setting.

Materials and Methods: Using items easily found at a local hardware store, a surgical simulator was created to test and assist the surgical trainee aiming to learn and perfect his or her skills in fundamental techniques related to spine surgery. The simulator was built using piping, wood and foam blocks, various thin pliable materials, and surgical instruments. After IRB approval, 49 orthopaedic surgery trainees with varying experience were tested with the simulator, which included: (1) the use of a hand-held burr in minimally invasive surgery (MIS) and open fashion, (2) the use of a kerrison rongeur in MIS and open fashion, (3) triangulating with a gear shift awl at designated start points towards specified end-points, and (4) peg transfer activity with a pituitary rongeur down a long wider tube to simulate lateral access surgery. Subjects were divided into two groups based on level of training: novice (medical students, first and second year orthopaedic surgery residents) and experts (third, fourth, and fifth year orthopaedic surgery residents). Time, accuracy, and

performance were compared using chi-squared analysis and independent sample t-tests for categorical and continuous data, respectively (statistically significance was defined as p-value of < 0.05).

Results and Conclusions: Overall, 49 subjects fulfilled our inclusion criteria. There were 41 subjects who were classified as novice and 8 subjects were experts. The expert group was faster in completing MIS ($p=0.025$) and open ($p=0.061$) tasks using kerrison rongeur, along with lateral access tasks using pituitary rongeur ($p=0.029$) than novice group. Additionally, expert subjects were significantly more likely to complete the MIS task using kerrison rongeur ($p=0.017$) and hold the kerrison rongeur ($p=0.009$) and hand-held burr ($p=0.002$) correctly compared to the other subjects. For the hand-held burr task, expert subjects were more likely to support their elbow ($p=0.042$). No statistically significant difference was found between the groups in regards to the gear shift awl tasks (Table 1). This study demonstrates the construct validity of a cost-effective novel surgical simulator for training the fundamentals of spine surgery, objectively demonstrating the higher-level performance in terms of time and completion of tasks by experts or senior trainees for majority of tasks when compared to novices or those without experience in spine surgery. The results of this study encourage the application of this simulator as a training tool for resident education.

Platelet-Rich Plasma for Muscle Injuries: A Systematic Review of the Basic Science Literature

Kyle N. Kunze BS, Charles P. Hannon MD, Jared Fialkoff BS, Brian J. Cole MD, MBA

Introduction & Purpose: Over the past decade, increased interest in PRP has led to its use clinically for both acute and chronic muscle injuries despite the lack of both basic science and clinical evidence that justifies its use and efficacy. Several clinical studies and trials on PRP for muscle injury have been published with varying results. The purpose of this study was to evaluate the basic science literature on the use of platelet-rich plasma (PRP) for musculoskeletal muscle pathology.

Materials & Methods: A systematic review of the PubMed/MEDLINE and EMBASE databases was performed in December 2017 using the following parameters: (platelet rich plasma OR PRP OR autologous conditioned plasma OR ACP) AND (muscle OR myocyte OR myositis OR skeletal muscle OR muscle injury). The inclusion criteria for full-text review were in vivo and in vitro studies examining the effects of PRP on muscles and/or myocytes and/or myoblasts. Data were extracted included information on PRP preparation, study methods, and results. Studies were analyzed for trends, comparing and contrasting the reported effects on PRP.

Results: The search yielded 23 basic science studies on effects of PRP on muscle pathology. Fifteen studies were in vivo, 6 were in vitro, and 2 had both an in vitro and an in vivo study component. Only one study reported a complete cytology of PRP including platelet count, red blood cell count, and white blood cell count. Five in vitro studies reported increased proliferation, four studies found increased gene expression, and three found superior cellular differentiation. Five in vivo muscle studies found increased gene expression, three found superior muscle regeneration, and seven found improved histological quality of muscular repair tissue.

Conclusion: The basic science literature on the use of PRP in muscle pathology demonstrates that PRP treatment confers several potentially beneficial effects on healing in comparison to controls. Future basic science research is needed to determine the optimal cytology, dosing, timing, and delivery method of PRP for both chronic and acute muscle pathology.

THIRTY-FIRST ANNUAL THESIS DAY

Room 542 Professional Building

8:00 A.M. **WELCOME**

***Joshua J. Jacobs, M.D.,* Department Chairman**

8:05 A.M. **CASE PRESENTATIONS**

Moderator: Mark Cohen, M.D.

FELLOW PRESENTATIONS

Hand Fellowship

Mark Cohen, M.D., Moderator

9:05 A.M. **Maj. David Wilson, M.D.**

"Restoration of Peak Strength and Endurance Following Distal Biceps Reconstruction with Allograft"

Adult Reconstruction Fellowship

Tad L. Gerlinger, M.D., Moderator

9:13 A.M. **BRIAN FULLER M.D.**

"Which Non-Operative Treatments Do Patients Feel Are Most Effective for Hip and Knee Arthritis"

Spine Fellowship

Howard An, M.D., Moderator

9:21 A.M. **TYLER KREITZ, M.D.**

"Using Porous PEEK Interbody Cages for Multi-level Anterior Cervical Discectomy and Fusion: Clinical and Radiographic Outcomes"

9:30 A.M. **BREAK**

9:45 A.M. **Introduction of Visiting Professor: *Mark Cohen, M.D.***

THE WILLIAM A. HARK,, M.D. VISITING PROFESSOR

Peter J. Stern, M.D.

"Excellence in Orthopaedics"

10:15 Break

Foot and Ankle Fellowship

Simon Lee, M.D., Moderator

10:30 A.M. **Stephen Jacobsen, M.D.**

"Radiographic Assessment of First Metatarsal Shortening Following Hallux Valgus Correction: A comparison of Surgical Techniques"

Sports Medicine Fellowship

Bernard R. Bach, Jr., M.D, Moderator

10:38 A.M. **BENEDICT NWACHUKWU, M.D.**

"A Predictive Model for Achieving the Minimal Clinically Important Difference Following Hip Arthroscopy: An Analysis of 2,511 Patients"

Primary Care Sports Medicine Fellowship

Kathy Weber, M.D., Moderator

10:46A.M. **Shannon Powers, M.D.**

"Assessing the Knowledge and Awareness of the Female Athlete Triad in Female Collegiate Athletes"

10:54A.M. ***THE WILLIAM A. HARK, M.D. VISITING PROFESSOR***

Peter J. Stern, M.D.

"Iatrogenesis, Imperfecta, Profunda

END OF MORNING SESSION

Outcomes After Proximal Tibial Osteotomy: A Systematic Review of Return to Work and Sport and Meta-Analysis of Opening and Closing-Wedge Techniques

Kyle N. Kunze BS, Alexander Beletsky BA, Charles P. Hannon MD, Adam B. Yanke MD PhD, Brian J. Cole, MD MBA, Jorge Chahla, MD PhD

Introduction & Purpose: Proximal tibia osteotomy has been shown to be an effective treatment leading to good functional outcomes in younger patients. While many studies have reported successful functional outcomes after PTO there is a paucity of summarized data on return to sport and return to work after PTO in both recreational and competitive athletes. The purpose of this study is to (1) quantify current return to sport (RTS) and return to work (RTW) rates after PTO and to (2) quantify incidence of complications and conversion to total knee arthroplasty (TKA) following PTO for all patients and for the proportion of patients undergoing opening- and closing-wedge PTO separately.

Materials & Methods: The Cochrane Database of Systematic Reviews, the Cochrane Central Register of Controlled Trials, PubMed (2008-2019), EMBASE (2008-2019), and MEDLINE (2008-2019) databases were queried. Data pertaining to (1) article information; (2) patient demographics; (3) surgical techniques; (4) rates of complication and conversion TKA; (5) patient-reported outcome scores; (6) RTS and (7) RTW were extracted. Data was synthesized and a random -effects meta-analysis of proportions using continuity correction methods was performed to determine the proportion of opening- and closing-wedge PTO patients who experienced adverse events.

Results: A total of 33 studies with involving 1,914 PTO procedures derived from 2,429 patients (2,464 knees) with a weighted mean (± standard deviation) age of 50.3±9.9 years and body mass index (BMI) 26.9±2.3 kg/m^2 were included. The pooled RTS and RTW rates were 75.7% in 814 patients and 58.9% in 372 patients, respectively. The pooled TKA and complication rates for all patients were 12.5% and 11.1%, respectively. The overall random pooled summary estimate of the proportion of patients who underwent opening-wedge PTO and subsequently converted to TKA was 2.0% (95% confidence interval [CI] 1.0% - 4.0%, I^2 = 63.65) and who experienced a complication was 6.0% (95% CI 3.0% - 9.0%, I^2 = 87.01%). For closing-wedge, the proportion of patients who converted to TKA was 5.0% (95% CI 1.0% - 9.0%, I^2 = 93.1%) and experienced a complication was 2.0% (95%CI 1.0% - 3.0%, I^2 = 90.0%). Only 53.8% of studies that referenced RTS provided postoperative RTS rates, and 80% of studies that referenced RTW provided RTW rates. Only one study defined RTS criterion, no studies defined RTW criterion, and 31 different outcome measures were reported across all studies.

Conclusion: Patients undergoing PTO experience high rates of RTS and RTW regardless of technique used. These patients also experience low rates of complications and conversion to TKA, regardless of opening- or closing-wedge technique. Much heterogeneity exists with regards to criterion used to define RTS, RTW, and of patient reported outcome measures to assess clinical and functional improvements after PTO.

	TKA, matched (N=2,383)		UKA, matched (N=2,383)		
	Num-	Frequency	Num-	Frequency	P Value
Overall Complications					
2 weeks	260	10.91%	136	5.71%	P < 0.001
3 months	418	17.54%	270	11.33%	P < 0.001
1 year	582	24.42%	386	16.20%	P < 0.001
Revision (any component)					
2 weeks	<11	*	<11	*	*
3 months	18	0.75%	23	0.96%	P = 0.433
1 year	46	1.93%	66	2.77%	P = 0.056
5 year	26/643	4.04%	43/643	6.69%	P = 0.035
Irrigation and Debride-					
2 weeks	<11	*	<11	*	*
3 months	17	0.71%	12	0.50%	P = 0.352
1 year	22	0.92%	15	0.63%	P = 0.248
5 year	<11	*	<11	*	*
Stiffness requiring MUA					
2 weeks	<11	*	<11	*	
3 months	66	2.77%	16	0.67%	P <
1 year	93	3.90%	21	0.88%	P <
DVT					
2 weeks	57	2.39%	33	1.38%	P = 0.011
3 months	88	3.69%	54	2.26%	P = 0.004
1 year	118	4.95%	75	3.14%	P = 0.002
PE					
2 weeks	20	0.84%	<11	*	
3 months	29	1.22%	11	0.46%	P = 0.006
1 year	35	1.47%	19	0.80%	P = 0.029
UTI					
2 weeks	55	2.31%	31	1.30%	P = 0.009
3 months	117	4.90%	75	3.14%	P = 0.002
Acute Renal Failure					
2 weeks	51	2.14%	14	0.59%	P < 0.001
3 months	63	2.64%	25	1.05%	P < 0.001
1 year	100	4.19%	53	2.22%	P < 0.001

1:00 P.M. **INTRODUCTION**
Joshua J. Jacobs, M.D.
Chairman, Department of Orthopedic Surgery

SENIOR RESIDENT THESIS PRESENTATIONS
Monica Kogan, M.D., Moderator
Director, Orthopedic Residency Program

1:05 P.M. **ALLISON RAO, M.D.**
"Does Pre-operative Doxycycline Reduce Propionibacterium Acnes in Shoulder Arthroplasty?"

1:15 P.M. **JOSHUA BELL, M.D.**
"Does Peritrochanteric Fat Thickness Increase the Risk of Early Reoperation Following Total Hip Arthroplasty"

1:25 P.M. **TIMOTHY LUCHETTI, M.D.**
"Role of the Triangular Fibrocartilage Complex in Distal Radioulnar Joint Stability"

1:35 P.M. **KEVIN CAMPBELL, M.D.**
"A Novel Text-Messaging Automated System is Effective in Patients Undergoing Total Joint Arthroplasty"

1:45 P.M. **PHILIP LOUIE, M.D.**
"The Cervical Spine: How Does the Work We've Done Yesterday, Make a Lasting Global Impact Tomorrow?"

1:55 P.M. **BREAK**

2:10 P.M. ***THE WILLIAM A. HARK, M.D. VISITING PROFESSOR***

PETER STERN, M.D.

"Impact Procedures in Orthopaedic Surgery During my Lifetime"

2:40 P.M. **CLOSING REMARKS AND AWARD PRESENTATIONS**

RUSH UNIVERSITY MEDICAL CENTER

SENIOR RESIDENT

ABSTRACTS

ACADEMIC YEAR 2018-2019

Unicompartmental Total Knee Arthroplasty is Associated with Lower Risk of Perioperative Complications Despite Higher Risk of All-Cause Revision

Robert A. Burnett MD, E. Bailey Terhune MD, Charles P. Hannon MD, Max Courtney MD, Craig Della Valle MD

Introduction & Purpose: Unicompartmental knee arthroplasty (UKA) has emerged as an attractive alternative to total knee arthroplasty (TKA) with many arguing the procedure is associated with expedited recovery, lower morbidity, and lower cost. However, concerns remain regarding the high risk of failure and need for revision surgery. The purpose of this study was to determine the incidence of medical and surgical complications in matched unicompartmental and total knee arthroplasty cohorts, and to compare revision rates at five year follow up.

Materials & Methods: Patients in the Humana Inc administrative claims database who underwent primary unilateral TKA or UKA between 2007 and 2016 were identified based on CPT codes. The UKA and TKA patient cohorts were matched based on Charlson Comorbidity Index (CCI), age, and gender. Medical complication rates following the respective procedures were determined using ICD-9 and ICD-10 codes at two weeks, three months, and one year post-operatively. Revision rates and rates of irrigation and debridement for TKA and UKA were evaluated up to five years post-operatively.

Results: A total of 63,036 primary TKA patients were identified. 2,383 UKA patients were identified and matched to a cohort of TKA patients. After matching, the TKA and UKA cohorts were 45% female with an average age of 69.2 years. The groups were similar in age, sex, and comorbidity profile with the exception of 3 variables: the TKA group had a higher incidence of obesity ($p= 0.0001$), preoperative anemia ($p= 0.0019$), and other neurologic disorders ($p=0.035$). Six percent of UKAs were completed in an outpatient setting, compared to only 1.5% of TKAs.

TKA cohorts had a significantly higher overall complication rates compared to patients in the UKA cohort at all timepoints (Table 1). Rate of stiffness requiring manipulation under anesthesia was significantly increased in TKA compared to UKA patients at both 3 months (2.77% compared to 0.67%, $p<0.0001$) and 1 year (3.90% compared with 0.88%, $p<0.0001$) postoperatively. Rates of deep venous thrombosis, pulmonary embolism, urinary tract infection, acute renal failure, and post-operative anemia were all significantly higher in the TKA group at all timepoints studied (Table 1). There was no difference in rates of superficial or deep prosthetic joint infection, pneumonia, irrigation and debridement, or overall mortality. Revision rates for the matched TKA and UKA groups were similar at 3 months and 1-year post operatively. However by five year follow up, rates of revision surgery was significantly higher in patients who had undergone UKA (4.04% vs 6.69%, $p=0.0068$).

Conclusion: Comparison of total and unicompartmental knee arthroplasty outcomes revealed significant increased overall complications rates in TKA compared to UKA. At early follow-up, revision rate is comparable between TKA and UKA, but at 5 years the rate of revision is higher for UKA patients .

Taper Corrosion Presenting as Late Instability Following Metal-on-Polyethylene Total Hip Arthroplasty

Charles P. Hannon MD, Eric J. Cotter MD, H. John Cooper MD, Robert M. Urban PhD, Carl A. Deirmengian MD, Wayne G. Paprosky MD, Jose A. Rodriguez MD, Joshua J. Jacobs MD

Introduction & Purpose: Taper corrosion at modular junctions can cause a spectrum of adverse local tissue reactions (ALTR) in patients who have undergone total hip arthroplasty (THA). As these reactions are usually painful, taper corrosion has become part of the differential diagnosis of hip pain following THA. However, these destructive lesions may not always cause pain. The purpose of this study is to describe a cohort of patients presenting with late instability following metal-on-polyethylene THA due to underlying taper corrosion and ALTR.

Material & Methods: This is a multicenter retrospective case series of seventeen patients presenting with late instability secondary to ALTR and corrosion at the modular head-neck taper. The cohort included 12 women and 5 men with a mean age of 62.6±9.4 years (range, 42 – 73). All patients had a metal (CoCr)-on-polyethylene bearing surface, but had a range of CoCr and Ti-alloy stem designs from three different manufacturers. Patients experienced a mean of 2.7±1.5 dislocations (range, 1 to 6) at an average of 4.3±4.1 years (range, 0.4 to 17.0) following their index surgery. Although most reported some degree of discomfort around the hip, instability was the primary presenting symptom in all seventeen patients, and seven were otherwise completely asymptomatic. Serum metal levels were obtained in 12 patients and demonstrated a greater elevation of cobalt (mean 6.9±6.3 ng/mL) than chromium (mean 1.9±1.2ng/mL). Infection workup including serum inflammatory markers, hip aspiration, and frozen intraoperative cultures documented the absence of periprosthetic joint infection.

Results: Radiographic analysis demonstrated cups were well positioned, with a mean abduction angle of 44.0° (range, 37° to 55°) and mean anteversion angle of 19.6° (range, 15.9° to 27.1°). Patients were revised for instability at a mean of 6.8±4.8 years (range, 2.1 to 19.4) following their index surgery. At the time of revision, ALTR was encountered in every case, with extensive tissue necrosis and abductor damage or insufficiency in the majority. The modular head-neck junction demonstrated visible corrosion seen as fretting, surface damage, and deposition of a black, flaky material. An irrigation and debridement with exchange of the CoCr head to a ceramic head with a titanium sleeve and placement of a constrained liner was performed for a majority of patients (n=15, 88.2%).

Conclusions: Although ALTR resulting from modular taper corrosion typically presents with hip pain, some patients can present with recurrent instability in the absence of other significant symptoms. Recurrent instability in the setting of otherwise well-positioned components and without another obvious cause should raise concern for ALTR as a potential underlying etiology.

Next Generation Sequencing for Diagnosis of Infection: Is More Sensitive Really Better?

Allison J Rao, MD; Ian S MacLean, MD; Amanda J Naylor, MA; Grant Garrigues, MD; Nikhil N Verma, MD; Gregory P Nicholson, MD

Background: Next Generation Sequencing (NGS) has seen increased interest in situations of revision arthroplasty. However, the utility in differentiation active infection versus contaminant or baseline flora remains a challenge. The purpose of this study is to compare NGS with culture-based methods in primary shoulder arthroplasty.

Methods: With IRB approval, a prospective series of primary open shoulder procedures were enrolled. Patients with an infection history or antibiotic use within 60 days of surgery were excluded. All patients received standard perioperative antibiotics. After skin incision, a 1cm by 3mm sample of the medial skin edge was excised. A 2cm by 2cm synovial tissue biopsy was taken from the deep interval after subscapularis take down. One set of deep and superficial specimens was sent for NGS and the other for standard cultures. NGS samples were sent to MicroGenDX laboratory for analysis.

Results: Samples from 25 patients were analyzed. Standard aerobic/anaerobic cultures were positive in ten skin samples (40% [95% confidence interval (CI), 20.4% to 59.6%]) and in three deep samples (12% [90% CI, 1.1% to 22.9%]). Next-generation sequencing detected at least one bacterial species in 17 of the skin samples (68% [95% CI, 49.3% to 86.7%]) and in seven deep samples (28% [95% CI, 9.0% to 47.0%]). There was a significant difference ($p<0.03$) between the mean number of bacterial species detected in skin samples using NGS between the group with positive standard cultures (1.6 species) and negative standard cultures (5.7 species). The three most common bacteria identified by NGS in skin samples were *C acnes* [44%, 11 individuals], *Staphylococcus epidermidis* (*S epidermidis*) [24%, six individuals], and *Escherichia coli (E coli*) [20%, five individuals]. The three most common bacteria identified by NGS in deep tissue samples were *E coli* [16%, four individuals], *C acnes* [12%, three individuals], and *S epidermidis* [8%, two individuals].

Conclusion: NGS identified bacteria at higher rates in skin and deep tissue samples than culture in native uninfected patients undergoing primary procedures. Additionally, it identified several atypical bacteria not identified on cultures at high rates. The results of this study and the paucity of existing literature on NGS highlight the need for further research on this subject prior to reliable use of NGS in orthopedic cases.

The Effect of Time Interval from MRI to Rotator Cuff Repair on Tear Size: Imaged vs. Actual Tear Size

Amanda J. Naylor, MA; Michael D. Charles, MD; Allison J. Rao, MD; Gregory L. Cvetanovich, MD; Michael C. O'Brien, MA; Gregory P. Nicholson, MD

Background: MRI is the advanced imaging modality of choice for the evaluation and diagnosis of full thickness rotator cuff tears (RCT). Tear size progression has been correlated with increasing pain. However, there is little data on tear size progression in symptomatic RCT with regard to time from MRI to actual rotator cuff repair (RCR). The purpose of the study was to evaluate the effect of time (from date of MRI measured tear dimensions to date of RCR measured intraoperative tear dimensions) on tear size progression.

Methods: In the course of a study on physical examination manual muscle tests in patients with known full thickness RCT requiring repair, MRI was obtained for each patient undergoing RCR. Tears were measured intraoperatively in the Anterior-Posterior (A-P) and Medial-Lateral (M-L) dimensions with a graduated probe. Location (anterior, central, posterior in the supraspinatus tendon), area of the tear, and anterior band of supraspinatus status (intact/ not intact) were recorded. The preoperative MRI was evaluated by the same examiner blinded to the operative results at least 4 weeks after the RCR and the same parameters measured. There were 64 consecutive shoulders with 40 male, 24 female at an average age of 58 yrs (40-76) that had MRI and underwent RCR. The mean MRI dimensions were: A-P tear: 16.53mm (SD 9.70); M-L tear: 17.3mm (SD 9.75); Tear area: 366.7 square mm. The average time from preoperative MRI to RCR was 107.3 days (range 12-399 days). Operative mean RCT dimensions were: A-P tear: 18.38mm (SD 10.0); M-L tear: 14.06mm (SD 8.15); Tear area: 307.7 square mm. Descriptive statistical analysis with two-sample T-test was performed to determine the temporal effect on tear size from date of MRI to the date of surgery, and whether there was a change. Patients were grouped in the following time cohorts based on the length of time elapsed between the preoperative MRI and date of RCR: ≤1 month, 1 month to 2 months, 2 months to 3 months, 3 months to 9 months, and ≥9 months. The delta, or difference between intraoperative measurements and preoperative MRI measurements, was calculated for each cohort.

Results: The t-test revealed a significant time effect with regard to tear size between the MRI and the intraoperative measured tear requiring repair. This was significant for the A-P dimension ($p<0.001$), the Medial-Lateral dimension ($p<0.001$), and the total area of the tear ($p=0.009$). In an attempt to determine a "watershed" or critical time interval where MRI and RCT size correlated, an additional analysis was performed. The change in A-P tear dimension between MRI and RCR findings showed increasing delta with increasing time. Positive mean delta in A-P dimension was seen in the 2-3 month group (2.64), with larger differences seen in the 3 month to 9 month (5.89) and ≥9 month (7.3) groups. A similar trend was seen for mean delta values in the M-L dimension among the cohorts.

Conclusions: In a consecutive series of RCTs undergoing repair, the measured MRI dimensions and the intraoperative dimensions were recorded and analyzed. A surgeon can have a level of confidence that the RCT size will correlate with MRI tear size within a certain time frame. There is a significant effect of time on tear size progression from MRI dimensions to actual RCT dimensions at time of repair.

Anesthesia and Analgesia Practices in Total Joint Arthroplasty: A Survey of the AAHKS Membership

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Introduction & Purpose: There are many anesthetic and analgesic options to control pain after TJA. Multimodal analgesic regimens in TJA have garnered significant interest because they limit the use of opioids peri-operatively. The purpose of this study was to survey the current analgesia and anesthesia practices used by total joint arthroplasty surgeon members of the American Association of Hip and Knee Surgeons (AAHKS). Understanding current practice patterns in anesthesia, analgesia, and opioid prescribing may serve as a platform for future work aimed at establishing best clinical practices of maximizing effective postoperative pain control and minimizing the risks associated with prescribing opioids.

Materials & Methods: A survey of 28 questions was created in accordance with the Dillman's Tailored Design Method. The 28 question survey was then approved by the AAHKS Research Committee. The survey was distributed to all 2,208 board certified adult reconstruction surgeon members of AAHKS in November 2018.

Results : There were 622 responses (28.2%) to the survey. A majority of respondents (93.2%, n=576) use preemptive analgesia prior to total joint arthroplasty (TJA). Most respondents use a spinal for total knee arthroplasty (TKA) (74.4%) and for total hip arthroplasty (THA) (72.6%). A peripheral nerve block is routinely used by 68.7% of respondents in primary TKA. Periarticular injection or local infiltration anesthesia is routinely used by 80.3% of respondents for both TKA and THA patients. The average number of opioid pills prescribed postoperatively after TKA is 49 pills (range 0 – 200) and after THA is 44 pills (range 0 – 200). Most surgeons (58%) expect this prescription should last for 2 weeks. A majority of respondents (74.0%) use multimodal analgesics in addition to opioids.

Conclusion: There is no consensus regarding the optimal multimodal anesthetic and analgesic regimen for TJA among surveyed board certified arthroplasty surgeon members of AAHKS. Understanding current practice patterns in anesthesia, analgesia, and opioid prescribing may serve as a platform for future work aimed at establishing best clinical practices of maximizing effective postoperative pain control and minimizing the risks associated with prescribing opioids.

Who is Prescribing Opioids Preoperatively? A Survey of New Patients Presenting to Tertiary Care Adult Reconstruction Clinics

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Introduction & Purpose: Preoperative opioid use has been shown to lead to a higher risk of complications and inferior outcomes following lower extremity joint arthroplasty. The purpose of this study is to identify the prevalence of preoperative opioid use prior to elective hip and knee arthroplasty and the characteristics of this population.

Materials & Methods : 461 Consecutive new patients presenting for evaluation of an arthritic hip or knee were retrospectively evaluated using institutional data and the Illinois Prescription Monitoring Program (IPMP) to identify opioid prescriptions within 6-months prior to their first appointment. The primary outcomes were the number of patients prescribed opioids preoperatively and the specialty and practice setting of the prescriber. Secondarily, we assessed patients who did not report opioid prescriptions but were identified using the IPMP.

Results:105 Patients (22.8%) received pre-appointment opioids, with 46 of these patients (10.0%) receiving only tramadol. Primary care physicians were the most common prescriber (59.5%, $p < 0.001$) followed by pain medicine specialists (11.3%) and orthopaedic surgeons (11.3%). More prescribers practiced in the community than an academic setting (63.8% versus 36.2%, $p < 0.001$). 78 Patients (74.3%) reported opioid prescriptions with the remaining 27 (25.7%) identified only after query of the IPMP. In regression analysis, higher BMI, diagnosis other than osteoarthritis, and benzodiazepine use were associated with receiving opioid prescriptions ($p < 0.05$). Regression analysis also found that preoperative opioid users who also were taking anti-depressant medication were less likely to report their opioid ($p = 0.044$).

Conclusion: A striking number of patients are being treated with opioid pain medication for hip and knee arthritis. Further, many patients who have taken opioids within six months do not report their opioid use. While primary care physicians prescribed the majority of opioids for nonoperative treatment of arthritis, a substantial amount came from orthopaedic surgeons. Further education of physicians and patients on the ill effects of opioids when used for the non-operative treatment of hip and knee arthritis is warranted.

Is Distal Peripheral Neuropathy More Common After Shoulder Arthroplasty?

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Background: Complications after shoulder arthroplasty include neurologic injury. Less is known, however, about the precipitation of distal peripheral neuropathy (DPN) following shoulder arthroplasty. In this study, we report on the incidence of DPN requiring surgical intervention following shoulder arthroplasty requiring carpal or cubital tunnel release.

Methods: A retrospective review was conducted of a prospectively collected shoulder arthroplasty registry at a single institution from a single surgeon from April 2006 to April 2017. Patients were included in the series if they had primary surgical intervention for ipsilateral or contralateral peripheral neuropathy following primary shoulder arthroplasty. Patients were excluded if they had known peripheral neuropathy or cervical radiculopathy prior to surgery. DPN was defined for the study as symptoms or diagnostic testing consistent with cubital tunnel or carpal tunnel syndrome. Demographics, patient reported outcome measures, and pre- and post-operative shoulder range of motion was collected.

Results: 1,387 total shoulder arthroplasties were performed in this period. During the study period, 16 shoulders (1.2%) underwent surgery for ipsilateral DPN while 6 shoulders (0.4%) underwent surgery for contralateral DPN. This difference was not statistically significant. ASES scores, SANE scores, and shoulder flexion improved significantly from pre- to post-operatively for both groups. There was not significant different in post-operative scores between groups.

Conclusion: Distal peripheral neuropathy requiring operative intervention is not more common after shoulder arthroplasty. Emergence of DPN symptoms following arthroplasty is likely coincidental and due to a previously asymptomatic, progressing process.

Does Pre-operative Doxycycline Reduce *Propionibacterium Acnes* in Shoulder Arthroplasty?

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Background: *Propionibacterium Acnes (P.acnes)* is the most common bacteria associated with infection after shoulder arthroplasty (SA). This bacteria can be cultured from the skin after standard pre-operative skin preparation and antibiotics. The purpose of this study was to determine whether adding pre-operative intravenous doxycycline reduces the incidence of *P. acnes* culture positivity from the skin and deep tissues at the time of prosthetic joint implantation during SA.

Methods: This is a randomized controlled trial. An *a priori* power analysis determined a sample size of 56 patients. Patients undergoing SA were randomized to receive either standard peri-operative cefazolin or a combination of doxycycline and cefazolin. Tissue cultures were then taken from the skin edge and swabs were taken from the superficial dermal tissue and glenohumeral joint. All cultures were held for 14 days to allow for *P.acnes* detection. Groups were compared to determine if the addition of doxycycline reduced the rate of culture positivity.

Results: 56 patients were enrolled and randomized. 21/56 patients (38%) had at least one positive culture for *P.acnes*, with no significant difference between cefazolin alone (10/27 patients (37%)) and the combined doxycycline and cefazolin group (11/29 patients (38%)) (p=0.99). The greatest numbers of culture positive samples were obtained from the skin (30%), followed by dermal tissue (20%), and glenohumeral joint (5%). Patients with positive cultures were younger (64.9+/-7.7 vs 69.4+/-7.7, p=0.041), and tended to be male (16/21 76% males vs 17/35 49% females, p=0.053) with lower Charlson Comorbidity Index scores (3.35+/-1.3 vs 4.09+/-1.4 p=0.051). There were no differences for BMI (p=0.446) or arthroplasty type (8/27 for anatomic SA vs 13/29 for reverse SA, p=0.280). There were no doxycycline-related adverse events.

Conclusions: In this randomized controlled trial, doxycycline did not significantly decrease *P.acnes* culture positivity in the skin, dermis, and glenohumeral joint of patients undergoing shoulder arthroplasty. The addition of prophylactic intravenous antibiotics to cover *P. acnes* may not be an effective method to reduce post operative and peri prosthetic shoulder joint infections.

Large Opioid Prescriptions are Unnecessary after Total Joint Arthroplasty: A Randomized Controlled Trial

Charles P. Hannon MD, Tyler E. Calkins BS, Jefferson Li BS, Chris Culvern MS, Brian Darrith BS, Denis Nam MD, Tad L. Gerlinger MD, Craig J. Della Valle MD

Introduction & Purpose: Opioids are an important component of multimodal postoperative analgesia, but improper utilization places patients at risk for overdose, addiction, or even death. The purpose of this randomized controlled trial is to determine whether the quantity of opioid pills prescribed at discharge is associated with the total amount of opioids consumed or unused by patients after total hip (THA) and knee (TKA) arthroplasty.

Materials & Methods: 304 Opioid naïve patients undergoing THA or TKA between August 2017 and April 2018 were randomized to receive a postoperative prescription for either 30 or 90 5mg oxycodone immediate release (OxyIR) pills after discharge. All patients received acetaminophen, meloxicam, tramadol, and gabapentin perioperatively. Daily opioid consumption, reported in morphine equivalent dose (MEQ), number of unused OxyIR pills, and pain scores were calculated for 30 days after discharge with a patient-completed medication diary. The number of OxyIR refills and total MEQ received were recorded for 90 days postoperatively. Power analysis determined that 141 patients per group were necessary to detect a 25% reduction in means in opiate consumption between groups. Statistical analysis involved t-test, rank sum, and chi-squared tests with alpha=0.05.

Results: 161 Patients were randomized to the to receive 30 pills and 143 to receive 90 pills. In the first 30 days after discharge, the median number of unused OxyIR pills was 15 pills in the 30 OxyIR group versus 73 in the 90 OxyIR group ($p<0.0001$). By 3 weeks postoperatively, 80.8% of the 30Oxy patients and 74.8% of the 90Oxy patients discontinued the use of OxyIR (p=0.28). Within 90 days of discharge, 26.7% of the 30Oxy group and 10.5% of the 90Oxy group filled an OxyIR refill ($p<0.001$), leading to a mean of 777.1 MEQ versus 1089.7 MEQ prescribed for the 30 OxyIR and 90 OxyIR groups, respectively ($p<0.0001$). While there was no difference between groups in mean MEQ consumed, regression analysis demonstrated that being prescribed 90 OxyIR pills was independently associated with taking more OxyIR pills within 30 days of discharge when other variables were considered (p=0.028). There was no difference in pain scores within the first 30 days and no difference in patient reported outcome scores at 6 weeks postoperatively.

Conclusion: Prescribing fewer OxyIR pills is associated with a significant reduction in unused opioid pills and decreased opioid consumption with no increase in pain scores and no difference in patient reported outcomes. A single prescription for 30 pills of 5mg OxyIR given at the time of hospital discharge appears to be adequate for the majority of patients undergoing primary hip and knee arthroplasty. With over 1 million joint replacements performed annually in the US, discharge prescriptions of 30 opioid pills compared to 90 pills, could reduce the number of unused opioids pills in the U.S. by 58 million pills annually.

Conclusions

Irrigation and debridement can be an effective treatment for elbow periprosthetic joint infection, particularly in acute infections. Our preferred algorithm is to attempt an I&D with implant retention whenever possible as the initial treatment of PJI due to the destructive nature of removing well-fixed implants. Current evidence is limited to retrospective case series and one comparative study. Further prospective study with larger samples comparing I&D, 2-stage revision, and 2-stage revision performed after failed I&D would help elucidate proper treatment of elbow PJI.

Do Champagne Toast and Champagne Pour Clinical Tests Correlate with Location and Size of Rotator Cuff Tears?

Amanda J. Naylor, MA; Allison J. Rao, MD; Gregory L. Cvetanovich, MD; Michael C. O'Brien, MA; Michael D. Charles, MD; Gregory P. Nicholson, MD

Background: The "Champagne Toast" and "Pour" arm positions of manual muscle testing revealed a better isolation of supraspinatus activity compared to the Jobe test in a previous EMG study. The purpose of this study was to evaluate the clinical utility of preoperative "Champagne Toast" and "Champagne Pour" positions in patients with known rotator cuff tears undergoing rotator cuff repair (RCR) with regard to tear location and size.

Methods: 77 consecutive shoulders undergoing arthroscopic RCR were analyzed. There were 31 (40%) female and 46 (60%) male with an average age of 57.8 years (40-76). 68 (88%) of patients were right hand dominant, while 9 (12%) were left hand dominant, with the operative side being the right in 58%. An independent examiner performed manual muscle test examination trials for Toast, Pour, Jobe test, External rotation (ER) at side, and Belly press. The results of clinical pain and weakness responses were classified preoperatively.

Intraoperatively, tear size (A-P, M-L dimensions), tear location (anterior, central, and/or posterior within the supraspinatus), and status of the anterior band of the supraspinatus (intact/not intact) were recorded. We excluded any shoulders with previous surgery, stiffness, or neurologic conditions. Preoperative MRI were independently evaluated for tear location, size, and muscle grading (Goutallier). Descriptive statistical analysis with One-way ANOVA was performed for correlations between the tests and tear dimensions, area, location, and the status of the anterior band of the supraspinatus.

Results: Significant correlations were seen between pain rating in the Champagne Pour position and greater tear area ($p=.037$) and larger A-P dimension ($p=.011$). ER at side weakness trended toward a significant association with anterior supraspinatus tear location ($p=.062$). No significant correlations were seen between other preoperative physical exams and tear location, and no physical exam test results were associated with intraoperative status of the anterior band of the supraspinatus. The Jobe test for either pain or weakness did not clinically correlate to known rotator cuff tear size, location, or area.

Conclusion: The Champagne Pour position of manual muscle testing for supraspinatus activity elicited pain that significantly correlated with supraspinatus A-P dimension and total area of the tear. None of the other manual muscle physical exam tests had significant correlations.

Return to Sporting Activity after Ulnar Nerve Transposition for Isolated Neuritis in Competitive Overhead Athletes

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Introduction: Medial elbow pain secondary to ulnar neuritis can cause dysfunction and pain in overhead athletes. Although ulnar neuritis can occur secondary to pathologies including ulnar collateral ligament (UCL) tear, stress fractures, and traction apophysistis, isolated ulnar nerve dysfunction can also contribute to medial elbow pain. The purpose of this study is to evaluate the short-term functional outcomes of overhead athletes undergoing anterior ulnar nerve transposition for ulnar neuritis.

Methods: All overhead athletes with an isolated ulnar nerve transposition between 2009-2016 by three senior surgeons for refractory ulnar neuritis were identified. The primary outcome of interest was return to sport, and secondary outcome measures included the Kerlan-Jobe Orthopaedic Clinic (KJOC) shoulder and elbow score, Mayo Elbow Performance Score (MEPS), Disabilities of the Arm, Shoulder, and Hand (DASH) score, Single Assessment Numeric Evaluation (SANE), and Visual Analog Scale (VAS) for pain. Perioperative complications and rates of secondary reoperation were recorded.

Results: A total of 26 overhead athletes underwent ulnar nerve transposition at an average age of 18.4 years (SD 3.3; range, 11-25), including 21 males and 5 females. At an average of 54.4 months follow-up (+/-27.6; range 12-105), 24 patients (92.3%) returned to their sporting activity at an average of 2.67 months post-op, including 16 at the previous level of play (61.5%). Two patients (7.8%) experienced adverse outcomes, including one with persistent dysesthesias and one with medial elbow pain that compromised athletic performance. One additional patient needed subsequent reoperation for posteromedial olecranon impingement. Average VAS pain improved from 4.70 +/-2.46 preoperatively to 0.40 +/-1.49 postoperatively (p=0.015). The average postoperative PROs were: KJOC 79.83+/-18.56 [95% CI (72.70, 86.96)], SANE 85.05+/-25.06 [95% CI (75.42, 94.68)], Quick DASH 4.90+/-7.28 [95% CI (2.10, 7.70)], and MEPS 91.39+/-11.98 [95% CI (86.79, 95.99)].

Conclusion: Cubital tunnel syndrome can be a source of medial elbow pain in overhead athlete in the presence of a normal UCL. At mid-term follow up, 92.3% of overhead or throwing athletes were able to return to sporting activity after ulnar nerve transposition, with 61.5% resuming their previous level of performance. Furthermore, there was a low rate of symptomatic recurrence (3.8%) of preoperative ulnar nerve symptoms.

Is there a role for irrigation and debridement with implant retention for elbow periprosthetic joint infection? A systematic review

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Introduction: Periprosthetic joint infection (PJI) after total elbow arthroplasty (TEA) is a potentially devastating complication that can occur at a rate of 0-12%. Despite the prevalence of TEA PJI, there is no consensus over the optimal treatment. TEA implant revision is a technically challenging procedure. This is due to many factors, including limited bone stock, cortical thickness of the ulna and humerus, lack of soft-tissue coverage around the elbow, and the relative lack of TEA implant revision systems designed over the past 30 years.

Purpose: The purpose of this systematic review was to determine the role for irrigation and debridement with implant retention when treating elbow periprosthetic joint infection.

Materials and Methods: A systematic review was performed according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines to determine if there is a role for irrigation and debridement with implant retention for treatment of elbow periprosthetic joint infection and whether modular components should be exchanged. Three independent reviewers queried the PubMed and Scopus databases. Titles, abstracts, and full texts were screened. Inclusion criteria consisted of all primary literature written in English from all years that addressed the primary question. The primary end point was examination of infection recurrence. Extracted data was then qualitatively analyzed in order to address this study's primary question. When possible, infection recurrence rate was stratified by infection (acute defined as less than 3 months from the index procedure, subacute defined between 3 months and 12 months from the index procedure, late defined greater than 12 months after the index procedure). A meta-analysis was not performed given the clinical heterogeneity of the studies' treatment algorithms.

Results: Overall, 9 studies were included for qualitative analysis. A total of 198 patients were treated for prosthetic joint infection of a total elbow arthroplasty. Infection recurrence rates following each operation were as follows: irrigation and debridement (range 19-89%), staged revision (range 0-33%), and resection arthroplasty (0-13%). Stratified by infection timing, recurrence rates following irrigation and debridement were as follows: acute (0%, 50%, 60%, 80%), subacute (0%, 60%, 100%), and late (33%, 60%, 100%).

Table 1: Postoperative golf performance*			
	PRC (n=12)	FCA (n=25)	p-value
Return to golf	10 (83.3%)	20 (80.0%)	0.813
Timing of return to golf (months)			
In any capacity	8.0 ± 2.8	8.3 ± 2.4	0.813
With minimal pain	11.1 ± 2.0	10.8 ± 3.0	0.710
Steady state	11.1 ± 2.0	11.1 ± 3.3	1.000
Rounds played per year	37.0 ± 31.3	34.5 ± 29.2	0.836
Hours practiced per year	28.0 ± 14.0	30.8 ± 18.4	0.647
Level of golf performance compared to preoperatively, if returned			0.394
Worse	0 (0%)	0 (0%)	-
Same	2 (20%)	7 (35%)	-
Better	8 (80%)	13 (65%)	-
Change in golf level from preoperatively, if returned (scale 1-10; 1 worse, 10 better)	8.2 ± 1.1	7.6 ± 1.5	0.234
Expectations for returning to golf met (scale 1-10), all patients	7.2 ± 1.3	6.1 ± 1.4	**0.025
Satisfaction with golf participation (scale 1-10), all patients	8.1 ± 2.3	8.0 ± 2.3	0.919

*Data are expressed as mean ± standard deviation or number (percentage).

**Denotes statistical significance based on alpha level 0.05

Does Peritrochanteric Fat Thickness Increase the Risk of Early Reoperation Following Total Hip Arthroplasty?

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Introduction: Radiographically measured subcutaneous tissue depth in the peri-incisional area has been correlated with postoperative complications after cardiac, cervical spine, and total knee surgery. Its impact following primary total hip arthroplasty (THA) has not been studied. We hypothesize that radiographic measurement of peritrochanteric tissue thickness about the greater trochanter is a reproducible way to predict acute post-operative wound complications in THA patients.

Materials and Methods: A retrospective case-control analysis was performed at a single institution. Patients taken to the operating room within 90 days of their primary THA for any wound complication between 2008-2016 were identified. Patients <18 years old, with history of open surgery on the affected hip, or with inadequate radiographs were excluded. Patients were matched 1:1 for gender, age, BMI, and ASA score to THA patients without early wound complications. Measurements of two, independent observers were analyzed using paired t-tests and Pearson's correlation coefficients.

Results: There was no difference in peritrochanteric fat thickness measurements between no complication and complication cohorts including the sourcil to skin surface (89.5 $\pm$ 23.1mm vs. 91.9 $\pm$ 28.1mm, p=0.5), tip of greater trochanter to skin surface (52.9 $\pm$ 24.4mm vs. 53.7 $\pm$ 30.4mm, p=0.8), and lateral greater trochanter to skin surface (36.0 $\pm$ 23.3mm vs. 37.8 $\pm$ 30.3mm, p=0.6). Pearson's correlation coefficients were high (>0.9) for all measurements.

Conclusions: Contrary to other previously reported surgical procedures, radiographic measurement of subcutaneous depth is not a valid tool for predicting wound complications in the early post-operative period following total hip arthroplasty.

Physician Extenders in Hand Surgery: The Patient's Perspective

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Introduction: Midlevel providers (i.e. "physician extenders": physician assistants [PAs] and nurse practitioners [NPs]) are being integrated into health care systems due to the exponentially increasing demand for care. There is a paucity of literature regarding patients' perspectives towards midlevel providers in hand surgery.

Purpose: We hypothesized that hand patients will have distinct preferences regarding midlevel provider involvement in their care.

Materials and Methods: 939 consecutive first-time patients of three hand surgeons were administered an anonymous survey before their new patient visit. Content included patient perspectives towards midlevel providers, including: ideal scope of clinical practice, importance of midlevel provider credentials when initially choosing a hand surgeon, and reimbursement equity between hand surgeons and midlevel providers. Patient responses were tabulated, with means and percentages reported.

Results: Of 939 consecutive patients, 784 (84%) responded. 46% were female and 54% male with an average age of 44.1 ± 17.1 years. Most (65%) patients consider the training background of the midlevel provider when initially choosing a hand surgeon (Figure 1). Patients responded that certain clinical services should be physician-provided (Figure 2), such as: advanced diagnostic studies (e.g. MRI) (69%), follow-up for abnormal tests or imaging (68%), and new patient visits (67%). Patients were amenable to other specific services being midlevel-provided (Figure 2), including: minor in-office procedures (64%), preoperative teaching (63%), and long-term postoperative clinic visits (61%). Patient perspectives towards reimbursement equity for hand surgeons and midlevel providers were variable, despite 72% of patients responding that the hand surgeon provides a higher-quality consultation (Figure 1). These findings are pertinent to providers, patients, and payors as the midlevel workforce increases rapidly to address the rising demand for care.

Conclusions: As health care becomes increasingly consumer-centric and value-driven, a data-based approach in midlevel staff utilization will allow hand surgeons to optimize efficiency, quality, and patient satisfaction. In clinical staff planning, hand surgeons may consider which services patients prefer be physician-provided or midlevel-provided. It may be beneficial to include the midlevel provider in marketing efforts, as most patients considered the training background of the surgeon's midlevel provider when initially choosing a hand surgeon. Patients lacked a consensus towards reimbursement equity for hand surgeons and midlevel providers, despite reporting that the hand surgeon provides a higher quality exam and consultation.

High Return to Golf Rates after Proximal Row Carpectomy and Four-Corner Arthrodesis for Scapholunate and Scaphoid Nonunion Advanced Collapse

Nitin Goyal MD, Faisal Akram BS, Andrew G. Tsai MD, Robert W. Wysocki MD

Introduction: The most common motion preserving reconstructive procedures to treat scapholunate (SLAC) and scaphoid nonunion advanced collapse (SNAC) arthritis include proximal row carpectomy (PRC) and scaphoid excision with four-corner arthrodesis (FCA). It has been long debated how outcomes differ between the two procedures especially in range of motion and grip strength, both of which are factors that can theoretically contribute to golf performance. To date, there is no strong evidence surgeons can use in counseling patients regarding their ability to return to golf after PRC or FCA.

Purpose: Our purpose was to quantify the rate of preoperative golf participation and characterize patients' ability to return to golf after undergoing PRC and FCA for scapholunate SLAC/SNAC arthritis. We hypothesized that patients would return to golf faster after PRC than FCA given the shorter immobilization time.

Materials and Methods: All PRC and FCA performed between September 2011 and July 2017 at a single institution were reviewed. Patients were included if the indication for surgery was SLAC or SNAC arthritis and if they participated in golf on a regular basis preoperatively. Patients were contacted at a minimum of 1 year postoperative and surveyed about golf participation.

Results: A total of 90 patients were surveyed. Thirty-seven patients (12 PRC, 25 FCA; 41.1% of surveyed patients) participated in golf on a regular basis preoperatively. Overall, 83.3% of PRC and 80.0% of FCA patients returned to golf in some capacity at a mean of 8.0 months and 8.3 months, respectively **(Table 1)**. With regard to level of golf played, 80% of PRC and 65% of FCA patients returned to a subjectively better level of golf compared to preoperatively. Satisfaction with participation in golf was 8.1/10 in the PRC group and 8.0/10 in the FCA group. No significant differences in return to golf were found between groups.

Conclusions: This study found a relatively high rate of return to golf, often with improvement in golf performance after PRC and FCA. Surgeons can utilize this information to set appropriate expectations.

Table 1. Analysis of reoperation following primary TEA and ORIF

	TEA	ORIF	Adjusted HR†	95% CI	P-value
Overall					
Total number of patients	142	522			
Reoperations	12.7%	24.5%	0.57	0.35-0.93	0.025**
1-year					
Number at-risk	113	449			
Reoperations	6.1%	23.0%	0.26	0.12-0.57	<0.001**
2-year					
Number at-risk	98	394			
Reoperations	12.8%	25.8%	0.47	0.27-0.82	0.008**
5-year					
Number at-risk	42	232			
Reoperations	15.3%	27.2%	0.55	0.33-0.92	0.021**

TEA = total elbow arthroplasty; ORIF = open reduction internal fixation; HR = hazard ratio; CI = confidence interval

** indicates statistical significance.

†Associations are adjusted for age (65-69, 70-74, 75-79, 80-84, ≥85 years), sex, race (white, black, other/unknown), census region (Midwest, Northeast, South, West), Charlson Comorbidity Index (0, 1-2, 3-4, ≥5 points), year of procedure, socioeconomic status (using presence/absence of state Medicare buy-in).

Table 2: Reoperations following primary TEA and ORIF*

Reoperation	TEA (n=142)		ORIF (n=522)	
	Incidence	Time to reoperation (months)	Incidence	Time to reoperation (months)
ORIF	2 (1.4%)	36.2 ± 48.6	20 (3.8%)	13.8 ± 36.7
Revision TEA	7 (4.9%)	14.1 ± 11.7	-	-
Conversion to TEA	-	-	19 (3.6%)	13.8 ± 17.1
Resection arthroplasty	-		1 (0.2%)	16.2
Removal of implant/ hardware	7 (4.9%)	18.5 ± 11.5	67 (12.8%)	9.4 ± 12.8
Elbow release	2 (1.4%)	11.7 ± 6.6	15 (2.8%)	8.8 ± 9.4
Ulnar nerve surgery	1 (0.7%)	0.8	20 (3.8%)	6.6 ± 6.3
Irrigation and debride-ment	1 (0.7%)	1.6	-	-
Single stage revision	1 (0.7%)	11.0		

*Data are expressed as mean ± standard deviation or number (percentage).

TEA = total elbow arthroplasty; ORIF = open reduction internal fixation

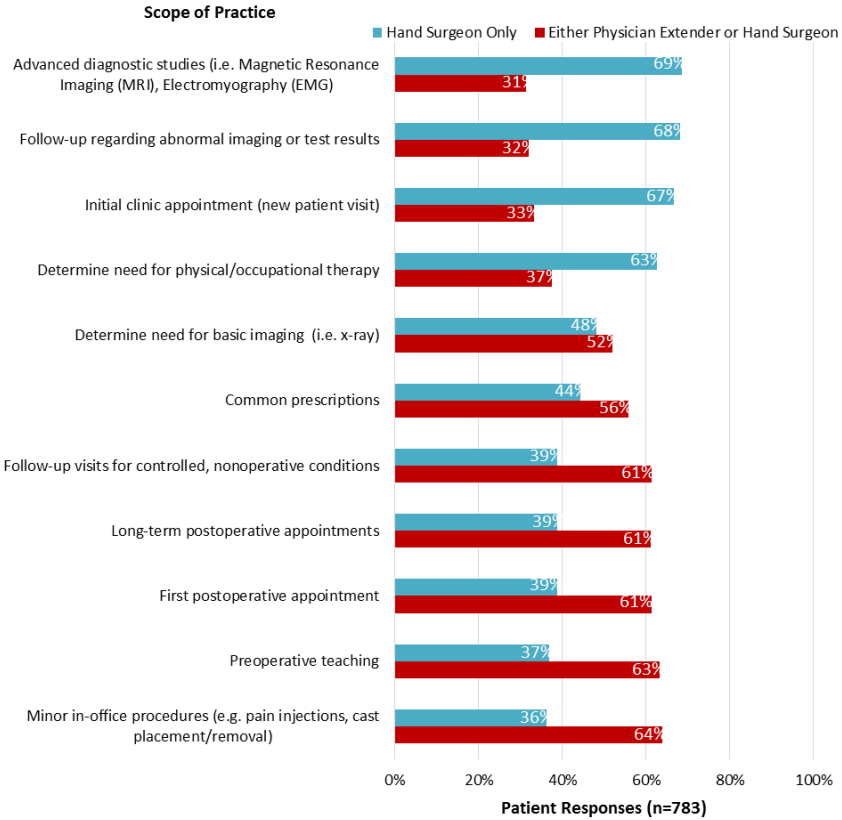

Figure 2: Midlevel Providers' Scope of Practice in Hand Surgery
Survey participants were asked "In a hand clinic, who should provide…?" with each respective clinical service subsequently listed. Response options were "Should be provided by hand surgeon only" or "Can be provided by either physician extender or hand surgeon".

Role of the Triangular Fibrocartilage Complex in Distal Radioulnar Joint Stability: A Biomechanical Assessment

Timothy J. Luchetti, MD[1]; Brandon J. Manderle, MD[1]; Elizabeth Shewman, PhD, MS[2]; Anirudh K. Gowd, MD[1]; Alexander Beletsky, BA[1]; John J. Fernandez, MD[1]

Introduction: The triangular fibrocartilage complex (TFCC) is a key stabilizer of the distal radioulnar joint.[2,3] The role of the central TFC in distal radio-ulnar joint (DRUJ) stability is unclear. Degenerative tears of the TFCC are often treated via arthroscopic debridement. Surgeons typically perform a minimal resection in an effort to avoid iatrogenic destabilization of the DRUJ. Currently, there is a paucity of objective data to guide the treating surgeon as to the limits of safe resection. Studies suggest that roughly 20% of patients may experience persistent symptoms after surgery, with inadequate resection a likely culprit.[1,4]
Purpose: To determine what effect, if any, sequential and complete resection of the central TFCC confers on sagittal stability of the DRUJ.
Materials and Methods: Ten fresh-frozen cadaver upper extremities were used. All skin, muscles, and capsuloligamentous structures from the elbow down were preserved. The humerus and radius were affixed to a custom wrist jig designed to isolate DRUJ motion while allowing forearm rotation. For biomechanical testing, the ulna was attached to a materials testing machine (MTS) (Eden Prairie, Minnesota). Load-displacement curves were obtained while translating the ulna dorsally or palmarly with respect to the radius at a velocity of 1.25mm/s. This was repeated in neutral forearm rotation, 60 degrees of pronation, and 60 degrees of supination. Arthroscopic measured resection of the central 50% of the TFCC was performed and MTS testing was repeated. A second arthroscopic resection to remove 100% of the TFCC was performed and a third iteration of MTS testing was repeated. CT imaging was obtained in all three positions (60° pronation, neutral, and 60° supination) before and after testing. Statistical comparisons of DRUJ stability were compared using described static measurements of the DRUJ on axial CT sequences. A two-way ANOVA with subsequent Tukey Honest Significance Difference (HSD) was performed examining the 2 independent variables of TFCC resection state and forearm position to determine their independent effects on sagittal stability of the DRUJ.
Results: Forearm position independently affected DRUJ stability ($p=0.003$), with significantly more displacement seen in neutral position than pronated position (8.29 ± 2.32 vs. 6.79 ± 2.37, $p=0.022$), or supinated position (8.29 ± 2.32 vs. 6.45 ± 1.75, $p=0.004$). TFCC resection had no statistical effect on DRUJ stability ($p=0.08$). Axial CT static measurements also failed to demonstrate any significant change in radio-ulnar relationship after complete resection of the central TFCC.
Conclusions: These findings suggest that the central portion of the TFCC has no bearing on DRUJ stability in the sagittal plane. Inadequate resection of this structure may be a source of persistent pain after debridement. Iatrogenic instability of the DRUJ is unlikely, and the surgeon should feel comfortable resecting a significant portion of the central TFCC in order to avoid persistent pain and poor outcomes.

Lower Risk of Reoperation Associated with Total Elbow Arthroplasty Versus Open Reduction and Internal Fixation for Distal Humerus Fractures in Elderly Patients

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Introduction: Total elbow arthroplasty (TEA) and open reduction and internal fixation (ORIF) are valid surgical options for treating intra-articular distal humerus fractures in elderly patients. Comparative studies have demonstrated either lower or similar complication rates for TEA compared with ORIF. However, these studies are limited by small sample sizes or short-term follow-up, and were performed primarily at academic centers.

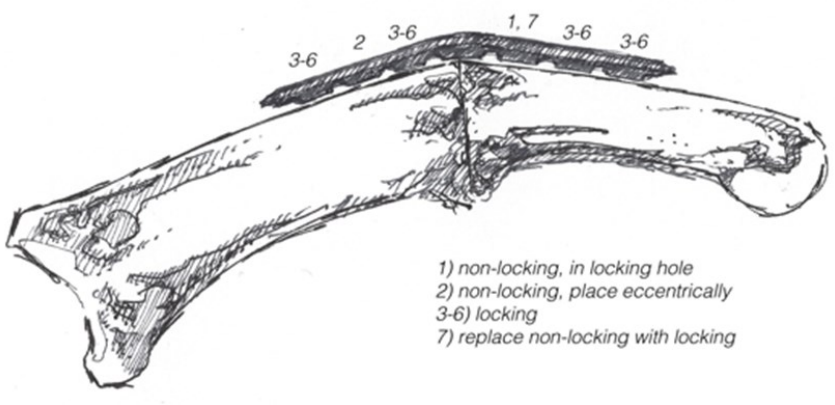
Purpose: Our purpose was to compare risk for reoperation following TEA and ORIF for intra-articular distal humerus fractures in elderly patients using a large, national database with potential for longer follow-up. We hypothesized that TEA would be associated with an overall lower risk for reoperation compared to ORIF.

Materials and Methods: A retrospective comparative study was conducted using the 5% Medicare Part B claims database. Patients over 65 with closed distal humerus fractures undergoing primary TEA or ORIF from 1996-2016 were included. Subsequent reoperations including ORIF, revision TEA, conversion to TEA, removal of hardware/implant, elbow release, ulnar nerve surgery, resection arthroplasty, arthrodesis, elbow arthroscopy, irrigation and debridement, and staged revision for infection were analyzed. Overall risk of reoperation was compared between TEA and ORIF groups using multivariate Cox proportional hazards modeling, controlling for age, gender, race, region, Medicare buy-in, and Charlson Comorbidity Index (CCI).

Results: A total of 664 patients were identified, of which 142 underwent TEA and 522 underwent ORIF. Patients undergoing TEA had greater age and greater CCI compared to patients undergoing ORIF ($p<0.05$). TEA was associated with an overall significantly decreased risk for reoperation compared to ORIF (12.7% vs 24.5%; adjusted hazard ratio=0.57; $p=0.025$) **(Table 1)**. Revision TEA occurred in 4.9% of patients **(Table 2).** The death rate was 65.5% in TEA group at a mean of 3.6 years and 55.7% in ORIF group at a mean of 4.9 years.

Conclusions: In this study, TEA was associated with a decreased risk for reoperation compared to ORIF. The relatively high death rate within several years of the index procedure may contribute to the low TEA revision rate even when attempting to follow patients into the medium and long-term. This database data adds to the growing support for TEA as the superior treatment option compared to ORIF for intra-articular distal humerus fractures in the elderly.

Figure 1: Illustration demonstrating order of screw placement in dorsal locking plate.



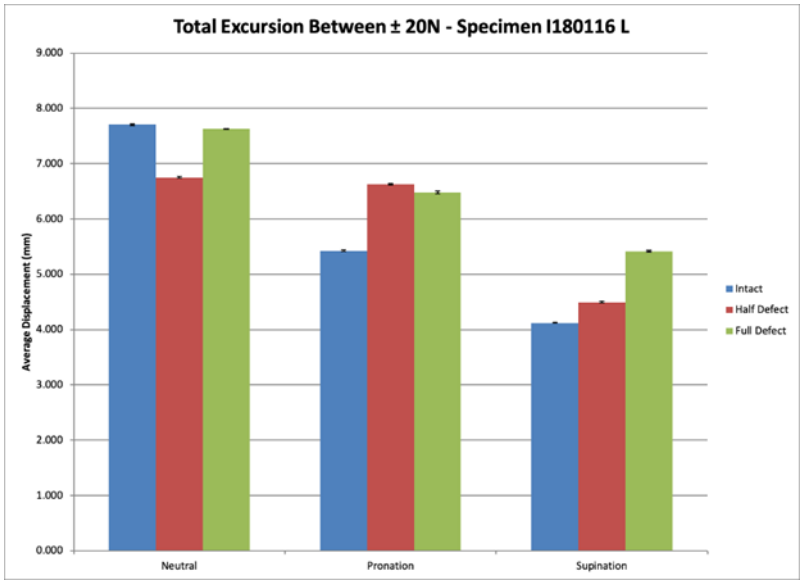
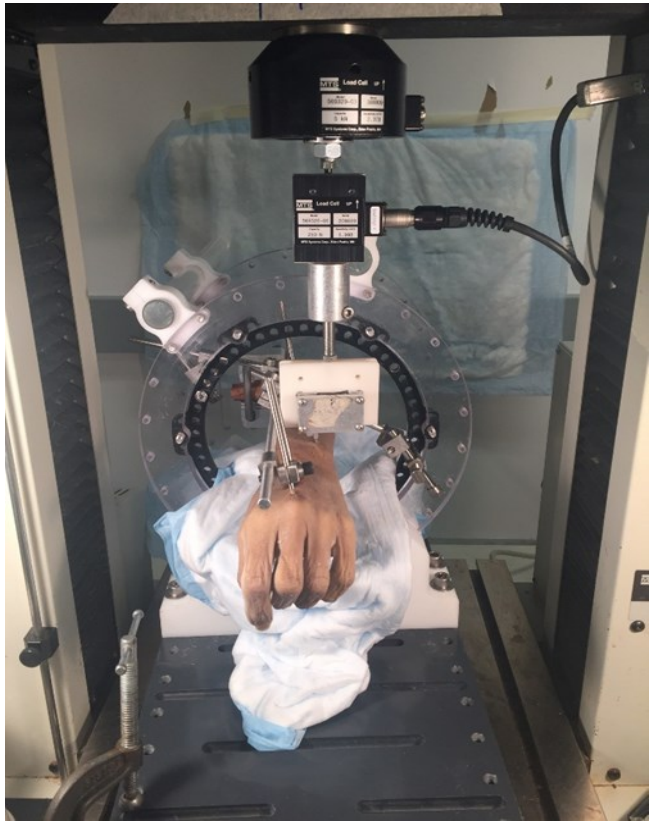


Table 1: Achievement of union stratified by plate length and number of screws	
	Successful union without revision
Plate length	
5-hole	1 (33.3%)
6-hole	2 (100%)
7-hole	7 (100%)
8-hole	1 (100%)
Number of screws	
4 screws	1 (33.3%)
5 screws	1 (100%)
6 screws	7 (100%)
7 screws	2 (100%)
*Data are expressed as number (percentage).	



Hypoalbuminemia Is Associated with Increased Postoperative Mortality and Complications in Hand Surgery

Timothy J. Luchetti, MD; Andrew Chung, DO; Neil Olmscheid, BA; Daniel D. Bohl, MD, MPH; and Joshua W. Hustedt, MD, MHS

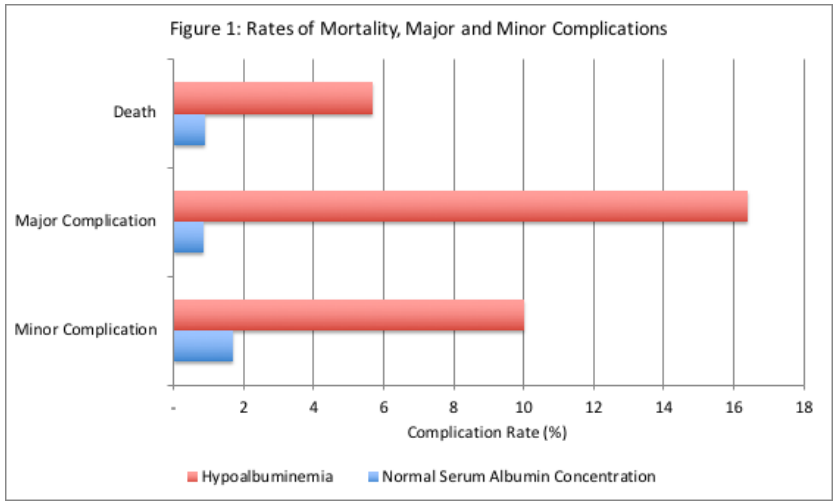
Background: Malnutrition has been associated with increased perioperative morbidity and mortality in orthopedic surgery.

Purpose: This study was designed with the hypothesis that preoperative hypoalbuminemia, a marker for malnutrition, is associated with increased complications after hand surgery.

Materials and Methods: A retrospective cohort study of 208 hand-specific Current Procedural Terminology codes was conducted with the American College of Surgeons National Surgical Quality Improvement Program database from 2005 to 2013. In all, 629 patients with low serum albumin were compared with 4079 patients with normal serum albumin. The effect of hypoalbuminemia was tested for association with 30-day postoperative mortality, and major and minor complications.

Results: Hypoalbuminemia was independently associated with emergency surgery, diabetes mellitus, dependent functional status, hypertension, end-stage renal disease, current smoking status, and anemia. Patients with hypoalbuminemia had a higher rate of mortality, minor complications, and major complications.

Conclusions: Hypoalbuminemia is associated with an increased risk of postoperative morbidity and mortality in patients undergoing hand surgery. As such, increased focus on perioperative nutrition optimization may lead to improved outcomes for patients undergoing hand surgery.



Index Finger Metacarpophalangeal Joint Arthrodesis with a Dorsal Locking Plate

Nitin Goyal M.D., David J. Wilson M.D., Michael B. Salzano B.S., Robert W. Wysocki M.D., Mark S. Cohen M.D., John J. Fernandez M.D

Introduction: Index finger metacarpophalangeal (MCP) joint arthrodesis and arthroplasty are potential reconstructive options for recalcitrant MCP arthritis. While MCP arthroplasty is often strongly recommended in the long, ring, and small fingers in an effort to preserve motion, the radially directed load from pinch applied to the index finger leads many to favor arthrodesis in order to provide a stable post for pinch. In the setting of rheumatoid arthritis involving ulnar drift at multiple MCP joints, an index finger arthrodesis may serve as protection of adjacent arthroplasties from ulnarly directed forces during pinch and grasp.

Purpose: We present a series of patients treated with index finger metacarpophalangeal arthrodesis using a dorsal locking plate. The purpose of this study was to describe our surgical technique and evaluate union rate, time to fusion, complications, and prevalence of reoperations. We hypothesized that index finger metacarpophalangeal arthrodesis using a dorsal locking plate would have a high union rate.

Methods: Consecutive cases of index finger metacarpophalangeal arthrodesis with a dorsal locking plate performed by two surgeons at a single institution between January 2014 and July 2018 were identified. All patients underwent arthrodesis with a dorsal locking plate with compression technique **(Figure 1)**. Union rate, time to fusion, complications, and reoperation rate were analyzed. Patients were contacted via telephone and DASH and VAS scores were obtained. Patients were additionally surveyed regarding their satisfaction with the operation.

Results: Twelve consecutive patients (13 index fingers) underwent index finger metacarpophalangeal arthrodesis with a dorsal locking plate. The mean length of follow-up was 16.0 months (range 5.6 to 30.6 months). Eleven cases (84.6%) went on to union at mean of 11.6 weeks. Overall, a total of five patients required reoperation (38.5%). One patient underwent revision arthrodesis for nonunion (7.7%) and one patient underwent revision for hardware failure with associated infection (7.7%). Both of the above patients had 4 cortices of fixation on either side of the arthrodesis site, whereas a majority of the other cases (82%) had at least 6 cortices of fixation **(Table 1)**. Three patients underwent hardware removal for symptomatic hardware (23.1%). The mean (± standard deviation) DASH score was 25.7 ± 14.0. The mean VAS score was 1.7 ± 0.9. Subjective satisfaction the index finger metacarpophalangeal joint arthrodesis was reported as 7.8 ± 2.1 (out of 10).

Conclusions: Index finger metacarpophalangeal arthrodesis is a reliable, overall well tolerated alternative reconstructive option for a deformed or damaged index finger metacarpophalangeal joint. At least 6 cortices of fixation should be used proximal and distal to the arthrodesis site.

Table 1: Patient characteristics*			
	TXA (n=10)	Non-TXA (n=21)	p-value
Age (years)	52.8 ± 8.0	50.5 ± 13.7	0.568
Male	8 (80.0%)	18 (85.7%)	1.000
Post-traumatic arthritis (versus osteoarthritis)	3 (50.0%)	9 (42.9%)	1.000
Two incisions (versus one incision)	7 (33.3%)	1 (10.0%)	0.222

TXA = tranexamic acid

*Data are expressed as mean ± standard deviation or number (percentage)

A Novel Text-Messaging Automated System is Effective in Patients Undergoing Total Joint Arthroplasty

Kevin J. Campbell, MD, Philip K. Louie, MD, Daniel D. Bohl, MD, MPH, Tori Edmiston, MD, Christopher Mikhail, MD, Jefferson Li, BA, Derek Khorsand, MD, Brett R. Levine, MD, Tad L. Gerlinger, MD

Background: Digital patient engagement platforms are designed to improve the efficacy of the perioperative home, but the currently available solutions have shown low patient and provider adoption. The purpose of this study was to evaluate the effectiveness of a text-messaging (SMS) bot with respect to patient engagement following joint replacement procedures in a randomized clinical trial.

Methods: One hundred and fifty-nine patients (83 in control group, 76 in intervention group) were enrolled in a randomized controlled clinical trial comparing the effectiveness of an SMS bot (intervention group) with the traditional perioperative education process (control group) in patients undergoing primary total knee and hip arthroplasty. There were no significant differences in the demographic characteristics between the two groups. Time participating in home-based exercises (primary outcome), knee range of motion, the use of narcotics, Visual Analog Scale (VAS) mood score, calls to the office, patient satisfaction, and visits to the emergency department (ED) were measured and compared between the two groups. Continuous outcomes were analyzed using linear regression, while categorical outcomes were analyzed using Pearson's chi-squared test.

Results: Patients in the intervention group exercised for 8.6 minutes more per day (46.4 ± 17.4 vs 37.7 ± 16.3 minutes; $p<0.001$), experienced better moods (7.5 ± 1.8 vs 6.5 ± 1.7 VAS; $p<0.001$), stopped their narcotic medications 10 days sooner (22.5 ± 13.4 vs 32.4 ± 11.8 days; $p<0.001$), placed fewer phone calls to the surgeon's office (0.6 ± 0.8 vs 2.6 ± 3.4 calls; $p<0.001$), had greater knee ROM three weeks after surgery (101.2° ± 11.2° flexion vs 93.8° ± 14.5° flexion; $p=0.008$), but had equal ROM at 6 weeks. There was a trend towards fewer visits to the ED in the interventional group, but this comparison lacks statistical power at this time.

Conclusions: An SMS bot can improve clinical outcomes and increase patient engagement in the early postoperative period in patients undergoing hip and knee arthroplasty.

The Cervical Spine: How Does the Work We've Done Yesterday, Make a Lasting Global Impact Tomorrow?

Philip K. Louie, MD

Introduction: According to the Global Burden of Disease studies reported in The Lancet, neck pain was the 4th leading cause of disability worldwide, due largely to degenerative changes. If conservative measures fail to alleviate the neck pain and radicular/myelopathic symptoms, an anterior discectomy and fusion (ACDF) is successful to relieve the disabling symptoms. However, there remain a modest percentage of patients who experience suboptimal radiographic and clinical outcomes following surgery.

Purpose: To present a summary of my research to determine/predict which patients will do well or are at risk of suboptimal outcomes following an ACDF. While addressing how this work can create a lasting global impact.

Methods: This review summarizes studies performed starting July 2014 and include work that is still in process. There are many factors that play significant roles in the radiographic and clinical outcomes following an ACDF. The clinical studies were divided into the following impact groups: 1) perioperative patient specific factors, 2) the role of radiographic measurements and findings, and 3) iatrogenic factors: surgeon volume, patient selection, and surgical technique. Lastly, I will describe how current studies developing patient risk profiles and potential guidelines can leave a global footprint with a lasting impact.

Results:

Part 1: How can we identify/predict which patients will do well after an ACDF surgery?

Looking specifically at patient-specific perioperative features prior to surgery, our studies have identified factors that may be associated with suboptimal outcomes, including: obesity, gender, duration of symptoms, and the use of patient-controlled analgesia (PCA). Radiographically, we have focused on risk-factors and associations related to the development of adjacent segment degeneration (ASD). Evaluations of various parameters have helped us identify specific surgical techniques and radiographic features that may impact outcomes, including: number of levels fused, rigidity of plating system, radiographic sagittal parameters, type of bone graft used, as well as specific anatomic considerations of adjacent level spondylolisthesis and the cervicothoracic junction. Additionally, the role of the surgeon plays the greatest role in ACDF outcomes. Our work has identified the role of surgeon volume, as well as educating future surgeons on the importance of patient selection/meticulous surgical technique through the creation of the Video Atlas of Spine Surgery and a Spine Surgery Skills Training Simulator.

Part 2: Where are we headed and how can we make a global impact with our efforts?

Similar to many other areas of medicine that have developed risk profiles and guidelines for more precision in patient care, we are filling this research and clinical gap in spine surgery through the development of machine learning/artificial intelligence and predictive clinical modeling of degenerative cervical spine conditions and their respective imaging. As well as peri-operative protocols, such as an international anticoagulation practice guideline through AOSpine.

The Use of Tranexamic Acid in Open Elbow Release

Nitin Goyal M.D., David J. Wilson M.D., Robert W. Wysocki M.D., John J. Fernandez M.D., Mark S. Cohen M.D.,

Introduction: Tranexamic acid (TXA) has been shown to be safe and effective in reducing perioperative blood loss in hip, knee, and shoulder arthroplasty. There are no reports regarding the efficacy of TXA in open elbow release, a procedure that typically has notable perioperative blood loss due to bony debridement.

Purpose: Our purpose was to compare drain output, estimated blood loss, and postoperative transfusion rate in patients who have and have not received perioperative TXA for open elbow release with bony debridement. We hypothesized the TXA group would be associated with less perioperative blood loss compared to the non-TXA group.

Materials and Methods: Consecutive open elbow releases with bony debridement performed by a single surgeon between September 1, 2017 and April 1, 2019 were identified. Beginning on November 29, 2018, the use of perioperative TXA was implemented as part of routine care. These patients received an intravenous dose (1 gram) of TXA within 30 minutes prior to incision and a topical dose of TXA (1 gram in 20 mL saline solution) that was infused into a deep hemovac drain after fascial closure. A tourniquet was used on all patients. The drain was pulled on postoperative day 1 approximately 24 hours after placement. Unpaired Student's t-tests for continuous variables and Fischer's exact tests for categorical variables were used to compare age, gender, diagnosis (post-traumatic arthritis versus osteoarthritis), and number of incisions utilized (one versus two) between TXA and non-TXA groups. Unpaired Student's t-tests were used to compare estimated blood loss, drain output, postoperative transfusion frequency, and postoperative aspiration in clinic between TXA and non-TXA groups.

Results: Thirty-one consecutive patients underwent open elbow release with bony debridement, including 21 who did not receive perioperative TXA followed by 10 who did. Groups were similar with regard to age, gender, diagnosis, and number of incisions utilized ($p>0.05$ for all) (**Table 1**). Drain output was significantly lower in the TXA group (131.5 ± 120.3 mL, range 10-340 mL) compared to the non-TXA group (242.7 ± 147.1 mL, range 50-660 mL) ($p=0.036$). Estimated blood loss was similar between TXA group (44.5 ± 38.6 mL, range 10-125 mL) and non-TXA group (49.0 ± 34.3 mL, range 5-125 mL) ($p=0.755$). No patient required a blood transfusion. There was no statistically significant difference in postoperative aspiration frequency between the TXA group (30%) and non-TXA group (4.8%) ($p=0.144$).

Conclusions: Tranexamic acid was associated with significantly decreased drain output in this study. Perioperative use of tranexamic in open elbow release with bony debridement is effective in reducing perioperative blood loss. There was a trend toward increased postoperative aspiration in clinic in the TXA group, suggesting that these patients may have deferred blood accumulation.

Figure 1: A standard dorsal approach to the wrist between the 3rd and 4th compartments is performed. An ulnar incision is utilized to protect the dorsal cutaneous branch of the ulnar nerve.

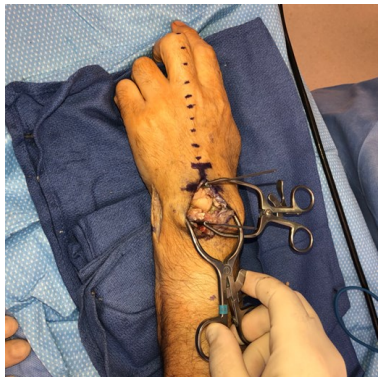


Figure 2: A cerclage wire is placed across the screws under direct visualization. The wrist is ulnarly deviated and the wires are pulled radially

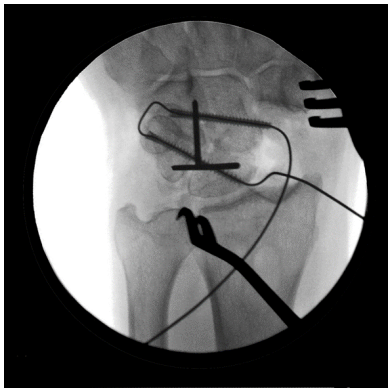
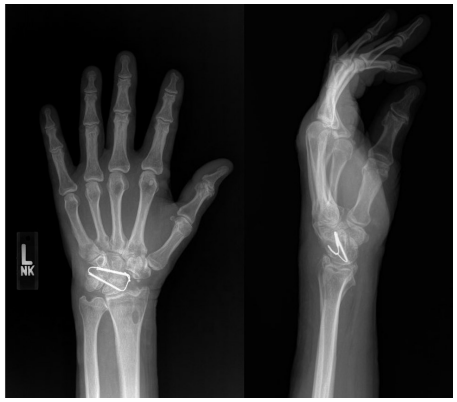


Figure 3: Postoperative radiographs demonstrating cerclage fusion device in place



Comparison of Stand-alone Lateral Lumbar Interbody Fusion and Open Laminectomy and Posterolateral Instrumented Fusion in the Treatment of Adjacent Segment Disease following Previous Lumbar Fusion Surgery

Philip K. Louie, Jannat M. Khan, Gregory D. Lopez, Howard S. An, Frank M. Phillips

Introduction: Adjacent segment disease (ASD) following previous lumbar spine fusion can lead to severe back pain, radiculopathy and/or neurogenic claudication. Varied surgical fusion techniques can be applied with varying morbidity. Stand-alone lateral lumbar interbody fusion (LLIF) may be an attractive option as it provides a less-invasive solution to achieve interbody fusion and indirect spinal canal decompression.

Purpose: To evaluate clinical and radiographic outcomes for patients who underwent stand-alone LLIF or open laminectomy and posterolateral instrumented fusion for symptomatic ASD.

Methods: 47 consecutive patients who underwent LLIF or PLF for symptomatic ASD between January 2007 and August 2016 after failure of conservative management. Patient-reported outcomes (PROs) were collected on all patients at pre-operative, post-operative and most recent post-operative visit using the Oswestry Disability Index, Visual Analog Scale (VAS) –Back, and VAS–Leg surveys. Pre-operative, immediate post-operative and most recent post-operative radiographs were assessed for: pelvic incidence, fusion, intervertebral disc height, segmental and overall lumbar lordosis (LL). Symptomatic ASD was diagnosed if back pain, neurogenic claudication, or lower extremity radiculopathy presented following a previous LF. Pre-operative plain radiographs were evaluated for evidence of adjacent segment degeneration.

Results: 47 patients (23 LLIF, 24 PLF) met inclusion criteria. Operative times ($p<0.001$) and intra-operative blood loss ($p<0.001$) were significantly higher in the PLF group. Patients who underwent PLF were discharged approximately 3 days after the LLIF patients ($p<0.001$). PROs in the PLF and LLIF cohorts showed significant and equivalent improvement, with equivalent radiographic fusion rates. LLIF significantly improve segmental lordosis ($p<0.001$), total LL ($p=0.003$) and disc height ($p<0.001$) from pre-operative to immediate post-operative and final follow-up ($p=0.004$, $p=0.019$, $p=<0.001$, respectively).

Conclusions: Stand-alone LLIF appears to be a safe and effective approach with substantially less peri-operative morbidity, shorter length of hospitalization, acceptable complication rates, significantly better restoration of radiographic sagittal alignment parameters, and similar successful PROs compared to patients undergoing open PLF for symptomatic ASD.

Sagittal Alignment Parameters and Radiographic Changes Associated with Early Adjacent Segment Pathology after Anterior Cervical Discectomy and Fusion

Philip K. Louie; Bryce A Basques; Arya Varthi; Justin C Paul; Dino Samartzis; Edward J Goldberg; Howard S An

Introduction: Changes in cervical alignment from pre- to post-operative may alter cervical spine mechanics, and increase rate of early ASD.

Purpose: To evaluate the relationship between pre- and post-operative cervical spine sagittal alignment, and identify early radiographic changes suggestive of adjacent segment degeneration (ASD) following anterior cervical discectomy and fusion (ACDF).

Methods: Retrospective cohort analysis was conducted of patients undergoing ACDF who developed early radiographic ASD(+) [103] matched with those without ASD(-) [132] at average 1-year follow-up. Radiographic measurements: change in C2-C7 lordosis, T1 angle, levels fused, sagittal vertical axis, fusion mass lordosis, proximal and distal adjacent segment lordosis. Radiographic ASD indicated by: new/enlarged osteophytes, spondylolisthesis, endplate sclerosis, disc space narrowing >30%, and/or increased calcification of the anterior longitudinal ligament. Patient-reported outcomes (PROs) obtained as Neck Disability Index and Visual Analog Scales scores for neck and arm.

Results: Greater kyphosis throughout the cervical spine at final follow-up (OR 0.97, p=0.040), greater pre-operative kyphosis through the planned fusion segment (OR 0.93, p=0.003), loss of lordosis through the fusion from initial post-op to final follow-up (OR 0.85, p<0.001), and greater change in pre- to post-operative fusion segment lordosis (OR 1.06, p=0.019) were all found to exhibit a greater risk of ASD. Specifically, patients with ≤2 radiographic ASD signs had a reoperation rate of 2.73%, while patients with ≥3 signs experienced a reoperation rate of 31.25% (p<0.001). All patients showed improvement in PROs. Reoperation, fusion, and subsidence rates were similar for both groups.

Discussion/Conclusion: Greater pre-operative cervical kyphosis, kyphosis through the proposed fusion segment, greater correction of cervical lordosis post-operatively, and loss of lordosis at fusion segment may have greater odds of developing early radiographic ASD, and subsequent clinical symptoms at these levels. Thus, there is a balance between over- and under-correction of lordosis that warrants further exploration.

Cerclage Fusion Technique for Four-Corner Arthrodesis

Nitin Goyal MD, Daniel D. Bohl MD MPH, John J. Fernandez MD

Introduction: Four-corner arthrodesis is commonly performed for symptomatic scapholunate advanced collapse and scaphoid nonunion advanced collapse arthritis. Current described techniques for achieving four-corner arthrodesis include Kirschner wires, headless screws, staples, and dorsal plates, each method with its own potential limitations. Potential complications associated with current techniques include nonunion, hardware issues, and dorsal impingement. A method for achieving four-corner arthrodesis with strong internal fixation and effective compression while avoiding dorsal and cartilage bearing surfaces can maximize the benefits of the fusion while minimizing the aforementioned complications.

Purpose: We present a cerclage fusion technique for achieving four-corner arthrodesis. Proposed benefits of this technique include ease of fixation placement in the coronal plane, inclusion of a large surface area for compression, avoidance of dorsal and cartilage bearing surfaces, and the ability to adjust sagittal alignment in the midcarpal joint.

Surgical Technique: A dorsal approach to the wrist is performed, and the scaphoid is resected in its entirety. A separate 2 centimeter incision is made along the ulnar carpus extending from the distal ulna to the ulnar aspect of the hamate **(Figure 1)**. The dorsal cutaneous branch of the ulnar nerve and its branches are identified and protected. Dissection is carried down ulnar to the extensor carpus ulnaris tendon, exposing the ulnar portion of the hamate and triquetrum. Guide pins and subsequent cannulated screws are placed across the triquetrum and lunate, as well as the capitate and hamate. The midcarpal joint is distracted and decorticated with a high-speed burr. A 20-gauge stainless steel cerclage wire is passed through the screws and tensioned radially with neutral sagittal alignment, yielding even compression through the midcarpal joint **(Figure 2)**. The dorsal capsule, soft tissues, and skin are closed in a layered fashion. A volar splint is applied, and the patient is immobilized with subsequent short-arm casting at the first follow-up appointment. The cast is converted to a removeable thermoplastic splint at 6-8 weeks depending on radiographic appearance and clinical examination. A CT scan is typically confirmed at 8-10 weeks to confirm successful fusion, after which the patient is weaned from the splint and is allowed to engage in passive range of motion, stretching, and progressive strengthening.

Case Illustration: A 70-year-old male presented with over 2 years of left wrist pain. Radiographs demonstrated SLAC III wrist. The patient underwent a four-corner arthrodesis with cerclage fusion technique **(Figure 3)**. At his 6-week follow-up visit, radiographs demonstrated excellent alignment, presence of cerclage fusion, and consolidation at the fusion sites (Figure 11B). The patient underwent therapy focusing on range of motion and strengthening. At his most recent visit at 4.5-months post-operative, the patient reported excellent pain relief and is scheduled for a four-corner arthrodesis of the contralateral wrist.

Conclusions: The described cerclage fusion technique for achieving four-corner arthrodesis has several potential benefits, including ease of fixation placement, even compression, and avoidance of cartilage bearing surfaces. Further study is necessary to evaluate patient clinical and functional outcomes.

Table 1: Predictors of time spent in the patient's room.

	Aver-age time (±	Coeff.	95% CI	P-value
Age				
<50 years	**6.5±3.9**	**Ref.**		
≥50 years	**8.5±4.6**	**2.0**	**0.8 to 3.1**	**<0.001**
Sex				
Male	**6.4±4.2**	**Ref.**		
Female	**8.1±4.4**	**-1.7**	**-2.9 to -0.5**	**0.005**
Type of appointment				
New patient	**8.5±4.3**	**Ref.**		
Follow-up patient	**6.7±4.3**	**-1.7**	**-0.5 to -2.9**	**0.005**
Outside records reviewed				
No	**7.1±4.2**	**Ref.**		
Yes	**9.5±4.7**	**2.4**	**0.6 to 4.3**	**0.010**
X-Rays obtained				
No	7.2±4.3	Ref.		
Yes	7.8±4.4	0.6	-0.7 to 1.8	0.381
Patient paperwork not completed before appointment				
No	7.8±3.9	Ref		
Yes	7.3±4.4	-0.5	-2.1 to 1.2	0.576
Provider seeing patient prior to attending				
Resident/Fellow	7.3±4.1	Ref.		
Physician Assistant	7.4±4.5	0.1	-1.0 to 1.3	0.811
Patient late for appointment				
No	7.4±4.4	Ref.		
Yes	7.4±4.3	0.04	-1.2 to 1.3	0.956

SD= Standard deviation; coeff = coefficient; CI= confidence interval.

A Novel Cost-Effective Training And Assessment Simulator For Spine Surgery

Philip K. Louie MD, Arash J. Sayari MD, Jannat Khan BS, Kyle Kunze BS, Bryce A. Basques MD, Howard S. An MD, Gregory D. Lopez MD

Introduction: Increasing complexity in spine surgery techniques has created a niche for improved surgical training. Currently, spine surgery simulation current includes synthetic bone activities, cadaver laboratories, and virtual reality simulators that are costly and often unaffordable for residency programs, or are not replicable.

Purpose: The purpose of this study is to introduce a novel simulator for spine surgery that is feasible, easily reproducible at any institution, and applicable in a clinical setting.

Materials and Methods: Using items easily found at a local hardware store, a surgical simulator was created to test and assist the surgical trainee aiming to learn and perfect his or her skills in fundamental techniques related to spine surgery. The simulator was built using piping, wood and foam blocks, various thin pliable materials, and surgical instruments. After IRB approval, 49 orthopaedic surgery trainees with varying experience were tested with the simulator, which included: (1) the use of a hand-held burr in minimally invasive surgery (MIS) and open fashion, (2) the use of a kerrison rongeur in MIS and open fashion, (3) triangulating with a gear shift awl at designated start points towards specified end-points, and (4) peg transfer activity with a pituitary rongeur down a long wider tube to simulate lateral access surgery. Subjects were divided into two groups based on level of training: novice (medical students, first and second year orthopaedic surgery residents) and experts (third, fourth, and fifth year orthopaedic surgery residents). Time, accuracy, and performance were compared using chi-squared analysis and independent sample t-tests for categorical and continuous data, respectively (statistically significance was defined as p-value of <0.05).

Results: Overall, 49 subjects fulfilled our inclusion criteria. There were 41 subjects who were classified as novice and 8 subjects were experts. The expert group was faster in completing MIS ($p=0.025$) and open ($p=0.061$) tasks using kerrison rongeur, along with lateral access tasks using pituitary rongeur ($p=0.029$) than novice group. Additionally, expert subjects were significantly more likely to complete the MIS task using kerrison rongeur ($p=0.017$) and hold the kerrison rongeur ($p=0.009$) and hand-held burr ($p=0.002$) correctly compared to the other subjects. For the hand-held burr task, expert subjects were more likely to support their elbow ($p=0.042$). No statistically significant difference was found between the groups in regards to the gear shift awl tasks (Table 1).

Conclusions: This study demonstrates the construct validity of a cost-effective novel surgical simulator for training the fundamentals of spine surgery, objectively demonstrating the higher-level performance in terms of time and completion of tasks by experts or senior trainees for majority of tasks when compared to novices or those without experience in spine surgery. The results of this study encourage the application of this simulator as a training tool for resident education.

Sagittal Alignment Parameters and Radiographic Changes Associated with Early Adjacent Segment Pathology after Anterior Cervical Discectomy and Fusion

Philip K. Louie; Bryce A Basques; Arya Varthi; Justin C Paul; Dino Samartzis; Edward J Goldberg; Howard S An

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Discussion/Conclusion: Greater pre-operative cervical kyphosis, kyphosis through the proposed fusion segment, greater correction of cervical lordosis post-operatively, and loss of lordosis at fusion segment may have greater odds of developing early radiographic ASD, and subsequent clinical symptoms at these levels. Thus, there is a balance between over- and under-correction of lordosis that warrants further exploration.

With Whom Does the Surgeon Spend More Time? A Study of the Orthopaedic Foot and Ankle Clinic

Connor J. Wakefield, B.S., Kevin Wu, B.S., Joe Skipor, Angad Ravanam, B.S., Savannah Benko, B.S. , Daniel D. Bohl, M.D., M.P.H., Simon Lee, M.D., Kamran S. Hamid, M.D., M.P.H.

Introduction: In the era of decreasing reimbursement and increasing financial pressure on the orthopaedic foot and ankle surgeon, improving clinic efficiency has value.

Purpose: The purpose of this study was to identify which patients and which types of clinical visits consume the greatest amounts of an attending orthopaedic foot and ankle surgeon's time.

Materials and Methods: A prospective, observational study was conducted in an outpatient orthopaedic foot and ankle clinic at a tertiary medical center. 210 adult patients were enrolled from the clinics of two fellowship-trained, board certified orthopaedic surgeons. Time spent in the exam room with the attending surgeon was the primary outcome. Independent variables included patient and appointment characteristics (i.e. age, sex, new/follow-up appointment, etc.). Linear regression was used to test for association between the independent variables and the primary outcome.

Results: Mean time spent by the attending surgeon in the exam room (± standard deviation) was 7.4±4.4 minutes (range, 1-20). Predictors of greater time spent in the exam room included patient age≥50 years (+2.0 minutes, 95% confidence interval [CI]=+0.8 to +3.1, p=0.001), female sex (+1.7 minutes, 95% CI=+0.5 to +2.9, p=0.005), outside medical records reviewed (+2.4 minutes, 95% CI=+0.6 to +4.2, p= 0.010), and new (versus follow-up) patient appointment (+1.7 minutes, 95% CI=+0.5 to +2.9; **Table 1**). In contrast, time spent in the exam room was not associated with the patient arriving late, completion of patient paperwork before the appointment, whether the patient obtained x-rays at the visit, or the type of provider that saw the patient prior to the attending (resident/physician assistant; p>0.05 for each).

Conclusion: Patients who are age≥50 years, identify as female, bring outside medical records for review, and are presenting to the surgeon for the first time consume the greatest amounts of a surgeon's time in the examination room. Surgeons can anticipate spending more time in the room with these types of patients and should schedule their clinics accordingly.

Table 1: Associations between wait time and patient/appointment characteristics.

Characteristic	Coeffi-cient	95% CI	P-value
Age			0.818
<50 years	Ref.		
≥50 years	-1.0	-9.3 to +7.3	
Sex			0.683
Male	Ref.		
Female	+1.7	-6.7 to +10.2	
Late for Appointment			
No	Ref.		0.863
Yes	+0.8	-8.1 to +9.7	
Outside Records Reviewed			
No	Ref.		0.952
Yes	+0.4	-12.6 to +13.4	
X-Rays Obtained			
No	**Ref.**		**<0.001**
Yes	**+15.4**	**+7.0 to +23.8**	
Patient did not complete paperwork before appointment			
No	**Ref.**		**<0.001**
Yes	**+36.9**	**+26.4 to +47.4**	

CI = confidence interval.

All Posterior Total En Bloc Spondylectomy for Spine Tumor

Philip K. Louie, Jannat M. Khan, Ira Miller, Matthew W. Colman

Introduction: Total en bloc spondylectomy (TES) involves disruption of the bony neural ring via bilateral pediculotomy and posterior en bloc laminectomy followed by the en bloc vertebrectomy. All-posterior TES allows for resection of malignant and benign aggressive spine tumors with minimal morbidity.

Purpose: To describe two cases of all-posterior spondylectomy using the recently developed Resegone retractor (K2M, Leesburg, VA, USA) which facilitates the all-posterior resection. The technique is well described and generally includes 3 major portions: a resection of the posterior elements with bilateral costotransversectomy, passage of threadwire saws anterior to the vertebral bodies, and en bloc resection of the anterior column. With the device in place, the sawing of the bone can be performed without risking pull-through into the cord, while cutting through the desired path in a smooth and parallel fashion.

Case 1: A 30-year-old male with past medical history of adolescent-onset Ewing's sarcoma of the right upper chestwall treated in 1994 with surgery, chemotherapy, and thoracic radiotherapy presented to clinic with 8 months of midline upper back pain first noticed after a skiing trip. Thoracic MRI and CT scans reveal a lytic lesion and complete collapse of the T7 vertebral body with soft tissue mass extension into the epidural space and the T6 and T8 bodies (MESSC Scale grade IV). The patient subsequently underwent a percutaneous transpedicular T7 biopsy, which displayed a monotonous fibroblast-like spindle cell proliferation with pleomorphic and hyperchromatic nuclei indicative of a high-grade post-radiation spindle cell sarcoma. This patient underwent an all-posterior T6-8 three-level en bloc spondylectomy, reconstructed with an expandable titanium device and T3-11 posterior spinal instrumented fusion. The resection was facilitated using the Resegone retractor for both the cephalad and caudad cuts.

Case 2: A 70-year-old female three years status-post radical resection of a 9x7cm left thigh high grade pleomorphic sarcoma presented to our emergency department with worsening thoracic back pain despite normal radiographs. Her original tumor had been treated with neoadjuvant chemotherapy and radiotherapy. MRI of the thoracic and lumbar spine revealed a lesion involving the T10 vertebral body with associated epidural posterior soft tissue component resulting in compression of the spinal cord (MESSC Scale grade V). Transpedicular needle biopsy demonstrated high grade pleomorphic sarcoma, consistent with the previous thigh primary. A radical all-posterior en bloc spondylectomy of T10 with partial T9 and partial T11 spondylectomies were facilitated by the Resegone retractor for both the cephalad and caudad cuts. Analysis of the removed specimen demonstrated negative margins with a marginal margin at the dural surface and viable high grade pleomorphic sarcoma. Reconstruction was performed using an expandable reconstruction cage with posterior instrumentation from T7 to L1.

Discussion/Conclusion: All-posterior TES can be facilitated technically with the use of a posterior, rod-mounted, malleable thecal sac protector. We describe two illustrative cases of its use, and believe that this device can help ensure clean, parallel cuts at the intended level and limit the risk of threadwire saw injuries.

MRI Phenotype Profile and its Association with the Development of Cervical Spondylotic Myelopathy

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Introduction: Cervical spondylotic myelopathy (CSM) is characterized by spinal cord compression secondary to degenerative changes. In CSM, early diagnosis can optimize management outcomes. "Spinal phenotypes" on MRI are observable traits, whereby certain patterns and severity, which may have a genetic predisposition, have been associated with low back pain development and intensity. However, patterns of MRI phenotypes of the cervical spine in relation to CSM remain largely unknown.

Purpose: As such, this study addressed the presence of various cervical spine MRI phenotypes and their association with the development of CSM.

Methods: A retrospective study design with prospectively collected data was performed consisting of patients who presented with neck pain, with/without upper extremity symptoms from 2008-2015. Sagittal 1.5T cervical spine MRIs were assessed. Cervical MRI phenotypes were evaluated, which consisted of detailed topographical patterning of disc degeneration, disc space narrowing, disc bulge/extrusion, high intensity zones, structural endplate abnormalities, Modic changes, osteophyte formation and ossified posterior longitudinal ligament from C2-T1. Cumulative scores of each phenotype were determined. A Cumulative Phenotype Index (CPI) was obtained, representing a summation of phenotype scores per level from C2-T1. Three individuals assessed the MRI phenotypes, whereby inter- and intra-rater reliability assessments were noted to be good to excellent ($\kappa > 0.80$). Standing plain radiographs were used to assess C2-C7 lordosis, T1-slope and sagittal vertical axis. Patient demographics were also evaluated. Patients were stratified into two groups. Group A consisted of CSM (with or without radiculopathy) and group B of non-CSM individuals. Univariate and multivariate regression modeling were performed to identify risk factors related to CSM. Receiver operating characteristic (ROC) curve analysis was used to obtain cut-off values of relevant phenotypes in relation to CSM.

Predictors of Wait Time in the Orthopaedic Foot and Ankle Clinic

Connor Wakefield, B.S., Kevin Wu, B.S., Joe Skipor, Angad Ravanam, B.S., Savannah Benko, B.S. , Daniel D. Bohl, M.D., M.P.H., Simon Lee, M.D., Kamran S. Hamid, M.D., M.P.H.

Introduction: Wait times represent a critical component of the patient experience, and prolonged waits are correlated with decreased patient satisfaction.

Purpose: We hypothesized that time spent waiting for radiology is the largest contributor to total patient wait time in our orthopedic foot and ankle clinic.

Materials and Methods: A prospective, observational study was conducted in the outpatient orthopaedic foot and ankle clinic at a tertiary medical center. A total of 210 new and follow-up adult patients were enrolled. Patients were tracked from arrival until checkout with multiple time points being recorded by a trained observer. The time between patient arrival and first contact with the orthopaedic surgeon was broken down into five distinct categories. Total time between patient arrival and first contact with the orthopaedic surgeon was tested for association with patient and appointment characteristics using Student's t-test.

Results: The average total time spent waiting for first contact with the orthopaedic surgeon was 57.1±30.4 minutes. The largest contributor was time spent waiting for an exam room (33.1±25.5 minutes), followed by time spent waiting for radiologic imaging (21.7±19.9 minutes), time spent waiting for resident/PA (12.2±10.9 minutes), and time spent waiting for attending surgeon after seeing resident/PA (11.7±9.3 minutes). Factors contributing to a longer overall wait included obtaining x-rays at the visit (+15.4±4.2 minutes, 95% confidence interval [CI]=+7.0 to +23.8, $p<0.001$) and failure to complete patient paperwork beforehand (+36.9±5.3 minutes, CI=+26.4 to +47.4, $p<0.001$; **Table 1**). In contrast, overall wait time was not associated with age≥50 years, female sex, late arrival, or outside medical records needing review.

Conclusions: Time spent waiting for assignment to an exam room was the largest contributor to the time between patient arrival and first contact with the attending surgeon. In order, the other contributors were time spent waiting for radiology, time spent waiting for the resident/PA, and time spent waiting for the attending surgeon after seeing the resident/PA. Obtaining x-rays increased patient wait time and completing patient paperwork beforehand decreased patient wait time. Orthopaedic foot and ankle surgeons should work to avoid unnecessary x-rays and encourage completion of patient paperwork before arrival in order to optimize clinic flow and decrease patient wait times.

High Prevalence of Poor Sleep Quality in Chronic Foot & Ankle Conditions

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Introduction: Sleep disturbance is a known risk factor for poor healing and is associated with medical co-morbidities. Poor sleep quality is also a common complaint of pre-operative patients; yet, there remains a paucity of investigations in this realm.

Purpose: The purpose of this study is to quantify the prevalence of sleep disturbance in patients undergoing surgical management of chronic foot and ankle conditions.

Methods and Materials: Patients scheduled for first-time surgical management of a chronic foot and ankle condition were identified between May and November of 2018 at a tertiary care medical center. Patients with a known sleep disorder or refusal to participate were excluded. Of 139 patients initially identified, 84 (60.4%) were included and administered the Pittsburgh Sleep Quality Index (PSQI) pre-operatively. The PSQI ranges from 0-21, with a score ³5 indicative of poor sleep quality. Patients were also asked to rate their perception of how their foot or ankle pain influenced their sleep quality on a scale of 0-10 (foot ankle pain perception score, FAPPS). A multivariate linear regression model was used to determine predictors of sleep disturbance.

Results: The mean (± standard deviation) age of the 84 included patients was 48.2±13.8 years; body mass index (BMI) was 28.9±5.0 kg/m^2; 52.4% of patients identified as male; and conditions and treatments were varied (**Table 1**). The mean PSQI score was 7.6±4.3 (range, 2-21) and mean FAPPS was 3.2±2.7. A total of 64 (76.2%) patients had a PSQI score ³5, indicating presence of sleep disturbance. A total of 68 (81.0%) patients had a FAPPS ³1, indicating that a patient perceived that their foot or ankle pain contributed to sleep disturbance. Age, sex, BMI, and condition/treatment category were not correlated with PSQI score (p>0.05 for each); however, greater FAPPS was an independent predictor of a greater PSQI score (p<0.001).

Conclusion: Patients presenting for management of chronic foot and ankle conditions have a high prevalence of sleep disturbance pre-operatively. The majority of these patients perceive their foot and ankle conditions to significantly contribute to their sleep disturbance. Further testing assessing post-operative changes to sleep quality is warranted.

Table 1. Demographics. No.= Number of patients; SD= Standard deviation

Characteristic	No. (%) or mean ± SD
Total patients	84 (100.0%)
Age (years)	48.2±13.8
Male sex	44 (52.4%)
Body mass index (kg/m^2)	28.9±5.0
Diagnosis/procedure category	
Ankle/hindfoot arthritic or postural condition receiving fusion or reconstruction	34 (40.5%)
Forefoot arthritic or postural condition receiving fusion or reconstruction	29 (34.5%)
Conditions managed with arthroscopy, ligament/tendon reconstruction, or neurologic decompression	21 (25.0%)

Results: There were 337 patients (males: 50.4 %), with an overall mean age of 50 years (SD: 11.2 years). Patients in group A (n = 98) were more likely to be older (p < 0.001), female (p = 0.001) and to have a smoker history (p = 0.096) compared to patients from group B (n = 239). **Table 1** notes the prevalence of MRI phenotypes**.** Level-specific, caudal and rostral motion segmental variations were also found between groups. The mean CPIs for group A and B were 17.3 (SD: 10.1) and 12.7 (SD: 7.1), respectively (p < 0.001). Adjusting for patient demographics/imaging phenotypes and following multiple regression model scenarios, (Model 1) structural endplate abnormalities (OR: 3.22, 95 % CI: 1.79 – 5.81) and (Model 2) CPI (OR: 1.05, 95 % CI:1.02 – 1.09) demonstrated the most significant associations with CSM. A CPI linear dose response was noted to increase risk of CSM: CPI (ref 0 – 15) of 16 – 29 (OR: 2.18, 95 % CI: 1.95 – 3.99) and 30 or more (OR: 4.19, 95 % CI: 1.20 – 14.67).

Conclusions: This is the first study to significantly note structural endplate involvement and an overall severity index of degenerative spinal phenotypes as imaging markers in the development of CSM. A linear dose-response

Degenerative Cervical Spondylolisthesis: Does Adjacent Level Surgical Stabilization Result In Progressive Listhesis?

Philip K. Louie; Hollis E. Johanson; Jacob T. Emerson; Jannat M. Khan; Bryce A. Basques; Michael Nolte; Dino Samartzis; Howard S. An

Introduction: Patients with cervical spondylotic myelopathy (CSM) often present with multi-level disease and may experience spondylolisthesis within or adjacent to the levels of clinical pathology. The progression of an unfused degenerative cervical spondylolisthesis (DCS) segment remains unclear when it is not included within the surgical construct.

Purpose: To evaluate if unfused degenerative cervical spondylolisthesis (DCS) segments, adjacent to the fusion, develop worsening instability that requires surgery

Materials and Methods: We performed a retrospective cohort study of patients who presented with CSM, had radiographs revealing DCS at one or more levels, and underwent ACDF or posterior laminectomy and fusion from 2005 to 2013 with a minimum of 12 months of follow-up. Exclusion criteria included previous spine surgery, less than 12 months of follow-up, history of spine trauma, a diagnosis of ossification of the posterior longitudinal ligament (OPLL), rheumatoid arthritis, or currently undergoing hemodialysis; and incomplete set of radiographs (requirement to have pre-operative neutral, flexion, and extension imaging, and post-operative lateral and anterior-posterior neutral imaging). All patients showed no evidence of clinical symptoms present at the DCS level and had surgery performed at adjacent levels. Demographic information was collected for all patients: age, sex, body mass index, smoking status, and Charleston Comorbidity Index (CCI). Radiographic parameters were measured pre-operatively and at the last follow-up: amount of listhesis, cervical lordosis, sagittal vertebral axis, and T1 slope at the pathologic level. On lateral cervical plain radiographs, the number of millimeters (mm) of anterolisthesis was measured. Spondylolisthesis was deemed present if there was greater than 2mm of anterolisthesis. Patients were considered to have progressed if mm of spondylolisthesis on follow up XR was 0.5mm or greater than initial listhesis. This value was chosen to adjust for measurement error. Clinically, re-operation status was assessed. Baseline patient characteristics were compared using chi-squared analysis and independent sample t-tests for categorical and continuous data, respectively. Bivariate and multivariate regressions were subsequently used to compare radiographic outcomes. Multivariate analysis was used to find independent risk factors for progression of disease.

Physical Therapy on Postoperative Day Zero Following Total Knee Arthroplasty: A Randomized Controlled Trial of 394 Patients

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Background: Surgeons have increasingly emphasized early mobilization as a way to facilitate discharge following total knee arthroplasty (TKA).

Purpose: The purpose of this study was to determine whether starting formal physical therapy (PT) the afternoon of postoperative day (POD) 0, instead of starting PT the morning of POD 1, could shorten hospital length of stay.

Materials And Methods: Patients undergoing elective TKA with a planned minimum one-night hospital stay were randomized to start formal PT the afternoon following surgery or the morning of POD1. Length of stay in hours was the primary outcome. An *a priori* sample size calculation suggested that 394 patients were required to show a 4-hour difference between groups.

Results: Out of 394 patients enrolled and randomized, 378 (95.9%) completed the study (Figure 1). There were no differences in baseline characteristics, suggesting appropriate randomization (Table 1). Hospital length of stay did not differ between groups (intention-to-treat analysis: median of 32.0 hours for POD0 PT versus 31.0 hours for POD1 PT, p=0.646; as-treated analysis: median of 31.0 hours for POD0 PT versus 32.0 hours for POD1 PT, p=0.119; Table 2). The two groups did not differ in satisfaction with inpatient PT (10.0 vs. 10.0, p=0.766), patient-reported readiness for discharge at the time of discharged (10.0 vs. 10.0, p=0.968), or POD0 pain (3.3 vs. 4.0, p=0.789).

Conclusion: While PT the day of surgery has been suggested as one method to facilitate discharge following TKA, this randomized trial suggests no difference in hospital length of stay or patient satisfaction when PT is initiated on the day of surgery versus on the morning after surgery.

Table 1. Adverse event rates in development and validation cohorts.

	Development cohort (2015-2017; N=6,860)		Validation cohort (2006-2014; N=5,985)	
Adverse event	**Events (n)**	**Rate**	**Events (n)**	**Rate**
Any adverse event	411	5.99%	378	6.32%
Specific adverse events				
Death	17	0.25%	13	0.22%
Surgical site infection	71	1.03%	80	1.34%
Wound dehiscence	25	0.36%	18	0.30%
Pneumonia	23	0.34%	29	0.48%
Deep vein thrombosis	21	0.31%	25	0.42%
Pulmonary embolism	21	0.31%	17	0.28%
Unexpected intubation	11	0.16%	20	0.33%
Acute kidney injury	5	0.07%	8	0.13%
Urinary tract infection	76	1.11%	69	1.15%
Stroke	5	0.07%	2	0.03%
Cardiac arrest	2	0.03%	5	0.03%
Myocardial infarction	11	0.16%	5	0.08%
Blood transfusion	43	0.63%	48	0.80%
Sepsis	26	0.38%	22	0.37%
Return to operating room	101	1.47%	75	1.25%
Readmission	192	2.80%	126	2.11%

N = sample size (denominator); n = number of events (numerator).

Results: A total of 23 patients fulfilled inclusion criteria. Average follow-up was 31.5 months (range 6-76 months). DCS was present at C2-3 in three cases (13.0%), C3-4 nine cases (39.1%), C4-5 seven cases (30.4%), C5-6 two cases (8.7%), C6-7 no cases (0%), C7-T1 two cases (8.7%). The average pre-operative slip was 2.7mm±0.5mm. At final follow-up, five (21.7%) demonstrated progression (>0.5mm) of their slip, 18 (78%) remained stable (within 0.5mm) or improved. Older age and male sex were associated with progression, but did not increase the risk of reoperation. Two patients (8.7%) with DCS underwent revision surgery, one for symptomatic pseudoarthrosis, and one for myeloradiculopathy due to progression of the adjacent DCS.

Discussion/Conclusion: Despite the presence of altered stress at the DCS level with the adjacent surgical intervention, the majority of patients did not experience DCS progression at final follow-up nor require further surgical intervention. Given our findings, surgeons may not need to extend a proposed cervical fusion for CSM to include the adjacent asymptomatic DCS level.

Validated Risk Stratification System for Prediction of Early Adverse Events Following Open Reduction and Internal Fixation of the Ankle

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George B. Holmes Jr., M.D.[1] Kamran S. Hamid, M.D., M.P.H.[1]
Johnny Lin, M.D.[1] Simon Lee, M.D.[1]

Background: As orthopaedic surgery moves towards bundled payments, there is growing interest in identifying patients at high risk for early postoperative adverse events.

Purpose: The purpose of this study is to develop and validate a risk stratification system for the occurrence of early adverse events following open reduction and internal fixation (ORIF) of the ankle.

Materials And Methods: Patients undergoing ORIF of closed ankle fractures as part of the National Surgical Quality Improvement Program were identified. For patients undergoing surgery during 2015-2017, multivariate Cox proportional hazards modeling was used to identify factors that were independently associated with the occurrence of adverse events (including events such as reoperation, surgical site infection, and pulmonary embolism). Based on these results, a nomogram was used to generate a point-scoring system for risk stratification. To evaluate the validity of the point-scoring system, the system was applied to patients undergoing ankle ORIF during 2006-2014. To generate final estimates of risk for given point scores, the risk stratification system was applied to a combined cohort and logistic regression was used to evaluate risk.

Results: Of the 6,860 patients undergoing ankle ORIF during 2015-2017, 5.99% developed an adverse event (Table 1). Based on the Cox proportional hazards regression (Table 2), patients were assigned points for each of the following statistically significant risk factors: end-stage renal disease +5 points, anemia +3 points, chronic obstructive pulmonary disease +3 points, dependent functional status +2 points, insulin-dependent diabetes +2 points, dyspnea on exertion +2 points, age≥65 years +2 points, hypertension +1 point, female +1 point, and obesity +1 point (Table 3). 5,985 patients were identified in the 2006-2014 validation cohort. Among this second cohort, the risk-stratification system predicted the risk for early adverse events ($p<0.001$; Table 4). Final risk estimates are provided in Table 5.

Conclusions: The occurrence of early adverse events following ankle ORIF is associated with end-stage renal disease, anemia, chronic obstructive pulmonary disease, dependent functional status, insulin-dependent diabetes, dyspnea on exertion, age≥65 years, hypertension, female sex, and obesity. We present and validate a simple point-scoring risk stratification system to predict the risk of early adverse events.

Transverse Versus Longitudinal Incision for Minimally Invasive Achilles Tendon Repair

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Introduction: The rate of wound complications following traditional open Achilles tendon repair is reported at 3.6%. In an effort to reduce the rate of wound complications, orthopaedic surgeons have adopted novel minimally invasive techniques.

Purpose: The purpose of this study is to characterize the rate of wound and other early complications following a minimally invasive Achilles tendon repair, and to identify any factors associated with increased risk.

Materials and Methods: The postoperative courses of 92 patients who underwent minimally invasive Achilles tendon repair by two surgeons at separate academic medical centers were retrospectively reviewed. Mean follow-up was 10.5 months (range 3-24.5 months). Repair technique was similar in all cases, making use of the same commercially available suture-guidance jig, silicone-impregnated deep suture material, and locking stitch technique. However, 59 procedures used a longitudinal incision and a tourniquet (one surgeon's preference), while 33 procedures used a transverse incision and no tourniquet (the second surgeon's preference). Of the 33 procedures using transverse incisions, 2 had to be converted to L-shaped incisions to achieve better access to the tendon. The rates of complications were characterized and compared between patients with differing procedural characteristics.

Results: Of the 92 patients included in the study, two (2.2%) developed wound complications. Both wound complications appeared to be reactions to the deep suture material. There was no statistical difference in the rate of wound complications between patients in the longitudinal incision/tourniquet group and patients in the transverse incision/no tourniquet group (3.4% versus 0.0%; p =0.535). Four patients (4.3%) developed sural neuropraxia, which manifested as mild-to-moderate subjective numbness with sensation remaining intact to light touch. One patient developed a deep venous thrombosis. There were no cases of re-rupture. At final follow-up, all 92 patients had intact Thompson tests and well-healed wounds.

Conclusions: The rate of wound complications following minimally invasive Achilles repair is low at 2.2%. The present study could not demonstrate a difference in risk for wound complications between patients treated with a longitudinal incision and tourniquet and patients treated with a transverse incision and no tourniquet. The wound complications we observed were primarily attributable to inflammatory reactions to the silicone-impregnated deep suture material. Patients should be counseled that although risk for wound complications may be lower with minimally invasive techniques, such techniques do risk sural neuropraxia and deep suture reaction. Further prospective analysis is warranted.

RUSH UNIVERSITY MEDICAL CENTER

FELLOWSHIP

ABSTRACTS

ACADEMIC YEAR 2018 -2019

Restoration of Peak Strength and Endurance Following Distal Biceps Reconstruction with Allograft

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The Authors declare that there is no conflict of interest.

Background: Distal biceps tendon repairs are commonly performed surgeries. Direct tendon repair has been performed using a number of tenodesis techniques, many with high success rates and excellent reported functional outcomes. Allograft augmentation of the repair has been described in cases of chronic rupture. A few published series have reported near normal elbow flexion and supination strength restoration, however, study heterogeneity and small patient numbers complicate the clinical utility of the data.

Hypothesis: We hypothesized that biceps reconstruction with allograft would result in mildly decreased flexion and moderately decreased supination strength and endurance due to potential muscle fibrosis and alteration of muscle fiber relationships.

Methods: We retrospectively identified all patients who underwent distal biceps reconstruction with allograft at our institution from 2008 to 2018. Subjective outcome scores, including DASH and MEPS were obtained. Objective measurements of range of motion, grip strength, and BIODEX dynamometry were recorded.

Results: Of 21 patients (22 biceps) identified, 12 were available for complete clinical evaluation. We observed decreased peak flexion strength (-18.4%; p=0.037) and supination strength (-27.8%; p=0.008) compared to the unaffected arm. No significant differences in range of motion or grip strength was observed. The overall mean DASH score was 9.1, and the mean MEPS was 95.0. Satisfaction with biceps reconstruction was reported as 8.7 out of 10.

Conclusion: This is the largest reported cohort of allograft augmented biceps tendon repairs to date. In contradistinction to prior studies, we observed a 23.3% decrease in peak supination strength compared to the unaffected arm. Incomplete strength recovery may be due to changes in of muscle fiber length relationships.

Level of Evidence: Therapeutic, Level IV

Opioid Consumption Following Outpatient Foot and Ankle Surgery: A Prospective Analysis

Erick M. Heiman, BS, Kevin Wu, BS, Alexander J. Idarraga, BA, Daniel D. Bohl, MD, MPH, Johnny Lin, MD, George B. Holmes, MD, Simon Lee, MD, Kamran S. Hamid, MD, MPH

Introduction: Opioid abuse has recently reached the conscience of the US healthcare system and news cycle. This epidemic is in part propagated by surgeon over-prescription for common procedures.

Purpose: The purpose of this study is to examine postoperative opioid use following outpatient foot and ankle surgery in order to potentially guide prescription patterns of postoperative narcotics.

Materials and Methods: Patients undergoing outpatient foot or ankle surgery, performed by one of four fellowship-trained orthopedic foot and ankle surgeons from a single institution, were prospectively enrolled from January to November 2018. Subjects were consented to participate in a phone interview within 7 days of their surgery, with subsequent interviews as needed for continued monitoring. Information collected included: age, gender, procedure, smoking status, payor type, analgesic regimen, number of tablets remaining, pain scale, pain control satisfaction, additional analgesic medications taken, reason for stopping opioid medications, and any adverse reactions encountered.

Results: A total of 94 subjects were consented to participate. Of these, 11 were lost to follow up and 2 withdrew from the study, leaving 81 (86%) subjects for analysis. The mean (± standard deviation) number of opioid pills prescribed was 52.2 (±16.4; range: 6-80) pills. Subjects were satisfied or somewhat satisfied with their pain control in 91% of cases. On average, 18.4 (±14.9) pills were consumed by subjects, stopping consumption on post-operative day 4.8 (±3.6). There was no statistically significant difference in narcotic medications consumed whether undergoing ankle surgery (16.4, ±13.7) or foot surgery (20.7, ±15.9) (p=0.11). Overall, an average of 34.3 (±19.3) pills remained unconsumed at the completion of narcotic use, equaling a total of 2,706 excessively prescribed pills in the study cohort.

Conclusion: There is a substantial excess of opioid pain medication prescribed to patients for outpatient foot and ankle surgeries, with a wide variation in prescription patterns. Based on our institutional data, a prescription of 35 opioid pills should be sufficient for approximately two-thirds of outpatient procedures and 50 pills should be sufficient for approximately 95% of patients regardless of whether the procedure is for the ankle or foot. This quality improvement assessment has influenced physician practice in our group and prospective follow-up analysis after intervention is warranted.

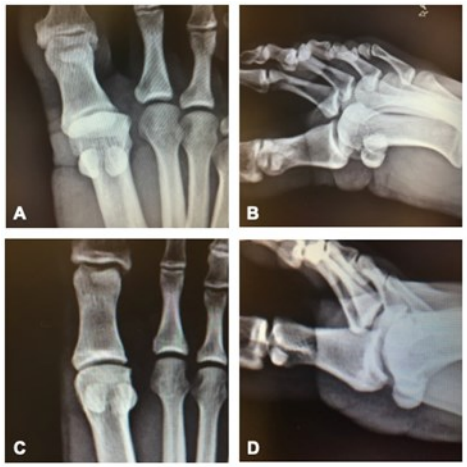

Figure 1

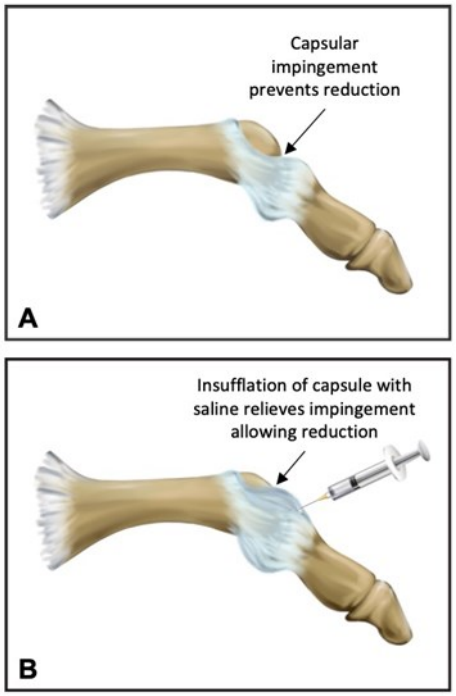

Figure 2

Which Non-Operative Treatments Do Patients Feel Are Most Effective for Hip and Knee Arthritis?

Brian Fuller, MD; Cindy Nahhas, BS; Charles Hannon, MD; Chris Culvern, MS; Tad L. Gerlinger MD; Denis Nam MD MSc; Craig J. Della Valle, MD

Background
The purpose of this study is to determine which non-operative treatments patients feel are most effective for managing hip and knee pain secondary to arthritis.

Methods
565 Consecutive patients referred to three joint arthroplasty surgeons at a single institution were surveyed with a voluntary and anonymous written questionnaire at their first clinic visit. The questionnaire was developed in consultation with an expert in survey design. Results were analyzed using standard descriptive statistics.

Results
436 Patients completed the questionnaire (response rate 77.2%). Respondents were 54.8% female, 75.5% white, and 77.8% had at least some college education with a mean age of 61.6 years. When asked to pick the most effective treatment, patients reported OTC or prescription NSAIDs (33.1%), intra-articular steroids (20.0%), narcotics (11.9%), physical therapy (11.5%), and intra-articular gel injections (9.4%). When accounting for treatments utilized, patients preferred narcotics (43.1%), OTC or prescription NSAIDs (33.8%), and steroid injections (33.2%). Platelet rich plasma injections and stem cell injections had the lowest reported utilization, efficacy, and preference. 27% Of respondents received narcotics, which were most commonly prescribed by primary care providers (48.2%) and orthopaedic surgeons (39.5%). Patients who received narcotics were younger ($p<0.001$) and less educated ($p=0.047$). A significant correlation was found between patients who tried narcotics as a non-operative treatment and lower reported effectiveness of physical therapy, Tylenol, steroid injections, and gel injections ($p<0.05$ for all).

Conclusions
Prior to presenting for arthroplasty evaluation, patients utilize an average of 4.1 non-operative modalities. OTC or prescription NSAIDs, intra-articular steroids, and narcotics were reported to be the most effective while biologics were least effective. A substantial number of patients continue to receive narcotic pain medications for treatment of arthritis. Additional education is needed for both patients and physicians regarding the ill-effects of narcotics.

Level of evidence: not applicable

Keywords: Non-operative treatment; pain; effective; arthroplasty; survey

Saline Lavage After A "Dry Tap": The Differential Is Still Useful

Nathanael Heckmann, Cindy Nahhas, Paul Yi, Chris Culvern, Tad Gerlinger, Craig Della Valle, Denis Nam

Background: In the setting of a "dry" aspiration, saline lavage is commonly used to obtain a sample for analysis. The purpose of this study is to prospectively determine the impact of saline lavage on synovial fluid markers in revision arthroplasty.

Methods: 58 Patients undergoing revision hip (14) and knee (44) arthroplasty were enrolled. Intraoperatively, prior to arthrotomy, the maximum amount of fluid possible was aspirated to simulate a dry-tap ("pre-lavage") followed by subsequent injection with 20 mL of normal saline and re-aspiration ("post-lavage"). Pre and post-lavage synovial white blood cell (WBC) count, percent polymorphonuclear cells (%PMN), and cultures were compared. Statistical analyses utilized the Wilcoxon signed-rank test.

Results: Nine patients met modified MSIS criteria for prosthetic joint infection (PJI). Pre and post-lavage %PMN were similar in septic patients (84.9% vs. 85.1%, p=0.6) but different in aseptic patients (34.2% vs. 41.3%, p=0.006). Pre and post-lavage WBC count was different in both cohorts (5,993 vs. 63,159 WBCs, p=0.008 for septic; 215 vs. 1,000 WBCs in aseptic, p<0.001). Using a pre-lavage cutoff of >80% PMN, the post-lavage aspirate correctly identified 77.8% of true positives (sensitivity) and 98.0% of true negatives (specificity). Using a pre-lavage cutoff of >3000 WBCs, the post-lavage aspirate correctly identified only 41.8% of true positives (sensitivity). As the synovial fluid WBC count increased, the correlation between pre and post-lavage %PMN was stronger (mean difference of 8.2% PMN in WBC <3000 vs. mean difference 2.2% PMN in WBC >3000, p=0.018). Of six positive pre-lavage fluid cultures, only 3 remained positive post-lavage.

Conclusion: While saline lavage aspiration significantly lowers the synovial WBC count, the %PMN is well maintained, particularly at WBC counts >3000. Our findings suggest that in the setting of a dry tap where saline lavage is required to obtain a sample, the %PMN has reasonable sensitivity (77.8%) for the detection of PJI.

Incarcerated Plantar Dislocation of the First Metatarsophalangeal Joint: Reduction using Intra-articular Saline Injection

Daniel D. Bohl, M.D., M.P.H; Kamran S. Hamid, M.D., M.P.H.; David M. Walton, M.D.

Introduction: The vast majority of dislocations of the first metatarsophalangeal (MTP) joint are dorsal dislocations, and the pathomechanics of dorsal dislocation have been well described. Much less is known regarding dislocation of the MTP joint plantarly. Indeed, only two acute closed plantar dislocations of the MTP joint have been reported, and only one of these occurred in an otherwise healthy foot. Because both were reduced by closed manipulation, a classification system developed by Zrig et al. in 2017 suggested that acute plantar dislocation of the first MTP joint should be reducible by simple closed manipulation.

Purpose: The purpose of this study is to provide the first report of an acute plantar dislocation of the first MTP joint that failed reduction with simple manipulation.

Materials and Methods: Prior to proceeding with open reduction, the authors attempted to facilitate reduction using injection of saline into the joint. This method—which to our knowledge has not been previously reported—resulted in immediate reduction of the MTP joint without requiring additional manipulation.

Results: A 26-year old male sustained a hyper-plantarflexion force to his first left MTP joint while attempting to "crack" his great toe. He noted the immediate onset of pain and deformity of his left great toe and presented to the emergency department. On exam, there was an obvious plantarflexion deformity of the great toe at the MTP joint. The great toe remained neurovascularly intact. X-rays demonstrated a plantarly dislocated MTP joint without evidence of bony fracture (Figure 1a-b). The patient was provided with oral and intravenous pain medications and attempted closed reduction was performed using intermittent attempts at recreation of the deforming force followed by (1) axial loading of the distal phalanx with the MTP joint in plantarflexion, and (2) forced dorsiflexion of the MTP joint. Longitudinal traction was avoided in accordance with the recommendations of Garcia et al. None of these methods led to any improvement in the clinical deformity. While the operating room was being prepared for open reduction, the authors made an attempt at closed reduction using a novel method. Specifically, injection of the MTP joint through a dorsal approach with 2.5cc sterile saline was performed. This resulted in near-immediate and spontaneous resolution of the clinical deformity without additional reduction force. Post-reduction radiographs were performed and the MTP joint was noted to be well reduced (Figure 1c-d). The patient was placed in a post-mold splint, discharged, and lost to follow-up.

Conclusions: Plantar dislocation of the first MTP joint is exceedingly rare, and in prior reported cases, simple closed manipulation easily enabled reduction. We present here the first reported plantar dislocation that failed closed manipulation. We also report a technique involving injection of saline into the joint to facilitate reduction. The saline insufflation likely relieves buttonholing of the metatarsal head through the dorsal joint capsule. For first MTP joint plantar dislocations that fail reduction with manipulation, we recommend attempting injection of the joint with saline prior to subjecting the patient to open reduction.

Table 1. Specialty distribution of participants.

Specialty	Number of participants	Percent of participants
Total	94	100%
Sports	24	26%
Adult reconstruction	18	19%
Upper extremity	11	12%
Spine	11	12%
General orthopaedics	10	11%
Foot & ankle	6	6%
Urgent care	6	6%
Shoulder & elbow	4	4%
Pediatrics	1	1%
Physiatry	1	1%
Rehab medicine	1	1%
Trauma	1	1%

Table 2. Surgeon survey responses.

Statement	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
The VSS is easy to use	70%	26%	1%	0%	3%
The VSS is fast	63%	29%	4%	1%	3%
The VSS is integrated with my workflow	67%	27%	2%	2%	2%
The VSS's security is acceptable	72%	18%	6%	0%	3%
The VSS's features allow me to perform my	68%	27%	2%	0%	3%
The VSS is reliable	59%	32%	5%	2%	2%
Information is accurate	39%	49%	9%	2%	1%
Information is complete	46%	43%	7%	1%	3%
Information is available when needed	54%	40%	3%	0%	2%
The information format is acceptable	62%	33%	3%	0%	2%
I am satisfied with the system as a whole	69%	22%	4%	2%	2%
I am satisfied with the system information	64%	27%	5%	2%	2%
I am satisfied with technical support	74%	17%	3%	3%	2%
I prefer the VSS to my previous documenta-	77%	16%	4%	1%	2%
The VSS benefits quality of care as much as I expected	55%	30%	11%	2%	2%

VSS= Virtual scribe service.

Wagner Cone Mid-term Survivorship and Outcomes

J. Joseph Gholson, MD, Faisal Akram, BS, Alejandro Gonzalez, BS , Sara S. Wallace, MD, Kyle N. Kunze, BS, Brett R. Levine, MD, MS

Background: Total hip arthroplasty in patients with abnormal proximal femoral anatomy requires an individualized treatment approach to prevent complications. Metaphyseal engaging stems in this population risk fracture, size mismatch, and aseptic loosening. The Wagner conical femoral implant is a short diaphyseal engaging femoral stem, which could improve treatment success in this difficult patient population. A large series of patients with mid-term outcomes of the Wagner femoral prosthesis has not been previously published.

Methods: We identified 302 patients having total hip arthroplasty using the Wagner cone femoral prosthesis between January 2010 and January 2017. Clinical, radiographic, and patient reported outcomes were obtained through chart review and radiographic measurements of post-operative x-rays. We utilized multivariate analysis to determine predictors of poor outcomes. Furthermore, a Kaplan-Meir curve was created to exhibit implant survivorship. The average follow-up was 3.2 years, with a minimum follow-up of 2 years.

Results: The implant retention survival rate during the 3.2 year study period was 98.7%. The overall reoperation rate was 4.2%, with infection followed by fracture being the most common reasons for reoperation. No patients were revised for aseptic loosening and no patients were revised for subsidence. The average subsidence was 1.1mm. The Harris Hip Score improved from 48.6 ±7.3 (range 28-64) preoperatively to 86.1 ±8.5 (range 66-100) at latest follow-up. The patient reported satisfaction rate was 98.3%.

Conclusion: The Wagner cone femoral prosthesis demonstrated excellent clinical, radiographic, and patient-reported functional outcomes at mid-term follow-up. We recommend the use of the Wagner cone in total hip arthroplasty patients with difficult proximal femoral anatomy, small femoral diameter, or poor metaphyseal bone quality.

Key Words: Wagner cone, dysplasia, total hip arthroplasty, subsidence, outcomes

Outcomes of Isolated Head and Liner Exchange Using Large Femoral Heads and Modern Implants in Revision Total Hip Arthroplasty

E. Grant Sutter, MD, MS., Faisal Akram, BS., Adam Miller, BS., Wayne G. Paprosky, MD., Richard A. Berger, MD., Tad L. Gerlinger, MD

Introduction

Isolated head and liner exchange (IHLE) in revision total hip arthroplasty is a popular option in the setting of well-fixed and well-positioned components to minimize bone loss and morbidity. It is used most commonly in the setting of polyethylene (PE) wear, acute infection, and metallosis. Despite its theoretical advantages, instability following IHLE remains the most common complication with reported rates of 18-25%. However, many of the patients in these reports were revised to constructs with ≤28 mm femoral heads. Therefore, the purpose of this study was to determine if the use of larger head sizes and modern implants can improve the rate of instability after IHLE compared to prior published data.

Methods

We identified 138 hips in 132 patients who underwent IHLE surgery between 2010 and 2017 for PE wear/osteolysis (57 hips, 57%), acute infection (37 hips, 27%), metallosis (18 hips, 13%), or other (4 hips, 3%). All patients underwent revision with either 32 (23%), 36 (62%), or 40 (15%) mm diameter heads. Crosslinked polyethylene was used in all revisions. A lipped/offset liner was used in 104 (75%) hips. Average follow-up was 3.5 (1.0 – 9.1) years. Patients were excluded if they were revised to a constrained liner or dual mobility construct. Descriptive statistics and statistical analyses were performed to determine survivorship and significant effects. Significance was set at $p < 0.05$.

Results

Revision-free survivorship for any cause was 94.6% and for aseptic causes was 98.2% at 5 years. 12 (9%) hips experienced a complication and 7 (5%) hips required additional revision surgery. Four (3%) hips experienced subsequent dislocation, 3 of which were managed non-operatively. One hip with chronic instability ultimately underwent revision surgery to a constrained liner construct. Five (4%) hips developed infection following revision including 3 acute infections treated with irrigation and debridement and 2 chronic infections treated with two-stage exchange. One (0.7%) patient was revised for trunnionosis. One patient experienced a leg-length discrepancy and was treated with a shoe lift and one patient experienced a greater trochanteric fracture after a fall 15 months after revision surgery that was treated non-operatively. No demographic or surgical factors significantly affected outcomes.

Conclusion

IHLE using large femoral heads and modern liners can give provide better stability than previous reports using different implants. The most common complication in our cohort was infection. Based on the numbers available in this study, there are no clear risk factors for patients who developed instability. Further study should focus on identifying specific patient and surgical/implant factors that may reduce the risk of complication in IHLE.

Virtual Scribe Services Are Associated with Higher Physician Satisfaction than Traditional Documentation Methods

Alexander J.P. Idarraga, BA, Daniel D. Bohl, MD, MPH, Benedict U. Nwachukwu, MD, MBA, Kamran S. Hamid, MD, MPH

INTRODUCTION: A virtual scribe service (VSS) is a form of medical documentation in which physician-patient encounters are recorded in clinic, transmitted to a remote medical scribe, and then transcribed into the electronic medical record (EMR).

PURPOSE: We hypothesize that the use of a VSS in an orthopaedic clinic results in accurate notes, simple integration, and high physician satisfaction.

MATERIALS AND METHODS: A modified version of a previously validated survey on physician documentation quality and satisfaction was digitally distributed to 193 orthopaedic surgeons utilizing a VSS. The survey consisted of 16 domains relating to implementation, ease-of-use, efficiency, integration, information quality, comparison to prior systems, and overall physician satisfaction.

RESULTS: Of the 193 physicians surveyed, 94 responded (49%; Table 1). Ninety percent of the 94 respondents agreed or strongly agreed that information recorded with the VSS was reliable, 88% that information was complete and accurate, and 94% that the VSS integrated well with their workflow (Table 2). Ninety-two percent were satisfied overall and 93% preferred the VSS over their previous documentation system.

CONCLUSIONS: A VSS was associated with high physician satisfaction in all tested domains and was preferred over traditional documentation in a cohort of orthopaedic surgeons. Prospective analysis of time, quality, cost metrics, and patient satisfaction is warranted.

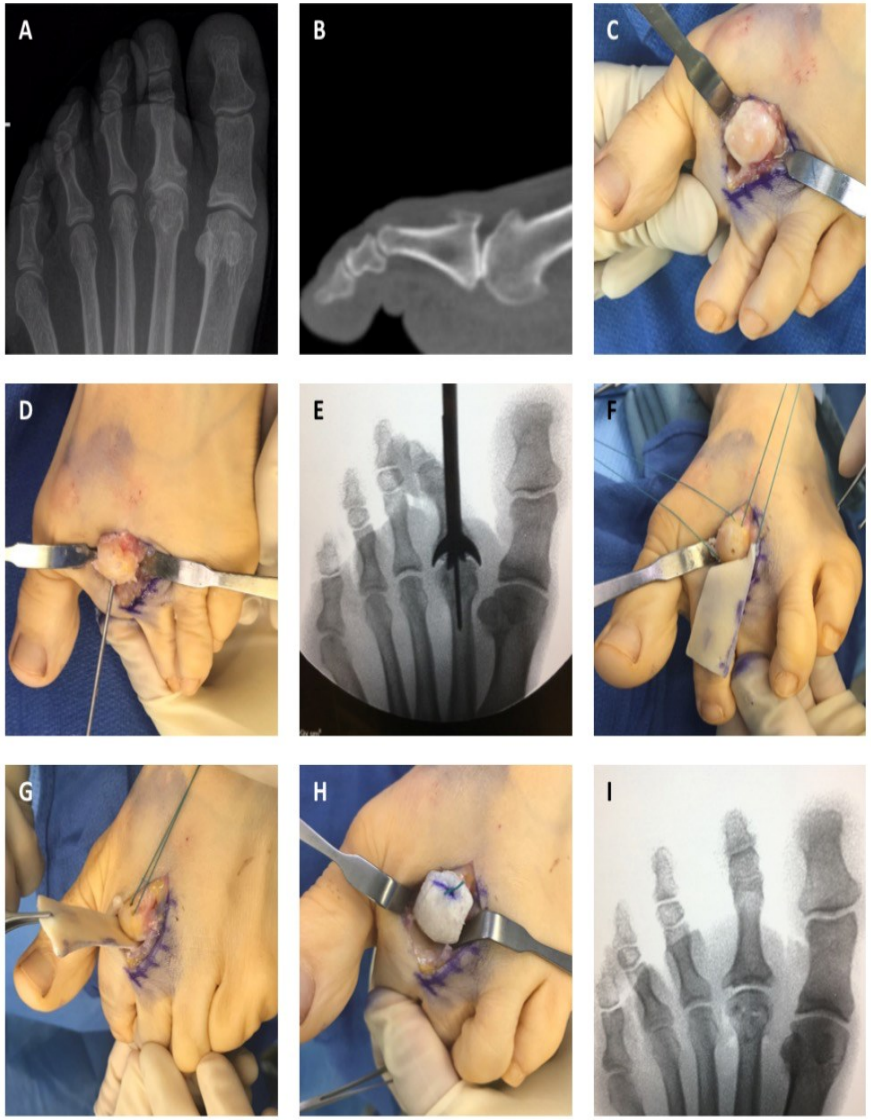

Figure 1

Isolated Tibial Revision with a Cruciate Retaining Femoral Component: Can You Stay CR?

Robert W. Tracey MD, Faisal Akram BS, Alejandro Gonzalez BS, Craig J. Della Valle MD, Richard A. Berger MD, Scott M. Sporer MD, Tad L. Gerlinger MD

Introduction: Total knee arthroplasty (TKA) is one of the most successful orthopaedic surgical procedures. Although most studies demonstrate excellent survivorship rates, an increasing number of patients require revision surgery. Tibial component loosening is one of the most common modes of failure in contemporary TKA. Despite approximately half of primary TKA being cruciate retaining (CR) implants limited literature is available on the outcomes of isolated tibial revision with a cruciate retaining femoral component.

Purpose: The purpose of this study was to determine the implant survivorship, outcomes and complications in patients who underwent isolated tibial component revision with an existing CR TKA. Ultimately, the goal was to determine if the CR femoral component can be retained while only revising the tibial component in patients with no signs of femoral component loosening.

Materials and Methods: We identified 135 patients (mean age 61.3 years and 62% female) who underwent an isolated tibial revision for aseptic loosening following a primary CR TKA from our institutional registry between 2007 and 2017. The mean time between the primary and revision procedures was 2.9 years (range 0.1 to 15.4 years). Revision with a diaphyseal engaging press-fit stem was performed in 79 patients and 56 patients were revised with a short fully cemented stem. Patients were evaluated clinically at a minimum of two year using the Knee Society Score (KSS) and the Knee injury and Osteoarthritis Outcome Score (KOOS) Jr as well as radiographically for implant loosening. Implant survivorship was determined using Kaplan-Meier survival analysis.

Results: At a mean follow-up of 5.1 years (range 2 to 11.6 years) there were six (4.4%) repeat revisions including three for periprosthetic infection (2.2%), two for instability (1.5%) and one fractured tibial stem (0.7%). The mean KSS improved from 51.6 preoperatively to 90.1 after surgery ($p<0.001$). The mean KOOS Jr increased from 56.1 before surgery to 89.7 postoperatively ($p<0.001$). Survivorship free of repeat revision for any cause was 93% at 5 years and aseptic revision survivorship was 95% at 5 years. No implants were radiographically loose.

Conclusions: In patients with tibial loosening and a well-fixed and well-positioned CR femoral component, isolated tibial revision provides excellent early to mid-term implant survivorship and clinical outcomes despite concerns that the use of a CR femoral component might lead to a high risk of postoperative instability.

Does Femoral Morphology Predict the Risk of Periprosthetic Fracture After Cementless Total Hip Arthroplasty?

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Introduction: Periprosthetic femur fracture remains a leading mode of early failure following cementless total hip arthroplasty (THA). The purpose of this study was to determine if a specific femoral morphology is associated with an increased risk of periprosthetic fracture after cementless THA.

Methods: An institutional arthroplasty registry was used to identify 35 primary, cementless THAs revised for acute, postoperative periprosthetic fracture ("fracture" cohort). Patients were matched 1:2 to 70 THAs without fracture ("control" cohort) for age, BMI, gender and stem design. Preoperative radiographic measurements performed on AP pelvis and femur radiographs included the neck-shaft angle, endosteal width at four locations and external cortical diameter at two locations. Measurements were used to calculate the morphological cortical index (MCI), canal flare index (CFI), canal calcar ratio (CCR), and canal bone ratio (CBR). Postoperative measurements included canal fill, stem alignment, and distal stem cortical contact. Statistical analyses included clustered regressions, Fisher's Exact, and Student's T test.

Results: Greater endosteal width in fracture versus control patients at 10cm distal to the lesser trochanter (15.28 vs. 14.37, p=0.1) resulted in differences in the CFI (3.05 vs 3.28, p=0.03), CCR (0.50 vs. 0.47, p=0.03), and CBR (0.46 vs. 0.43, p=0.03) between the two groups. These measurements indicate decreased meta-diaphyseal taper in fracture patients. Femoral neck angle was more varus in fracture patients (131.4 vs. 134.6 degrees, p=0.04). There were no differences in the stem canal fill (0.84 vs. 0.86 at mid-third, p=0.1; 0.85 vs. 0.88 at distal third, p=0.09), stem varus or valgus position (p=0.08), or distal stem-cortex contact (p=0.6) between cohorts.

Conclusions: Patients sustaining an acute, periprosthetic fracture with cementless femoral fixation after THA had thinner distal cortices and a decreased meta-diaphyseal taper. Surgeons should be aware of the potential risk of periprosthetic fracture in patients with this specific morphology when performing a cementless THA.

Second Metatarsophalangeal Joint Interpositional Arthroplasty using Decellularized Human Dermal Allograft

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Introduction: Success has been reported in treating first metatarsophalangeal joint osteoarthritis with allograft interpositional arthroplasty, but little has been published regarding the use of similar techniques for the second metatarsophalangeal joint.

Purpose: To test the hypothesis that second metatarsophalangeal joint allograft interpositional arthroplasty would result in improvement in patient-reported outcomes, a low rate of postoperative complications, and a low rate of reoperation at minimum follow-up of one year.

Materials and Methods: A retrospective review of medical records was conducted for patients having undergone allograft interpositional arthroplasty of the second metatarsophalangeal joint with at least one year of postoperative follow-up. Our technique included a dorsal incision and joint exposure, removal of the cartilage from the metatarsal head using a conical reamer, suture of a human decellularized dermal allograft to the metatarsal head though drill holes, and capsular repair (**Figure 1**). Preoperative and postoperative findings were compared, including Foot Function Index (FFI) and radiographic joint space measured on the AP view. Postoperative range of motion and satisfaction with the procedure were quantified.

Results: In total, 5 patients met inclusion criteria. Mean follow-up was 3.2+/-2.1 years. Three of 5 patients (60.0%) reported that they would have the procedure again, and mean satisfaction with the procedure was 6.0+/-5.1 out of 10. One patient had conversion to fusion at 2 postoperative years. Among the 4 unfused patients, Foot Function Index decreased from 75.7+/-29.8 preoperatively to 52.0+/-46.5 at final follow-up (p=0.526). Mean final arc of motion was 35.0+/-7.1 degrees. Radiographic joint space was 0.4+/-0.3mm preoperatively, increased to 2.2+/-0.5mm immediately postoperatively, and decreased to 1.5+/-0.8mm at final follow-up. The final follow-up joint space trended towards a larger number among the patients who stated they would have the procedure again compared to the patients who stated they would not (2.6+/-1.0mm versus 0.4+/-0.4mm, p=0.178).

Conclusions: Second metatarsophalangeal joint allograft interpositional arthroplasty is a reasonable alternative to arthrodesis for management of isolated late-stage second metatarsophalangeal joint osteoarthritis. Arthrodesis of the second metatarsophalangeal joint is suboptimal due to altered gait mechanics; hence, novel joint preserving procedures are of value. Despite the modest results of interpositional arthroplasty in this limited series, the procedure can result in pain relief while allowing for motion in a subset of patients. The major determinant of success among our cohort was the maintenance of radiographic joint space at final follow-up.

CONCLUSIONS: VSS in an orthopaedic foot and ankle practice decreases documentation time by approximately 4 minutes per new patient compared to TD, resulting in 2 hours of reclaimed physician time for every 30 new patients. With VSS, documentation is completed during the visit as opposed to TD, which is dictated on average approximately 2 hours later. A post-encounter survey identified no differences in patient satisfaction, perception of physician empathy and sufficient time spent with the physician, or understanding of the plan with VSS versus TD. Orthopaedic surgeons should consider VSS a HIPAA-compliant documentation option with time savings and no measurable difference in patient satisfaction.

Table 1. Time [minutes] spent on patient encounter (mean ± SD).

	Virtual Scribing Service (N=25)	Traditional Dictation (N=25)	P-value
Total time spent on the patient encounter but not with the patient*	1.19 ± 0.65	5.80 ± 1.70	<0.001
Total time spent with the patient	14.25 ± 5.86	11.37 ± 5.07	0.069
Total time spent on the encounter (with and without the patient)	15.44 ± 6.13	16.95 ± 6.71	0.410

* Study's primary outcome.

Table 2. Patient survey responses on scales of 0 to 10 (mean ± standard deviation).

	Virtual Scribing Service	Traditional Dictation	P-value
Satisfaction with visit	9.64 ± 0.91	9.92 ± 0.40	0.164
Perception of physician empathy	9.64 ± 1.15	10.00 ± 0.00	0.124
Understanding of the plan	9.96 ± 0.20	10.00 ± 0.00	0.322
Perception of sufficient time spent with physician	9.30 ± 1.37	9.76 ± 0.60	0.130

Radiographic comparison of disc space distraction and subsequent subsidence between differing methods of lumbar interbody fusion techniques.

Ferguson J, Phillips F.

Introduction: There is a proposed advantage of anterior lumbar interbody fusion (ALIF) and lateral lumbar interbody fusion (LLIF) over transforaminal lumbar interbody fusion (TLIF) in terms of prevention of subsidence of the interbody cage. This theoretical advantage is based on exposure and the placement of a larger cage that covers the apophyseal ring, which is more easily performed with the ALIF and LLIF procedures.

Purpose: The purpose of this study was to compare radiographic evidence of disc space distraction and subsequent postoperative subsidence between TLIF/ALIF/LLIF in one-level interbody fusion procedures done by a single surgeon, with at least six months of radiographic follow-up.

Materials and Methods: Patients were identified using CPT codes 22630 (TLIF) and 22558 (ALIF and LLIF). We reviewed all patients with the above codes who had surgery with a single surgeon who regularly performs all three procedures. Beginning with cases starting in January 2016 to ensure adequate follow-up, we identified 20 consecutive patients in each category who met the inclusion criteria of having a single-level interbody fusion procedure, adequate preoperative and postoperative imaging, and radiographic follow-up of at least six months. Using lateral radiographs only, we compared preoperative, postoperative and final follow-up. Measurements of the disc space were taken at the level of the anterior longitudinal ligament (ALL) and posterior longitudinal ligament (PLL). Preoperative to postoperative measurements were calculated, as were postoperative to final follow-up values (proposed subsidence). The percent change was also calculated. One-way ANOVA tests were run for each measurement difference between all three groups.

Results: For the TLIF group, preoperative to postoperative average ALL change was +2.40mm (21.6% increase), and PLL change was +2.15mm (34.1% increase). The postoperative to final follow-up ALL change was -1.60mm (11.9% decrease), and PLL change was -1.4mm (16.6% decrease).

For the ALIF group, preoperative to postoperative average ALL change was +10.2mm (100% increase), and PLL change was +3.35mm (68.4% increase). The postoperative to final follow-up ALL change was -2.10mm (10.3% decrease), and PLL change was -1.35mm (16.4% decrease).

For the LLIF group, preoperative to postoperative average ALL change was +5.75mm (57.5% increase), and PLL change was +2.65mm (70.7% increase). The postoperative to final follow-up ALL change was -1.85mm (11.8% decrease), and PLL change was -0.7mm (10.9% decrease).

A statistically significant difference was found between groups for preoperative to postoperative change in ALL measurement ($p<0.05$), but not for any other measurement comparison between groups.

Conclusion: While all groups experienced similar values for subsidence, both the ALIF and LLIF groups experienced a statistically significant initial increase in preoperative to postoperative ALL measurement on radiographs, as compared to the TLIF group. This is likely related to more complete discectomy and release that is possible with these procedures as compared to the TLIF procedure. Based on this limited data set, there is no statistically significant degree of radiographic subsidence between TLIF, ALIF and LLIF interbody cages.

Using Porous PEEK Interbody Cages for Multi-level Anterior Cervical Discectomy and Fusion: Clinical and Radiographic Outcomes

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Background: Porous surface polyether-ether-ketone (PEEK) interbody cages seek to combine the advantageous material properties of PEEK with a porous bony ingrowth surface in order to improve fusion characteristics. These implants have recently been introduced for anterior cervical discectomy and fusion (ACDF), however little data exists about the efficacy of these implants in multi-level procedures. As multi-level ACDF has been described as having increased rates of pseudoarthrosis and interbody implant-related complications such as cage migration and subsidence, porous PEEK is an attractive alternative for these procedures. The aim of the present study was therefore to evaluate the initial clinical and radiographic outcomes of porous PEEK devices for multi-level ACDF.

Methods: A multi-center retrospective cohort study was performed. Patients who underwent primary multi-level ACDF for degenerative cervical disc disease with porous PEEK cages between January 2016 and October 2018 by three fellowship-trained spine surgeons at three separate institutions with minimum 6 months postoperative follow-up were included in the study. Preoperative and final postoperative clinical outcome scores including Visual Analog Scale (VAS) Neck pain, VAS Arm pain, Neck Disability Index (NDI) were collected. Preoperative, immediate postoperative, and final neutral lateral radiographs were assessed to measure C2-C7 lordosis, cervical sagittal vertical axis (SVA), fusion segment lordosis, T1 slope, lordosis proximal/distal to fusion segment, and disc height. Rates of pseudoarthrosis, cage subsidence, and early adjacent segment degeneration (ASD) were also assessed on postoperative radiographs by two reviewers. Preoperative and postoperative clinical outcomes and radiographic measures were compared using paired t-tests. The threshold for statistical significance was set at $p < 0.05$.

Virtual Scribe Services Decrease Documentation Burden Without Affecting Patient Satisfaction: A Randomized Controlled Trial

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Introduction: Scribes are utilized in order to enhance the physician-patient interaction while reducing administrative burden on surgeons. Virtual scribe services (VSS) are a contemporary take on the scribe that use a HIPAA-compliant smart device to record patient encounters for transmission, remote transcription, and insertion into the electronic medical record.

Purpose: The purpose of this study was to determine if the use of a VSS could decrease the total time an orthopaedic surgeon spends on documentation without diminishing the patient experience when compared to traditional post-encounter dictation (TD).

Materials And Methods: Patients presenting for a first-time visit with an orthopaedic foot and ankle surgeon were consented and randomized to VSS or TD prior to the physician-patient encounter. Amount of time spent with the patient in the exam room and time used to document away from the patient were recorded. A post-encounter survey assessed patient satisfaction, perception of physician empathy, understanding of the plan, and perception of the amount of time spent with the physician on scales of 0 to 10. An *a priori* sample size calculation with an alpha level set at 0.05 and power of 80% estimated that 50 patients were necessitated to demonstrate a 2-minute difference in time spent documenting away from the patient. Comparisons were made using a two-sample Student's *t*-test.

Results: Of 50 patients enrolled, 25 were randomized to VSS. No differences in demographic characteristics were identified between cohorts indicating appropriate randomization ($p>0.05$ for each). Time spent documenting away from the patient differed between VSS and TD (1.19±0.65 minutes for VSS versus 5.80±1.70 minutes for TD, $p<0.001$; **Table 1**) as did time elapsed between the end of the visit and the start of dictation (0±0 for VSS versus 123±70 minutes for TD, $p<0.001$; **Table 1**). There was a trend towards more time spent with the patient for those in the VSS group as compared to TD (14.25±5.86 minutes versus 11.37±5.07 minutes, $p=0.069$; **Table 1**). There were no differences between groups in survey responses regarding satisfaction, empathy, understanding, or perception of sufficient time spent with the physician ($p>0.05$ for each; **Table 2**).

Table 1. Correlation between foot and ankle parameters and spinopelvic parameters.

	Lumbar lordosis (LL)	Pelvic incidence (PI)	PI- LL	Sacral Slope	Pelvic Tilt	Osteophytes present*	Disc narrowing present*	Spondylolithesis present*
Hallux Valgus								
Intermetatarsal Angle								
Beta	-0.11	0.12	0.03	0.02	0.11	-	-	-
Mean (±SD) without	-	-	-	-	-	9.0 ± 2.5	8.6 ± 2.45	8.7 ± 2.1
Mean (±SD) with	-	-	-	-	-	8.7 ± 2.8	8.9 ± 2.9	8.9 ± 3.2
p-value	-0.408	0.411	0.845	0.890	0.453	0.729	0.628	0.700
Hallux valgus angle								
Beta	-0.28	0.02	0.24	0.05	-0.06	-	-	-
Mean (±SD) without	-	-	-	-	-	12.6 ± 8.7	7.9 ± 5.3	12.6 ± 6.
Mean (±SD) with	-	-	-	-	-	12.8 ± 9.3	13.1 ± 9.3	12.8 ± 11.1
p-value	0.036	0.877	0.101	0.698	0.683	0.958	0.131	zz0.950
Hallux Rigidus Grade*								
Grade 0 (Mean ± SD or %)	33.4 ± 46.	56.8 ± 14.5	18.1 ± 42.7	37.5 ± 11.2	18.5 ± 9.2	88%	58%	50%
Grade 1 (Mean ± SD or %)	41.5 ± 12.5	51.1 ± 15.9	-1.8 ± 24.7	30.8 ± 8.8	20.5 ± 12.7	56%	78%	56%
Grade 2 (Mean ± SD or %)	23.3 ± 46.6	51.3 ± 12.6	15.2 ± 19.8	29.9 ± 8.1	19.6 ± 1.5	75%	75%	25%
Grade 3 (Mean ± SD or %)	45.6 ± 43.1	60.1 ± 52.1	14.5 ± 9.0	29.0 ± 38.4	24.0 ± 2.2	100%	100%	100%
p-value	0.876	0.782	0.927	0.269	0.839	0.108	0.564	0.525
Meary's angle								
Beta	-0.06	0.19	0.17	0.39	-0.17	-	-	-
Mean (±SD) without	-	-	-	-	-	-4.1 ± 10.1	-3.4 ± 8.1	-3.2 ± 9.0
Mean (±SD) with	-	-	-	-	-	-5.9 ± 11.4	-6.8 ± 12.4	-3.7 ± 12.6
p-value	0.656	0.188	0.249	0.004	0.245	0.665	0.302	0.137
Calcaneal pitch								
Beta	-0.23	0.06	0.17	0.15	-0.12	-	-	-
Mean (±SD) without	-	-	-	-	-	20.9 ± 4.9	21.8 ± 4.0	22.5 ± 4.6
Mean (±SD) with	-	-	-	-	-	21.1 ± 5.0	21.1 ± 5.5	20.3 ± 5.2
p-value	0.095	0.680	0.257	0.263	-0.428	0.763	0.617	0.015
Cuneiform height								
Beta	-0.35	0.15	0.34	0.29	-0.10	-	-	-
Mean (±SD) without	-	-	-	-	-	19.5 ± 5.9	19.0 ± 7.5	22.9 ± 6.0
Mean (±SD) with	-	-	-	-	-	19.2 ± 7.1	21.6 ± 6.5	18.5 ± 7.1
p-value	0.009	0.314	0.021	0.034	0.488	0.832	0.072	0.122
Talar coverage (%)								
Beta	0.02	-0.02	0.04	-0.20	0.20	-	-	-
Mean (±SD) without	-	-	-	-	-	77.1 ± 8.3	7.6 ± 7.6	77.1 ± 7.4
Mean (±SD) with	-	-	-	-	-	77.8 ± 7.0	78.5 ± 7.0	79.3 ± 6.9
p-value	0.911	0.889	0.811	0.145	0.178	0.156	0.870	0.259
Tibiotalar arthritis grade*								
Grade 0 (Mean ± SD or %)	38.8 ± 42.8	61.2 ± 17.2	13.7 ± 38.9	39.0 ± 10.9	19.0 ± 9.7	78%	67%	41%
Grade 1 (Mean ± SD or %)	26.8 ± 44.3	51.7 ± 12.9	18.1 ± 42.1	31.9 ± 12.9	20.3 ± 8.9	87%	65%	61%
Grade 2 (Mean ± SD or %)	43.3 ± 4.5	43.0 ± 6.2	-0.2 ± 1.6	32.7 ± 0.0	11.5 ± 6.6	50%	50%	50%
Grade 3 (Mean ± SD or %)	62.9	77.5	14.6	48.9	30.2	100%	0%	100%
Grade 4 (Mean ± SD or %)	38.4	38.7	0.3	27	9.8	100%	100%	100%
p-value	0.8205	0.0794	0.966	0.186	0.403	0.528	0.749	0.370
Medial distal tibial angle								
Beta	-0.21	-0.19	0.14	-0.08	-0.20	-	-	-
Mean (±SD) without	-	-	-	-	-	91.0 ± 4.4	90.2 ± 3.2	89.8 ± 3.6
Mean (±SD) with	-	-	-	-	-	89.2 ± 3.5	88.8 ± 3.9	88.9 ± 3.9
p-value	0.120	0.192	0.355	0.571	0.180	0.358	0.146	0.365
Anterior distal tibial angle								
Beta	-0.11	0.08	0.08	0.09	0.03	-	-	-
Mean (±SD) without	-	-	-	-	-	81.2 ± 11.3	83.8 ± 3.5	83.1 ± 7.2
Mean (±SD) with	-	-	-	-	-	83.2 ± 4.0	82.8 ± 7.0	83.0 ± 4.6
p-value	0.424	0.600	0.579	0.509	0.826	0.198	0.599	0.901
Tibiotalar angle								
Beta	-0.15	0.10	0.13	-0.09	0.25	-	-	-
Mean (±SD) without	-	-	-	-	-	110.0 ± 8.9	112.3 ± 8.9	111.8 ± 6.4
Mean (±SD) with	-	-	-	-	-	112.9 ± 6.8	111.8 ± 6.2	112.2 ± 8.0
p-value	0.263	0.499	0.380	0.534	0.089	0.975	0.286	0.845

* For hallux rigidus, 40 patients were categorized as grade 0, 9 as grade 1, 4 as grade 2, and 2 as grade 3. For tibiotalar arthritis, 27 patients were categorized as grade 0, 23 as grade 1, 2 as grade 2, 1 as grade 3, and 1 as grade 4. 45 patients had osteophytes present in the spine, 35 patients had disc narrowing, and 28 had spondylolisthesis.

Results: A total of 73 patients who underwent multi-level ACDF with porous PEEK cages were included in this study, with mean follow-up of 12 months (range 6-33 months). Mean age was 57.2 + 9.8 years, mean body mass index was 29.8 + 6.7 kg/m^2, 53.4% of patients were female, and 23.1% had a smoking history. Out of these patients, 34 patients (46.6%) had a two-level procedure, 24 patients (32.9%) had a three-level procedure, 14 patients (19.2%) had a four-level procedure, and one patient had a five-level ACDF (1.4%).

When comparing radiographic measurements (**Table 1**), there was a significant increase in preoperative-postoperative and preoperative-final overall cervical lordosis (Pre-Post p<0.001, Pre-Final p<0.001), fusion segment lordosis (Pre-Post p<0.001, Pre-Final p<0.001), T1 slope (Pre-Post p=0.017, Pre-Final p=0.001) and disc height (Pre-Post p=0.008, Pre-Final p<0.001). There was an initial increase in C7 SVA at the first postoperative visit (p=0.003) that disappeared by the time of final follow-up. Clinical outcomes (**Table 2**) showed significant improvement from the preoperative visit to final postoperative follow-up (NDI p<0.001, VAS Neck p<0.001, VAS Arm p<0.001). Five patients had cage subsidence (6.9%), two patients had pesudoarthrosis (2.7%), and one patient had early distal adjacent segment degeneration (1.4%). One patient (1.4%) underwent a reoperation for pseudoarthrosis.

Conclusion: The present study is the first to assess porous PEEK cages for multi-level ACDF procedures and indicates that these devices are a clinically viable alternative for achieving successful clinical and radiographic outcomes.

Table 1. Differences in radiographic outcomes at postoperative and final follow-up						
Measurement	Preoperative Mean (SD)	Postoperative Mean (SD)	Final Mean (SD)	Pre-Post p-value	Post-Final p-val-	Pre-Final p-value
C2-C7 lordosis	3.28 (11.75)	10.27 (10.63)	11.51 (9.43)	**<0.001**	0.267	**<0.001**
C7 Sagittal Vertical Axis (mm)	25.76 (18.57)	29.38 (19.61)	28.69 (19.48)	**0.003**	0.360	0.153
Fusion segment lordosis	-0.96 (9.05)	8.28 (7.92)	8.11 (8.82)	**<0.001**	0.533	**<0.001**
T1 slope	26.29 (8.20)	29.22 (8.28)	29.66 (8.21)	**0.017**	0.621	**0.001**
Proximal adjacent segment lordosis	0.88 (6.34)	0.62 (6.34)	1.20 (6.35)	0.791	0.548	0.332
Distal adjacent segment lordosis	2.04 (4.53)	2.10 (4.56)	3.03 (4.10)	0.938	0.379	0.215
Disc height (mm)	3.11 (1.71)	4.69 (5.05)	4.17 (2.58)	**0.008**	0.278	**<0.001**
Bolding indicates statistical significance (p < 0.05)						

Table 2. Preoperative and postoperative patient-			
Patient-Reported Outcome	Preoperative Mean (SD)	Final Mean (SD)	Preop-Final p-value
NDI	24.17 (13.48)	11.00 (14.14)	**<0.001**
VAS Neck	4.23 (2.84)	1.34 (2.37)	**<0.001**
VAS Arm	5.39 (2.66)	0.88 (2.03)	**<0.001**
Bolding indicates statistical significance (p < 0.05). NDI = Neck Disability Index, VAS = Visual Analogue Scale			

Associations in the Sagittal Plane: No Evidence that Foot Radiographs Predict Sagittal Alignment or Degeneration of the Spine

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Introduction:

The interaction between hip pathology and spinopelvic alignment is a current subject of interest in orthopedics with a number of recently performed studies. However, little is known regarding the interaction between foot & ankle (F&A) pathology and spinopelvic alignment, despite common complaints from patients such as back pain potentially caused by an outturning foot.

Purpose: The purpose this study is to test for associations between F&A pathology and spinopelvic alignment and degeneration.

Materials and Methods:

A retrospective cohort study was conducted involving consecutive patients who presented to both F&A and spine surgeons within the same practice. Inclusion criteria required that each patient have the following radiographic views while in a weight bearing, standing position: lateral of lumbar spine; anteroposterior (AP), lateral, and mortise of ankle; AP, lateral, and oblique of foot. Patients were excluded from analysis if there was radiographic evidence of previous surgical instrumentation in the spine, ankle, or foot. Bonferroni correction was performed to account multiple statistical analyses, which resulted in the level of significance set to $p<0.001$.

Results:

A total of 55 patients met inclusion criteria. There were no associations found between F&A pathology and spinopelvic alignment/degeneration ($p>0.001$ for each; **Table 1**).

Conclusions:

A common patient concern is that a foot condition may be contributing to low back pain through altered gait and postural dynamics. With the numbers available, we were unable to demonstrate statistical associations between F&A radiographic findings and spinopelvic alignment or degeneration. Orthopaedic surgeons can address patients' concerns about the relationship between their F&A and lumbar spine symptoms by citing that there is a lack of known association between radiographic findings used to evaluate these two regions of the body.

Brake Response Time after Modern Total Knee Arthroplasty: How Soon can Patients Drive?

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Introduction: Recent advances in the performance of total knee arthroplasty may allow for return to driving sooner than the current recommendation of six to eight weeks.

Purpose: The purpose of this study was to evaluate at what time point patients may safely return to driving after modern total knee arthroplasty.

Materials And Methods: Thirty-two consecutive patients underwent pre-operative and weekly post-operative assessments of brake reaction time before and for eight weeks after undergoing total knee arthroplasty (Figure 1). One-way ANOVA with repeated measures was conducted to determine when brake time returned to baseline. Two-way ANOVA with repeated measures was used to test the interaction of brake time with gender, age, and laterality.

Results: Overall, patients returned to their preoperative baseline brake reaction times by the second postoperative week (Figure 2). There was a significant difference in regard to gender but not laterality or age. Specifically, men achieved preoperative brake reaction times by the first postoperative week and women by the second (Figure 3).

Conclusion: Patients undergoing total knee arthroplasty with a modern perioperative pathway appear to achieve preoperative brake reaction times by the second postoperative week when not taking narcotic pain medication. However, the safe return to driving in each patient must be approached individually. Surgeon discretion to release a patient to drive is always prudent and the decision should be considered on an individual basis.

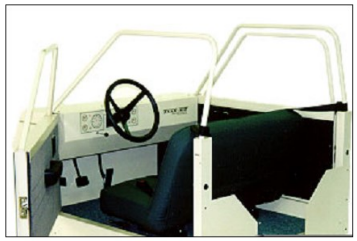

Figure 1

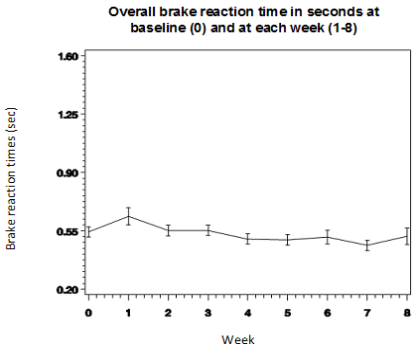

Figure 2

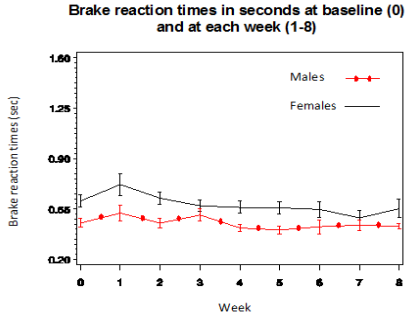

Figure 3

The Association between the Number of Patient Allergies to Medications and Outcomes of Posterior Lumbar Fusion Surgery.

Bryce Basques MD, Steven Fineberg MD, Garrett Harada BS, Jannat Khan BS, Gagan Grewal MD, Peter Derman MD, Matthew Colman MD, Howard An MD

Introduction: Accurate documentation of allergies is essential for patient care. The association between allergies and clinical outcomes has not been well characterized in lumbar spinal fusion patients. The purpose of this study is to explore the potential association between multiple reported allergies and clinical and radiographic outcomes following elective posterior lumbar spinal fusion (PLF).

Materials and Methods: A retrospective cohort study was conducted of consecutive patients who underwent primary elective PLF. Patients under 18 years of age or those who underwent surgery for the treatment of lumbar fracture, tumor, or infection were excluded. Patient and operative characteristics were collected and the number of medication allergies was dichotomized at three allergies, as this was the 95th percentile for the number of allergies. Preoperative and final postoperative Visual Analog Scale (VAS) Back pain, VAS Leg pain, and Oswestry Disability Index (ODI) were collected. Additionally, the rates of dural tear, postoperative complications, post-discharge destination, re-operation, achievement of minimally clinically important difference (MCID) for VAS back, VAS leg, and ODI, and pseudoarthrosis were collected.

Results: A total of 504 patients met inclusion criteria. There were 472 (93.65%) patients who reported less than three allergies, while 32 (6.35%) patients presented with three or more allergies. Patients with three or more reported allergies were older ($p=0.026$), more often female ($p<0.001$), and had American Society of Anesthesiologists Physical Status Score (ASA) equal to or greater than three ($p=0.038$). Patients with more allergies had significantly higher VAS leg scores preoperatively ($p=0.048$), and greater improvement in ODI scores from preoperative to final visit ($p=0.001$). At final follow-up ODI scores were similar between groups ($p=0.494$). No significant differences were found for post-operative complication ($p=0.347$) or re-operation rates ($p=0.825$).

Conclusions: Patients with three or more reported allergies have significantly increased preoperative leg pain, but demonstrated functional outcome scores similar to patients with fewer allergies. Differences in preoperative pain between groups is likely multifactorial and may be attributed to baseline characteristics such as age, gender, and general health. Regardless, patients with multiple allergies can expect similar outcomes following PLF as those with fewer allergies.

Table 1. Patient-reported outcomes

		Allergies < 3	Allergies ≥ 3	All patients	Multivariate linear regression	
		Mean (SD)	Mean (SD)	Mean (SD)	Beta	*p-value*
Preoperative						
	VAS back	6.53 (2.70)	7.34 (2.98)	6.58 (2.72)	0.80	0.271
	VAS leg	5.91 (2.83)	7.68 (2.64)	6.02 (2.85)	**1.51**	**0.048**
	ODI	44.76 (17.49)	49.48 (16.06)	45.06 (17.41)	4.83	0.287
Final						
	VAS back	3.93 (3.04)	4.20 (2.66)	3.95 (3.01)	-0.16	0.828
	VAS leg	3.22 (3.04)	3.54 (3.37)	3.24 (3.06)	-0.19	0.810
	ODI	30.14 (20.41)	29.72 (19.26)	30.11 (20.28)	-3.35	0.494
Change Preoperative to Final						
	VAS back	-2.63 (2.99)	-3.23 (2.67)	-2.67 (2.97)	-1.01	0.271
	VAS leg	-2.84 (3.62)	-4.54 (3.48)	-2.96 (3.63)	-1.69	0.135
	ODI	-14.64 (16.80)	-26.56 (18.83)	-15.47 (17.17)	**-16.68**	**0.001**

SD: Standard Deviation

VAS: Visual Analog Scales

ODI: Oswestry Disability Index

RESIDENT

ABSTRACTS

ACADEMIC YEAR 2018 -2019

Assessing the Knowledge and Awareness of the Female Athlete Triad in Female Collegiate Athletes

Shannon Powers, DO

Introduction: The Female Athlete Triad is a medical syndrome that can affect the lives of physically active women. Termed the triad, it is comprised of a spectrum of three conditions: 1. Low bone mineral density, 2. Low energy availability (with or without disordered eating), and 3. Menstrual dysfunction. To be diagnosed with the condition, a woman needs only one of these three conditions, however she may show signs of one, two, or all three conditions. Failure to identify and treat these conditions can lead to worsening medical conditions and complications including but not limited to stress fractures, osteoporosis, eating disorders, amenorrhea, cardiovascular complications, and poor sports performance. While many studies have been performed to assess awareness of the female athlete triad amongst coaches, physicians, care team members, and women, there is limited data to assess the knowledge and awareness female collegiate athletes have related to this topic. This study will assess the female collegiate athlete's baseline knowledge and understanding of the female athlete triad.

Purpose: The purpose of this study is to assess the knowledge and awareness of the female athlete triad in female collegiate athletes, and to determine whether intervention with a brief informational handout and viewing of an educational video will result in increased awareness and insight into this medical condition.

Materials & Methods: Division I female collegiate athletes at DePaul University will be invited to participate in the study. Athletes who wish to participate will be asked to complete a consent form to participate in the study.

Participants will be asked to complete a pre-intervention survey.

The participant will then be given a "The Female Athlete Triad" educational reading material to read upon completion of the survey. http://www.femaleathletetriad.org/wp-content/uploads/2010/03/Final_Hoogenboom_Public_Flyer-10.pdf

Upon completing reading of the educational pamphlet, the participant will then be asked to watch "The Female Athlete Triad" ACSM educational video. https://www.youtube.com/watch?v=lZ5MN6c0XFk

One week after completion of the initial pre-intervention survey, the participant will then be asked to complete the post-intervention survey. The study will end after completion of the second survey.

Results: Results for this study are still pending.

Conclusions: At the conclusion of this study, it is anticipated the data collected will support the hypothesis that intervention with a brief informational handout and viewing of an educational video will result in increased awareness and insight into the medical condition of female athlete triad. If this study supports this hypothesis, there may be benefit to providing a similar educational intervention early in a female collegiate athlete's career to prevent the athlete from developing this condition in the future.

Radiographic assessment of first metatarsal shortening following hallux valgus correction: a comparison of surgical techniques

Stephen Jacobsen, MD MS., Daniel Bohl, MD MPH., Alex Idarraga, BS., George Holmes, MD., Simon Lee, MD., Johnny Lin, MD., Kamran Hamid, MD MPH

Introduction: For patients with symptomatic hallux valgus who have failed conservative treatment, there are multiple different surgical techniques available for operative correction. The selection of the most appropriate technique for a given patient depends on a number of factors, including severity of disease, patient preferences, and surgeon preferences, among others. While several different techniques have been shown to provide correction of hallux valgus, there is variability in the degree of change in first metatarsal length postoperatively among the different techniques. Excessive shortening of the first metatarsal relative to the lesser metatarsals has been shown to be a risk factor for developing transfer metatarsalgia. By understanding the relationship between hallux valgus surgical technique and change in first metatarsal length, a surgeon may be able to select a more appropriate technique for a given patient based on preoperative radiographic measurements or determine the need for additional procedures to be performed simultaneously with hallux valgus correction, such as shortening of lesser metatarsals.

Purpose: The goal of this study is to determine the relative change in first metatarsal length associated with different surgical techniques for hallux valgus correction, including 1) first tarsometatarsal fusion (Lapidus), 2) proximal closing wedge osteotomy (PCWO), and 3) isolated soft tissue correction using a suture based technique.

Materials and Methods: Patients undergoing corrective surgery for hallux valgus by the above techniques by four fellowship trained foot and ankle surgeons at Midwest Orthopaedics at Rush during a 21 month period from 2017 to 2019 were identified retrospectively. Patients who underwent osteotomies of the lesser metatarsals or had undergone prior surgery for hallux valgus in the same foot were excluded. The relative length of the first ray compared to the second was measured on pre-operative and post-operative weight-bearing AP foot radiographs, in order to identify a post-operative change in length of the first ray.

Results: During the study time period, a total of 83 patients undergoing hallux valgus correction who met the inclusion criteria were identified, including 49 who underwent first tarsometatarsal fusion, 13 with PCWO, and 21 with a suture based technique. Relative length of the first ray compared to the second decreased in the fusion and osteotomy groups by an average of 1.8% and 2.0%, respectively, and increased with suture based correction by an average of 0.8%.

Conclusions: Patients undergoing first tarsometatarsal fusion and closing wedge osteotomy for the correction of hallux valgus showed a tendency towards slight shortening of the first ray relative to the second postoperatively, whereas patients undergoing isolated soft tissue and suture based correction showed a slight increase in relative first ray length. While many factors contribute to the development of transfer metatarsalgia, it is important to be aware of the potential for change in first ray length during hallux valgus correction so that it can be addressed intra-operatively if necessary.

Defining the MCID, PASS and SCB for Arthroscopic Hip Preservation Surgery at Minimum Five-Year Follow-up

Benedict U. Nwachukwu MD MBA, Eddie Beck MPH, Kyle Kunze BA, Jorge Chahla MD PhD, Shane Nho MD MS

Background: Minimal clinically important difference (MCID), substantial clinical benefit (SCB) and patient acceptable symptomatic state (PASS) have gained prominence as important variables in the orthopedic outcomes literature. In hip preservation surgery, much attention has been given to defining early clinically significant outcome, however, it is unknown what represents meaningful patient reported outcome improvement in the medium to long-term. The purpose of the present study was to define MCID, PASS and SCB at a minimum five years after hip arthroscopy for femoroacetabular impingement syndrome (FAIS). Secondarily, we sought to evaluate the time dependent nature of MCID, PASS and SCB.

Methods: Patients undergoing hip arthroscopy for FAIS between January 2012 and March 2014 were included. Clinical and demographic data were collected in an institutional hip preservation registry. MCID, PASS, and SCB were calculated for each outcome score at 1-, 2-, and 5- years. MCID was calculated using a distribution-based method while PASS and SCB were calculated using an anchor method.

Results: Two hundred and eighty-three patients were included with an average age of 34.2+11.9 years. The one year, two year and five-year MCID scores were as follows respectively: HOS-ADL (8.8, 9.7, 10.2); HOS-SS (13.9, 14.3, 15.2); mHHS (6.9, 9.2, 11.4) and iHOT-12 (15.1, 13.9, 15.1). PASS scores were as follows: HOS-ADL (89.7, 88.2, 99.2); HOS-SS (72.2, 76.4, 80.9); mHHS (84.8, 83.3, 83.6) and iHOT-12 (69.1, 72.2, 74.3). SCB scores were as follows: HOS-ADL (89.7, 91.9, 94.6); HOS-SS (78.1, 77.9, 85.8); mHHS (86.9, 85.8, 94.4) and iHOT-12 (72.6, 76.8, 87.5). More patients achieved MCID, SCB and PASS at two-year follow-up than at one-year and five year follow-up. However, 79% of the patients achieved MCID by 5 years.

Conclusion: The greatest proportion of patients achieve clinically significant outcome improvement at two-year follow-up after arthroscopic treatment of FAIS. Improvements are maintained out to five-year follow-up although there is a slight decrease in the proportion of patients achieving clinical significance by this time frame.

Level of Confidence: Case series, IV

Inter-Observer Reliability and Change in the Vertical Tibial Tubercle-Trochlear Groove Distance With Increasing Knee Flexion Angles

Ian J Dempsey, Taylor M. Southworth, Ian S. MacLean, Neal B. Naveen, Adam B. Yanke

Background: The Tibial Tubercle-Trochlear Groove (TT-TG) distance has served surgeons as a way to diagnose pathologic knee morphology and assist in pre-operative management. Sagittal plane pathology measured by the vertical Tibial Tubercle-Trochlear Groove distance (vTT-TG) is also important to consider as those with a more posterior tubercle may be at higher risk for cartilaginous injury.

Purpose: To (1) describe inter-observer reliability of the vTT-TG distance and (2) characterize the change in the vTT-TG distance with respect to changing knee flexion angles.

Study Design: Cadaveric study

Methods: Six non-pair matched cadaveric knees underwent magnetic resonance imaging (MRI) studies at each of the following degrees of knee flexion: -5, 0, 5, 10, 15 and 20. The vertical tibial tubercle-trochlear groove (vTT-TG) distance was measured on the axial T2 sequence. Four reviewers measured this distance for each cadaver at each flexion angle. Intraclass correlation coefficients were calculated to determine inter-observer reliability and reproducibility of the vTT-TG measurement. Analysis of variance (ANOVA) tests with Tukey's post-hoc analysis was performed for each cadaver to compare vTT-TG distances at each flexion angle. Significance was defined as $p<0.05$.

Results: There is excellent inter-observer reliability of the vTT-TG distance with all interclass correlation coefficients >0.9. The tibial tubercle progressively becomes more posterior in relation to the trochlear groove (more negative vTT-TG distance) with increasing knee flexion.

Conclusion: The vTT-TG distance is a measurement that is reliably accurate between attending surgeon's and across training levels. The vTT-TG distance is affected by knee flexion angle. Awareness of knee flexion angle on MRI is important when this measurement is utilized by surgeons.

The Biomechanical Effects of Limited Lateral Retinacular and Capsular Release on Lateral Patellar Translation at Varying Flexion Angles

Jourdan M. Cancienne, MD

Purpose: To determine the biomechanical effect of limited lateral retinacular and capsular release on lateral patellar translation at varying knee flexion angles.

Methods: Six pairs of bilateral cadaveric knee specimens (12 knees) were obtained from a tissue bank, dissected, and potted in a perfect lateral position based on fluoroscopy. A direct lateral force was applied to the patella through an eye screw in the midpoint of the lateral patella and each knee underwent testing in the intact state and following lateral retinacular and capsular release. All knees were tested in 0, 10, 20, 30, 45, 60, and 90 degrees of flexion using a custom-machined jig on an MTS machine with a 20N lateral force applied to the patella. Patellar displacement was recorded and compared for each specimen.

Results: Lateral displacement was significantly greater at all degrees of flexion in the lateral release specimens compared to those with an intact lateral retinaculum ($p < 0.05$). The largest difference in lateral displacement in the lateral release specimens was seen in full extension.

Conclusion: Lateral retinacular and capsular release results in significantly increased lateral patellar translation at all flexion angles compared to intact specimens. This suggests that the lateral retinaculum functions as a significant restraint to lateral translation even with intact medial soft tissue restraints. Thus, arthroscopic "limited" lateral retinacular and capsular release may be contraindicated in the setting of lateral patellar instability.

Level of Evidence: V, cadaveric investigation

PROMIS Instruments Correlate Better with Legacy Measures in Knee Cartilage Patients at Post-operative than at Pre-operative Assessment

Benedict U. Nwachukwu MD, MBA[1], Alexander Beletsky BA[1], Neal Naveen BS[1], Taylor M. Southworth BS[1], Kelechi R. Okoroha MD[1], Adam Yanke MD PhD[1], Brian J. Cole MD, MBA[1], Nikhil Verma[1] MD

Background: Patient-Reported Outcomes Measurement Information System (PROMIS) are being increasingly studied in the orthopaedic literature. The majority of published literature to this point has focused on pre-operative correlation of PROMIS to legacy measures. Additionally, relatively little is known about the performance of PROMIS in patients undergoing knee cartilage surgery. The purpose of this study was to define the psychometric properties of the PROMIS Physical Function (PF), PROMIS Pain Interference (PI) and PROMIS Depression CAT pre-operatively and post-operatively in patients undergoing knee cartilage surgeries..

Methods: The PROMIS PF, PI and Depression CAT were administered alongside legacy knee patient-reported outcome measures (PROMs) in patients undergoing knee cartilage surgeries. Included procedures were articular cartilage debridement, osteochondral allograft transplant (OAT), microfracture (MFX), and autologous chondrocyte implantation (ACI). Psychometric analysis examined correlative strengths, absolute and relative floor and ceiling effects, and instrument responsivity by calculation of Cohen's effect size. Secondary analyses included an evaluation of question burden and time-to-completion.

Results: Our study included 250 patients (143, 57.2% male). Cartilage patients required an average of 4.59, 4.28, and 6.25 questions on the PF, PI, and Depression CAT respectively, with time-to-completion requirements of 1.87, 1.53, and 1.91 minutes. Pre-operatively the PROMIS PF CAT exhibited very poor to very good correlations with legacy function PROMs (r=0.14-0.72), good correlation with health-related quality of life (HRQoL) measures (r=0.64-0.70) and very poor to poor correlations with mental health measures (r=0.12-0.32). The PI CAT similarly exhibited poor to very good correlations with function measures (0.29-0.77), good correlations with HRQoL measures (r=0.64-0.70), and very poor to fair correlations with mental health measures (r=0.16-0.44). At the six-month assessment, every single legacy PROM demonstrated improved correlation with the PROMIS PF CAT. At six months post-operative PROMIS PF CAT demonstrated very good to excellent correlation (r=0.82-0.93 absolute value) with legacy functional outcome PROMs except for the Marx, which exhibited a fair correlation (r=0.44). Similarly, the PROMIS PI CAT demonstrated improved correlation with each included legacy PROMs – very good to excellent correlations for function (r=-0.78 - -0.93) and HRQoL (r=-0.77 - -0.86) legacies except for the Marx. Post-operative Correlation on the PROMIS Depression improved from fair to good/very good. Across all legacy PROMs, PROMIS instruments demonstrated the most consistent correlation with IKDC (r=0.72-0.93 across all measurements).
None of the PROMIS instruments exhibited any significant floor or ceiling effects.

Conclusion: In pre-operative knee cartilage patients, the PROMIS PF, PI, and Depression CAT demonstrate variable correlation with legacy measures ranging from very poor to very good. Correlations however improve at 6 months post-operative and most PROMIS instruments demonstrate very good/excellent correlation at that time point. Of the legacy instruments, PROMIS tracks best with the IKDC – none of the observed correlations were rated lower than "very good". The current study may call into the question the role of PROMIS instruments for assessing the baseline status of knee cartilage surgery patients. By six months post-operatively however PROMIS is better aligned with legacies and appears to show greater discriminability in the post-operative setting. Continued work is needed to better understand the disease specific and time dependent nature of PROMIS instruments compared to legacies.

A Predictive Model for Achieving the Minimal Clinically Important Difference Following Hip Arthroscopy: An Analysis of 2,511 Patients.

Benedict U. Nwachukwu, M.D., Jourdan M Cancienne, M.D., Edward Charles Beck, PhD., Elaine K Lee, M.S., M.P.H., Brian R Waterman, M.D., Katlynn Paul, B.A. and Shane J Nho, M.D.

Background: Hip arthroscopy has become an important tool for surgical treatment of intra-articular hip pathology. Predictive models for clinically significant outcomes in all-comers undergoing hip arthroscopy for femoroacetabular impingement syndrome (FAIS) are unknown.

Purpose: To build a predictive model of preoperative variables for achieving Minimal Clinically Important Differences (MCID) at 2-years after undergoing hip arthroscopy for FAIS.

Level of Evidence: IV, Case Series

Methods: Data was analyzed for patients who underwent hip arthroscopy for FAIS by a high-volume, fellowship-trained surgeon between 01/2012-07/2016. The MCID cutoffs for HOS-ADL, HOS-SS, and mHHS were 9.8, 14.4, and 9.14, respectively. Predictive models for achieving MCID with respect to each were built using the LASSO (least absolute shrinkage and selection operator) algorithm for feature selection followed by Logistic Regression on the selected features. Study data were analyzed using PatientIQ, a cloud-based research and analytics platform for healthcare.

Results: Of 1,103 patients who met inclusion criteria, 898 (81.4%) had a minimum of 2-year reported outcomes and were entered into the modeling algorithm. A total of 73.9%, 73.5%, and 79.9% met the HOS-ADL, HOS-SS, and mHHS threshold scores for achieving MCID. Predictors of not achieving the HOS-ADL MCID included anxiety/depression, symptom duration for > 2 years before surgery, age 30-45 years, obesity, high preoperative HOS-ADL score, and preoperative hip injection (all $p<0.05$). Predictors of not achieving the HOS-SS MCID included anxiety/depression, preoperative symptom duration for > 2 years, high preoperative HOS-SS score, and preoperative hip injection, while running at least at the recreational level was a predictor of achieving MCID HOS-SS (all $p<0.05$). Predictors of not achieving the mHHS MCID included history of anxiety or depression, high preoperative mHHS score, and hip injections, while being female was predictive of achieving MCID (all $p<0.05$).

Conclusions: This study identified predictive variables for achieving clinically significant outcome after hip arthroscopy for FAIS. Patient factors including anxiety/depression, symptom duration >2 years, preoperative intra articular injection and high preoperative outcome scores are most consistently predictive of inability to achieve clinically significant outcome. These findings have important implications for shared decision-making algorithms and managing preoperative expectations following hip arthroscopy for FAI.

Dynamic Three-Dimensional Mapping of Isometric Posterior Cruciate Ligament Attachment Sites on the Tibia and Femur: Single vs Double Bundle Analysis

Brian Forsythe MD, Drew Lansdown MD, Bhavik H. Patel BS, Avinesh Agarwalla MD, Kyle N. Kunze BS, Yining Lu BA, Richard N. Puzzitiello MD, Brian J. Cole MD MBA, Nikhil N. Verma MD, Robert LaPrade MD PhD, Nozomu Inoue MD PhD, Jorge Chahla MD PhD

Objectives: (1) To map the length changes of the posterior cruciate ligament (PCL) femoral attachment on the medial femoral condyle with respect to various points about the tibial PCL footprint to determine the area that demonstrates the least amount of length change (isometry) through full range of motion, and (2) to identify a range of flexion that would be favorable for graft tensioning for single (SB PCLR) and double bundle reconstruction (DB PCLR) techniques.

Methods: In this descriptive laboratory study, six fresh-frozen cadaveric knees were obtained from screened individuals with no prior history of arthritis, cancer, surgery, or any ligamentous knee. For each knee, 3-dimensional computed tomography point-cloud models were obtained in succession from 0° to 135°. Standardized point grids were placed on the lateral wall of the medial femoral condyle and the tibial PCL facet. Intra-articular length was calculated for all combinations of femoral to tibial coordinates at all flexion angles. Points were then grouped to represent areas reflective of surgical bone tunnels for single bundle and double bundle reconstruction. Normalized length changes were compared.

Results: A femoral tunnel in the location of the PMB resulted in the smallest degree of length change (greatest degree of isometry) at each position on the tibia (Table 1). At graft fixation angles of 0°, 30°, and 90°, length-change patterns clustered by the location of the femoral tunnels, regardless of tibial tunnel location, indicating that strain properties of the PCL depend more on the femoral site than the tibial site (Figure 1). Fixation of the ALB in extension or at 30° of flexion resulted in significant over constraint of the graft, while the femoral tunnel location for a SB PCLR resulted in significant laxity at lower ranges of flexion. The results of 4-way ANOVA test demonstrated that normalized length significantly differed based on: femoral position ($F = 21.13$, $P < 0.001$); flexion angle ($F = 229.81$, $P < 0.001$); angle of fixation ($F = 629.93$, $P < 0.001$); interaction of femoral position and angle of flexion ($F = 28.14$, $P < 0.0001$); and the interaction of femoral position and fixation angle ($F = 105.70$, $P < 0.001$). Tibial position was not a significant factor in any case (all $P > 0.31$). Three-way ANOVA tests similarly demonstrated that minimum and maximum normalized length both varied significantly based on femoral tunnel position, flexion angle, and angle of fixation (all $P < 0.001$), but neither varied significantly based on tibial position (all $P > 0.22$).

Conclusions: Ligament length was highly dependent on femoral tunnel position and angle of fixation, whereas tibial tunnel position did not significantly contribute to observed differences. For DB PCLR, the PMB of the PCL demonstrates the highest degree of isometry throughout range of motion, although no area of the lateral wall of the medial femoral condyle was truly isometric. Finally, the ALB should be fixed at 90° as fixation in extension or at 30° of flexion resulted in significant over-constraint of the graft. SB PCLR demonstrated significant laxity at lower ranges of flexion

PROMIS Instruments Correlate Better with Legacy Measures in Knee Cartilage Patients at Post-operative than at Pre-operative Assessment

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Results: Our study included 250 patients (143, 57.2% male). Cartilage patients required an average of 4.59, 4.28, and 6.25 questions on the PF, PI, and Depression CAT respectively, with time-to-completion requirements of 1.87, 1.53, and 1.91 minutes. Pre-operatively the PROMIS PF CAT exhibited very poor to very good correlations with legacy function PROMs (r=0.14-0.72), good correlation with health-related quality of life (HRQoL) measures (r=0.64-0.70) and very poor to poor correlations with mental health measures (r=0.12-0.32). The PI CAT similarly exhibited poor to very good correlations with function measures (0.29-0.77), good correlations with HRQoL measures (r=0.64-0.70), and very poor to fair correlations with mental health measures (r=0.16-0.44). At the six-month assessment, every single legacy PROM demonstrated improved correlation with the PROMIS PF CAT. At six months post-operative PROMIS PF CAT demonstrated very good to excellent correlation (r=0.82-0.93 absolute value) with legacy functional outcome PROMs except for the Marx, which exhibited a fair correlation (r=0.44). Similarly, the PROMIS PI CAT demonstrated improved correlation with each included legacy PROMs – very good to excellent correlations for function (r=-0.78 - -0.93) and HRQoL (r=-0.77 - -0.86) legacies except for the Marx. Post-operative Correlation on the PROMIS Depression improved from fair to good/very good. Across all legacy PROMs, PROMIS instruments demonstrated the most consistent correlation with IKDC (r=0.72-0.93 across all measurements).
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Conclusion: In pre-operative knee cartilage patients, the PROMIS PF, PI, and Depression CAT demonstrate variable correlation with legacy measures ranging from very poor to very good. Correlations however improve at 6 months post-operative and most PROMIS instruments demonstrate very good/excellent correlation at that time point. Of the legacy instruments, PROMIS tracks best with the IKDC – none of the observed correlations were rated lower than "very good". The current study may call into the question the role of PROMIS instruments for assessing the baseline status of knee cartilage surgery patients. By six months post-operatively however PROMIS is better aligned with legacies and appears to show greater discriminability in the post-operative setting. Continued work is needed to better understand the disease specific and time dependent nature of PROMIS instruments compared to legacies.

Defining Minimal Clinically Important Difference and Patient Acceptable Symptom State After Isolated Endoscopic Gluteus Medius Repair

Okoroha KR, Beck EC, Nwachukwu BU, Kunze KN, Nho SJ

Background: Endoscopic gluteus medius repair is an increasingly performed procedure to treat patients with gluteus muscle tears. However, clinically significant outcomes (CSO) following the procedure have not been defined.
Purpose: To Define 1) Minimal Clinically Important Difference (MCID) and Patient Acceptable Symptomatic State in patients undergoing endoscopic gluteus medius repair and 2) determine correlations between preoperative patient characteristics and achievement of MCID/PASS.

Methods: A retrospective review was performed of prospectively collected data from all patients undergoing primary endoscopic repair of gluteus medius tears between January 1, 2012 and February 2017 with a minimum two-year follow up. Patient data collected included demographics, radiographic parameters, preoperative clinical function scores, and postoperative patient reported outcomes (PROS). Paired t-test were used to compare the differences in 2-year PROs. The MCID and PASS for each PRO was calculated and Spearman's coefficient analysis was used to identify correlations between MCID, PASS and preoperative variables.

Results: A total of 60 patients were included in the study. A majority of patients were female (91.7%), with an average age and BMI of 57.9±9.91 and 27.6±6.1, respectively. The MCID of HOS-ADL, HOS-SS, and mHHS was calculated to be 15.02, 14.53, and 14.13, respectively. The PASS of HOS-ADL, HOS-SS, and mHHS was calculated to be 77.9, 56.9, and 69.3, respectively. Eighty-eight percent of patients achieved CSO at 2 years postoperatively. No demographic factors were found to correlate with postoperative outcomes.

Conclusion: In patients undergoing endoscopic gluteus repair our study defined MCID and PASS for HOS-ADL, HOS-SS, and mHHS outcomes scores. A large percentage (88%) of patients achieved clinically significant outcomes at 2 years following surgery.