Claude T. Moorman, III, MD
1st Beth and Tom Smith Visiting Professor

30th Annual Resident Research Day

Department of Orthopaedic Surgery and Rehabilitation

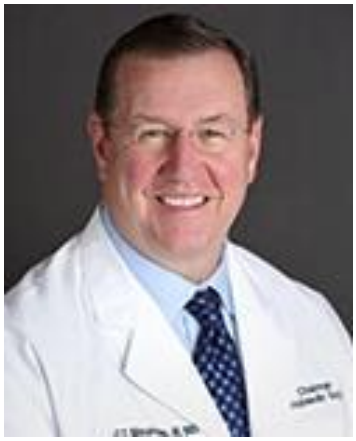
Wake Forest School of Medicine

June 9, 2021

Atrium Health

Wake Forest® Baptist Medical Center

Claude T. Moorman, III, MD
1st Beth and Tom Smith Visiting Professor



Claude T. Moorman, III, MD

Claude "T." Moorman, III, MD, is the president of Atrium Health's Musculoskeletal Institute and The Edward N. Hanley, Jr. Endowed Chair of the Department of Orthopaedic Surgery. Throughout his career, Dr. Moorman has married his deep-rooted passion for sports with his medical expertise. After more than two decades with over a dozen teams, he has considerable experience providing medical care to NFL, collegiate and high school athletic teams. Dr. Moorman is a leader in advancing treatments for shoulder and knee reconstructions with a special interest in multiple ligament knee injury and regenerative medicine. He has authored more than 150 publications and his research has been recognized with numerous honors, including the Neer Award and the Excellence in Research Award for innovations in shoulder reconstruction.

AGENDA

Emcee: T. David Luo, MD

8:20 Introduction: Kerry A. Danelson, PhD

Physician Scientists

8:25 Edward Beck, MD
8:35 Nequesha Mohammed, MD

8:45 Discussion

PGY3

8:55 Alex Jinnah, MD, PhD
9:05 Natalie Marenghi, MD
9:15 Rosser McCallie, MD
9:25 Chris Grimes, MD
9:35 Hunter Matthews, MD

9:45 Discussion

10:00 BREAK

10:05 First Beth and Tom Smith Visiting Professor
Claude T. Moorman, III, MD
Title: Sign Posts from the Adventure: Leadership Tips for Building a Practice

10:45 LUNCH / BREAK

PGY5

11:00 Michael Seem, MD
11:10 Andrey Zuskov, MD
11:20 Linda Chao, MD
11:30 Shane Tipton, MD
11:40 Alejandro Marquez-Lara, MD, PhD

11:50 Discussion

12:05 Awards Presentation: Claude T. Moorman, III, MD

12:10 Closing Remarks: L. Andrew Koman, MD

The effect of State-Level Prescription Opioid Legislation on Patient Outcomes After Lumbar Tubular Micro-Decompression

Edward C. Beck[1], MD, MPH, Jonathan C. White, BS[1], Anirudh K. Gowd, MD[1], Tianyi D. Luo, MD,[1] Maryam Khalil, BS[1], Carl Edge, BS[1], Ziyad O. Knio, MD[2], Tadhg J. O'Gara, MD[1,3]

Background: In the state of North Carolina, the Strengthen Opioid Misuse Prevention Act (STOP Act) was enacted in 2017 to limit prescription opioid use and reduce dependence. The impact of state legislation curbing opioid prescription on outcomes after spine surgery is unknown.

Objective: To evaluate whether functional scores at 1-year follow-up in patients who underwent lumbar tubular micro-decompression (LTMD) differ before and after the legislation enactment.

Methods: Data from consecutive patients undergoing LTMD for symptomatic lumbar spine stenosis from 06/2016-06/2019 was retrospectively analyzed. Cases between 06/2016-12/2017 represent the group before the STOP Act (Pre-STOP), while cases between 01/2018-06/2019 represent the group after legislation enactment (Post-STOP). Preoperative and postoperative patient functional scores including the EQ-5D, Oswestry Disability Index (ODI), and the visual analog scale (VAS) for back and leg pain were compared between both groups. The meaningful clinically important difference (MCID) was calculated for each score and were compared between both groups as well.

Results: A total of 176 patients met inclusion criteria, with 103 in the Pre-STOP group and 73 in the Post-STOP group. There were no statistical differences in demographics or history of prescription opioid use prior to surgery between both groups (p-value<0.05 for all). Analysis of postoperative scores demonstrated statistically lower VAS leg pain score averages in the Post group($p<0.05$). When controlling for confounding variables, linear regression indicated an association between VAS leg pain and undergoing surgery after legislation enactment. Higher trends in achieving MCID among the Post-STOP group was observed, however, the differences between both groups were not statistically significant ($p>0.05$ for all). Lastly, there were no differences in rates of unplanned pain-related clinic visits and pain-related calls within 90 days after surgery.

Conclusion: The enactment of state legislation to curb the prescribing of opioids for postoperative pain in lumbar micro surgical patients was associated with lower VAS leg pain score averages at 1-year follow-up when compared to those receiving surgery before enactment. Additionally, patients achieved meaningful clinical results at similar rates before and after enactment of the legislation.

Diabetes Predicts Hip and Shoulder Osteoarthritis in Non-Human Primates

Nequesha Mohamed MD, Johannes Plate MD PhD, John Olson,
Mark Cline MD, Jeffrey Willey PhD

Introduction: As consequences of aging, osteoarthritis (OA) and diabetes have become more prevalent in the American population, affecting more than 52 million and 34 million adults respectively. In addition to age, they share several risk factors, including obesity and metabolic changes. A background state of inflammation may be responsible for the progression of both conditions and contribute to their comorbidity. However, it can take years to monitor the development of OA and diabetes in the general populace, which can lead to poor documentation and follow-up. Rodent animal models have proven useful for inducing disease states for analysis, but the lack of microimaging capabilities needed to assess OA progression in diabetic rodents limits the utility of the model. Alternatively, non-human primates (NHP) are a fully translatable large animal model that provides an opportunity to longitudinally track the development of disease states similar to those of humans, particularly as these animals receive annual computed tomography (CT) scans at Wake Forest School of Medicine. Documenting the coincidence of OA and diabetes in a single cohort can provide the foundation for further studies investigating the specific mechanisms underlying both conditions. This study was designed to assess the long-term relationship between OA and diabetes in NHPs, as well as other potentially related disease states. We hypothesize that OA will be significantly associated with the presence of diabetes.

Methods: A total of 97 rhesus macaques were selected for analysis. The group consisted of 16 females and 81 males, with an average age of 13.4 years (range 7.4-23.1 years). These NHPs were part of a survival cohort of irradiated and non-irradiated NHPs as part of NIH-funded investigations to track the long-term consequences of survivable, total-body irradiation relevant to a terrorist attack. 79 animals received a single dose of total body irradiation (TBI: median dose 6.6 Gy, range 3.5 – 8.5 Gy) before adoption into a radiation survivor cohort for long-term monitoring and surveillance. The other 18 animals had no history of radiation and were adopted as radiation controls. At the time of this study, 67 animals were deceased, and 30 were still living. Importantly, as diabetes has previously been noted in members of this cohort, determining if radiation itself was a contributing factor to the development of diabetes was necessarily assessed in order to best determine the relationship between diabetes and OA in this NHP model.
Osteoarthritis was determined from annual CT scans between 2012 and 2021. The Kellgren-Lawrence (KL) grading system was utilized to give an arthritis score from 0 to 4 to the knee, hip, and shoulder joints, as well as the spine. Osteoarthritis was deemed present at a KL grade of 2, and if arthritis was present in any joint, the animal was identified as generally arthritic. Data records regarding medical conditions were accessed to provide information on the development of several comorbidities over the animal's lifetime, and included diabetes, obesity, hypertension, low bone mineral content (LBC), kidney disease and liver disease. Descriptive statistics and chi-square analyses were performed using SPSS. All significance values were set at $p<0.05$.

Results: *Radiation and Comorbid Diseases*
There was no relationship seen between radiation and overall OA status ($p=0.755$). Additionally, there were no associations observed between radiation status and OA of the knee ($p=0.296$), hip ($p=0.068$), or shoulder ($p=0.138$). Conversely, significantly more nonirradiated NHPs had spine arthritis ($p=0.018$). Diabetes did not demonstrate an association with radiation status ($p=0.109$), nor did LBC ($p=0.511$), kidney disease ($p=0.433$), or liver disease ($p=0.456$). There were significantly more nonirradiated animals that developed obesity ($p=0.030$), while significantly more irradiated NHPs developed hypertension ($p=0.036$).

Osteoarthritis and Comorbid Diseases
Overall OA was significantly more common in diabetic animals ($p=0.037$), specifically in the hip ($p=0.023$) and shoulder ($p=0.010$), though the knee just over the threshold of significance ($p=0.053$). The spine did not show any correlation with diabetes ($p=0.627$). There were no significant associations between LBC and overall OA ($p=0.999$), knee OA ($p=0.800$), hip OA ($p=0.291$), shoulder OA ($p=0.999$), or spine OA

(p=0.999). Obesity was significantly higher in animals with overall OA (p=0.020), knee OA (p=0.006) and shoulder OA (p=0.006). Hip OA (p=0.090) and spine OA (p=0.092) did not demonstrate a similar relationship. No associations were observed between kidney disease and overall OA (p=0.143), knee OA (p=0.225), hip OA (p=0.148), shoulder OA (p=0.483), and spine (p=0.543). Similarly, no relationships were noted for liver disease and OA (overall p=0.728; knee p=0.565; hip p=0.142; shoulder p=0.742; spine p=0.775), or hypertension and OA (overall p=0.999; knee p=0.647; hip p=0.639; shoulder p=0.601; spine p=0.817).

Diabetes and Comorbid Diseases

Diabetes had no significant relationship with LBC (p=0.109), kidney disease (p=0.628) or hypertension (p=0.781). Significantly more diabetic animals were obese (p<0.001). Furthermore, there were significantly more diabetic animals that also had liver disease (p=0.011).

Conclusion: Diabetic NHPs had a significantly higher incidence of OA and were more obese, supporting the theory of a shared metabolic disease state that may be responsible for potentiating both diseases. Although this was a radiation survivor cohort, there appears to be no effect of radiation on the incidence of OA or diabetes in this NHP cohort. Although obesity is a risk factor for both OA and diabetes, it had a predilection for the knee and shoulder, which are weight-bearing joints for NHPs. However, diabetes was more closely associated with hip and shoulder OA, and there were no associations with LBC, suggesting there may be another mechanism responsible for joint degeneration in affected animals. These results solidify the relationship between diabetes and OA and provide a foundation for future investigative studies to determine the pathways that may lead to the development of both diseases. Elucidation of underlying mechanisms may also give insight into other related comorbidities affected by the shared disease state.

Improved osseointegration using porcine xenograft compared to demineralized bone matrix for the treatment of critical defects in a small animal model

Alexander H. Jinnah MD PhD; Patrick Whitlock MD PhD; Jeffrey S. Willey PhD; Kerry Danelson PhD; Bethany A Kerr PhD; Omer A Hassan MD; Cynthia L Emory MD MBA; Thomas L Smith PhD; Daniel N. Bracey MD PhD

Background: Autograft (AG) is the gold standard bone graft due to biocompatibility, osteoconductivity, osteogenicity, and osteoinductivity. Alternatives include allografts and xenografts (XG).

Methods: We investigated the osseointegration and biocompatability of a decellularized porcine XG within a critical defect animal model. We hypothesized that the XG will result in superior osseointegration compared to demineralized bone matrix (DBM) and equivalent immune response to AG. Critical defects were created in rat femurs and treated with XG, XG plus bone morphogenetic protein (BMP)-2, DBM, or AG. Interleukin (IL)-2 and IFN-gamma levels (inflammatory markers) were measured from animal blood draws at 1 week and 1 month post-operatively. At 1 month, samples underwent micro-positron-emission tomography (microPET) scans following 18-NaF injection. At 16 weeks, femurs were retrieved and sent for micro-computerized tomography (microCT) scans for blinded grading of osseointegration or were processed for histologic analysis with tartrate resistant acid phosphatase (TRAP) and pentachrome.

Results: ELISA testing demonstrated greater IL-2 levels in the XG vs. AG 1 week post-op, which normalized by 28 days post-op. MicroPET scans showed increased uptake within the AG compared to all groups. XG and XG+BMP-2 showed a trend towards increased uptake compared with DBM. MicroCT scans demonstrated increased osseointegration in XG and XG+BMP groups compared to DBM. Pentachrome staining demonstrated angiogenesis and endochondral bone formation. Furthermore, positive TRAP staining in samples from all groups indicated bone remodeling.

Conclusions: This data suggests that decellularized and oxidized porcine XG is biocompatible and at least equivalent to DBM in the treatment of a critical defect in a rat femur model.

Distal Radius Fractures and Bone Health: A Retrospective Review of Referral Patterns and Utilization of an Institutional Fracture Liaison Service

Natalie Vaughn MD, Matthew Akelman MD, Natalie Marenghi MD, Anne Lake NP, Benjamin Graves MD

Background: Patients with low-energy distal radius fractures (DRF) often do not get appropriate screening for osteoporosis, missing a critical opportunity to improve the patient's bone health and overall outcomes. The purpose of this study is to report on a large retrospective cohort and examine how frequently patients received bone health screening in the setting of an institutional Fracture Liaison Service (FLS).

Methods: A retrospective review was performed to identify patients over the age of 50 who sustained a distal radius fracture between 2013 through 2018. High-energy or unknown injury mechanisms were excluded. The primary outcome examined was referral to a FLS. Patient demographics, DRF management, osteoporosis workup, and previous and subsequent fragility fractures were recorded. Descriptive statistics were applied to the demographic and referral data. Comparative statistics were used in the form of Fisher Exact Tests to determine differences in categorical data.

Results: 950 patients met inclusion criteria, with an average follow up of 2.4 years. 24.2% of these patients were referred to the FLS. Patients who were female ($p = 0.02$), treated operatively ($p = 1.0*10\text{-}4$), or managed by a hand specialist ($p = 8.0*10\text{-}4$) were more likely to receive a referral. The majority of DRF patients did not have metabolic labs (61.7%) or DEXA scans (70.6%) obtained within 6 months or 1 year of injury, respectively. 24% of patients had previously sustained a low-energy fracture. 13.3% sustained a subsequent fracture after their DRF. Prior to injury, 20.7% were being pharmacologically treated for osteoporosis. At the end of follow up, 25.3% of patients were being pharmacologically treated. 32.3% of these patients who presented to the FLS for workup were started on pharmacologic treatment for osteoporosis.

Conclusions: Despite the presence of an institutional FLS, there continues to be a need for improvement in the referral process and evaluation of bone health in low energy distal radius fractures.

Liposomal Bupivicaine use during Adolescent Idiopathic Scoliosis Surgery Decreases Post-operative Narcotic Usage

Rosser W McCallie MD; Alexander H Jinnah MD PhD; Alejandro Marquez-Lara MD PhD; Michael S Hughes MD; John Frino MD

Introduction: Post-operative pain control in adolescent patients after undergoing posterior spinal fusion (PSF) for adolescent idiopathic scoliosis (AIS) can be difficult. Liposomal bupivicaine is a slowly released local anesthetic that can be injected during surgical closure, allowing a more prolonged effect. The purpose of this study was to identify if use of liposomal bupivicaine at the time of closure after PSF would reduce post-operative narcotic use in AIS patients.

Methods: Beginning in November 2019 the senior author began using Liposomal Bupivicaine prior to closure in all AIS patients. The first 25 consecutive patients were matched with 25 AIS patients from the year prior charts were retrospectively reviewed. Liposomal bupivicaine was injected into the paraspinal musculature evenly along the entire length of the incision. Patient demographics, curve severity, and surgical levels were compared. Postoperative outcomes including length of stay (LOS) and visual analogue scores (VAS) for pain (scale 0-10) were recorded. Additionally, morphine equivalent doses during the hospitalization were analyzed and compared between groups.

Results: There were 25 patients in each group with no significant difference in age, gender, body mass index, LOS, or number of levels fused. The liposomal bupivicaine group had significantly less morphine equivalent totals (11.97 vs 16.89, $p=0.03$), but there was no difference in pain scores.

Discussion/Conclusion: The use of liposomal bupivicaine in these patients demonstrated a decrease in morphine equivalents used as an inpatient. However, the reported pain scores had no difference. This may be explained by patient's having a certain pain tolerance at which point they feel additional pain medication is needed, and we can postulate this is why patients who had liposomal bupivicaine did not reach this threshold as quickly as the control group. However, future studies with larger samples sizes and double blinding must be done to prove causation. In conclusion, based on our results the use of liposomal bupivicaine decreased the morphine equivalents used in pediatric patients with AIS following PSF surgery.

Dual Plating of Periprosthetic Distal Femur Fractures

Christopher Grimes, Kelly Stumpff, Sharon Babcock, Jason Halvorson, Holly Pilson, Eben Carroll

Purpose: Periprosthetic distal femur fractures are increasing in incidence as the number of total knee arthroplasties performed each year rises. Multiple fixation strategies have arisen including lateral locked plating, intramedullary nailing (IMN), dual implant with lateral locked plating/IMN and dual medial and lateral locked plating. Historically, lateral locked plating has led to high rates of nonunion. IMN alone has been reported to have higher rates of union but increased incidences of malunion, particularly given the more posterior entry due to the femoral component box as well as a short distal segment for fixation. Dual plating has become an attractive option that allows the patient to weight bear immediately postoperatively and we hypothesize leads to union rates comparable to IMN as well as near anatomic coronal plane reduction.

Methods: We retrospectively reviewed all patients at a Level I tertiary care center from 2018 – 2020. Patients were included if they sustained a periprosthetic distal femur fracture treated with dual plate fixation at the institution during this time frame. Primary outcomes evaluated were fracture union, complications, revision surgery, coronal and sagittal plane alignment was measured.

Results: A total of 31 patients underwent dual plating between 2018-2020 with average age of 78.8. Five patients were lost to follow up. 25 of 26 (96.2%) patients went on to achieve radiographic and clinical union at last follow up. The most common complication was painful implants. Two patients required a repeat operation (7.7%): one underwent deep implant removal for painful hardware (single screw removal), the second patient went on to atrophic non-union but sustained no implant failure. The average lateral distal femoral angle was 83 degrees, and the average posterior distal femoral angle was 85 degrees, which remains within the margin of error of anatomic alignment.

Discussion: Periprosthetic distal femur fractures remain a challenging problem in orthopaedics and have become an increasing component of geriatric trauma. Dual plating of periprosthetic distal femur fractures has several advantages including immediate postoperative weight bearing, improved coronal plane alignment, high union rates and low incidence of complications/repeat operations. Additionally, biomechanical studies have shown that dual plating constructs impart stronger fixation than both lateral locked plating and lateral plate/IMN combinations. Dual plating obviates the need to determine what total knee implants are in place and what intramedullary nail the femoral component box can accommodate. This can be challenging, particularly with older implants no longer in use and avoids possible contamination of the prosthesis by avoiding a knee arthrotomy. Because of these advantages, dual plating should be added to the surgeon's armamentarium for treatment of these fractures.

Open Hip Abductor Repair in the Elderly: Not Bad, but Not Great

J. Hunter Matthews, Alejandro Marquez-Lara, Keon A. Youssefzadeh, John S Shields

Introduction: Open hip abductor repair is recommended for patients who have failed conservative management of symptomatic hip abductor tears. There is limited data on patient and surgical specific factors that may affect outcomes. The purpose of this study was to assess the impact of age on postoperative outcomes following open hip abductor repair.

Methods: A retrospective chart review of 43 consecutive patients who underwent open hip abductor repair by a single surgeon was performed. The cohort was divided based on age into two groups, <65 years and >65 years. Patient factors including, body mass index (BMI), comorbidities, length of symptoms and gait mechanics were assessed. The repair technique, single vs double row, and use of augmentation tissue was also compared between groups. Postoperative outcomes including retear, revision of repair, clinical symptoms and gait mechanics were assessed. Appropriate statistics were performed.

Results: Median follow up time was 318 days, range 128-905 days. Average age of the elderly group was 71.7±5.0, compared to 52.9±7.1 of the younger group. There were no significant differences in preoperative patient factors. There was a significantly higher rate of double row repair in elderly patients compared to their younger counterparts (88.9% vs 37.5%, p=0.001). There were no difference in re-tear or revision rates between groups. At follow up, three patients (18.7%) of the younger cohort had persistent antalgic gait compared to eight (29.6%) of the patients in the elderly cohort.

Discussion and Conclusion: The present studies highlight the impact of age on open hip abductor repair. Elderly patients more often require a double row repair compared to younger patients. This suggests a combination of poor soft tissue quality and larger tears in elderly patients. Although not statistically significant, almost a third of patients in the elderly group reported persistent pain and antalgic gait at follow up. Further research is warranted to better characterize the impact of older age and associated factors with outcomes following open hip abductor repair.

Table 1: Open hip Abductor Repair by Age groups

	Age <65	Age ≥65	
N	16	27	
Age (years)	52.9±7.1	71.7±5.0	<0.001
Body mass index	29.9±4.7	27.4±4.5	0.101
Tobacco use	43.8%	29.6%	0.509
Duration of symptoms (months)	15.1±13.3	20.4±16.7	0.299
GT injections Preop narcotics/Tramadol	12 (75%) 2 (12.5%)	21 (77.8%) 5 (18.5%)	
Single Row Double Row	10 (62.5%) 6 (37.5%)	3 (11.1%) 24 (88.9)	0.001
Patch	1 (6.3%)	3 (11.1%)	0.842
Follow up (days)	378.2 (128-905)	377.4 (134-778)	0.993
Retear	2 (12.5%)	2 (7.4%)	0.621
Revision	1 (6.3%)	1 (3.7%)	
Antalgic gait	3 (18.7%) *	8 (29.6%) **	0.720

* 1 patient had a husband who fell on her and also had COPD, DM, fibromyalgia, Hx of TIA, 1 patient had hip dysplasia, 1 patient had known labral tear.

** 1 patient had muscle wasting, 2 patients were non-compliant with PT, 1 patient was on preop narcotics, 1 patient had 5-6 years of symptoms prior to surgery, 1 was >70 years, 1 was a smoker, 2 had diagnosis of DM

Comparative Motion Analysis for Virtual Reality Surgical Simulation

Michael Seem MD, Samuel Rosas MD, PhD, Alejandro Marquez-Lara MD, PhD,
Jason Halvorson MD

Introduction: Muscle memory and motor memory are two distinct, but related entities, and are especially important when it comes to surgical training. Muscle memory is the ability of a muscle fiber to remember a specific change or position over many years, whereas motor memory is the ability of the cerebral cortex to "remember" habitual activities such as walking or playing an instrument. Surgical proficiency is partially dictated by habitual movements and muscle memory by surgeons in the operating room (OR). Aside from true operating experience and surgical practice on imitation models and cadavers, reproducing the muscle actions required to achieve surgical proficiency is limited. Virtual reality (VR) has become an accepted method of surgical training for orthopaedic surgery residents in recent years, which allows for duplicating movements analogous to those seen in the operating room. The purpose of this study is to compare motion analysis data between VR and real-world surgical simulation. This comparison will provide insight into the effectiveness and reproducibility of VR surgical simulation, and its impact on surgical efficiency for the surgeon in training. Moreover, this type of analysis can direct trainees to a particular area of focus. The purpose of this study will be to provide a comparison between practical surgery and virtual reality simulation on body kinematics.

Methods: This study is a prospective comparative study evaluating body kinematics recorded through motion capture analysis of 5 orthopaedic surgery residents performing an identical procedure in both VR and on a saw bones model. A total of 5 co-investigators will be fitted with 14 retro-reflective markers on their trunk and both hands and arms and will perform a tibial nail on a saw bones model and in VR a total of 3 times each. Data will be recorded with a 6 camera motion capture system (Motion Analysis, Santa Rosa CA) operating at 60hz.

Results: Preliminary comparative results demonstrate significant similarities between surgical simulation on a saw bones model and VR surgical simulation.

Conclusion: While more data is needed to establish the similarities in overall kinematics, subjective data indicates nearly identical movements of the extremities for all aspects of the procedure. VR has proven to be an effective method of surgical training in previous studies, and our study further validates it's use for training in an orthopaedic residency.

Elbow Arthroscopy for Osteochondritis Dissecans in Adolescents: Long-term Follow-up

Andrey Zuskov, MD, T. David Luo, MD, James Kyriakedes, MD, Zhongyu Li, MD, PhD, Ethan Wiesler, MD Gary Poehling, MD, Michael Freehill, MD, Anastasios Papadonikolakis, MD, PhD

I**NTRODUCTION:** Osteochondritis Dissecans (OCD) is a condition of the cartilage/osteochondral interface. In the elbow, it occurs predominantly in the dominant arm of overhead adolescent athletes. Proposed pathophysiology is related to avascular necrosis of the subchondral bone and initial treatment is activity cessation/modification with a trial of NSAIDs. Surgical options include non-reconstructive procedures like debridement, loose body removal or microfracture. Short to medium term outcomes data after such procedures demonstrate promising outcomes, however long-term data is scarce. We hypothesized that adolescent elbow OCD lesions treated with non-reconstructive arthroscopic means will have excellent long-term outcomes.

METHODS: This was a single-center retrospective analysis of patients under 18 years of age with elbow OCD who underwent non-reconstructive arthroscopic treatment between 2006 and 2016. Patients who underwent reconstructive procedures, had follow-up of less than four weeks, or had history of prior elbow surgery were excluded. Demographics, medical history, operative notes, and patient-reported outcomes (QuickDASH and Likert Pain Scale scores) were reviewed. Student t-test and chi-square analyses were performed to compare continuous and categorical variables, respectively, with significance set at $p<0.05$.

RESULTS: Eighteen arthroscopies in 17 patients were included for analysis. Mean age at time of surgery was 14.1 ± 2.5 years. The 18 cases included 11: arthroscopic debridement with loose body removal, 6: arthroscopic debridement alone, and 1: debridement with microfracture. At mean follow-up time of 8.2 ± 3.5 years (range 2.9 to 12.9 years), mean QuickDASH score was 6.9 ± 16.4 and Likert score was 0.9 ± 1.7. There were two failures of initial treatment; one repeat elbow arthroscopy for removal of loose bodies and another patient who reported severe limitation to his operative elbow, with a QuickDASH score of 70.5 at 10-year follow-up.

DISCUSSION AND CONCLUSION: Adolescent elbow OCD lesions treated with non-reconstructive arthroscopic means have excellent long-term outcomes.

Surgical outcomes for brachial plexus birth palsy: A comparison of the Modified Hoffer and L'Episcopo techniques

Linda Chao MD, Jersey Burns MD, Zhongyu Li MD, PhD and L. Andrew Koman, MD

Introduction: Brachial plexus birth injuries/palsies (BPBP) usually resolve spontaneously after a few months. Rarely, nerve function does not fully recover, and the child may develop loss of abduction and external rotation, which can result in the development of shoulder contractures that predispose the child to malformation of the humeral head and glenoid. Transferring the latissimus dorsi tendon to the greater tuberosity (Sever-L'Episcopo) or directly to the rotator cuff (modified Hoffer) have been widely used in patients with BPBP. We investigated the long-term outcomes of these techniques.

Methods: Retrospective chart review of all children (n=150) treated for BPBP at our institution from 2000-2015 was completed. Birth history, surgical history, ROM measurements and functional status, including Mallet scores, were collected. Microsoft Excel was used for statistical analysis (descriptive statistics, single-factor ANOVA).

Results: Of the 150 patients treated for BPBP, 66 underwent surgical procedures about the shoulder (modified Hoffer n=16; L'Episcopo n=22). Longest follow up was 10.6 years. Range of motion (ROM) improved postoperatively in both groups, but differences between groups were not statistically significant. Mean improvements in shoulder active ROM in the Hoffer group were: external rotation (ER) 31.1±6.8˚; forward flexion (FF) 43.6±9.3˚; abduction (ABD) 40±10.6˚. In the L'Episcopo group, mean improvements were: ER 29.2±5.2˚; FF 29.7±10.4˚; ABD 23.8±9.9˚. In the Hoffer group, 1/16 (6.25%) of patients had a secondary operation (elbow contracture release). In the L'Episcopo group, 7/22 (31.8%) underwent a secondary operation (humeral osteotomy n=1; Z-lengthening of subscapularis tendon n=1; Hoffer n=2; elbow contracture release n=3).

Conclusion: The modified Hoffer and Sever-L'Episcopo procedures are effective in improving shoulder aROM in children with BPBP, with no statistically significant difference in improvement of ROM between the two methods. However, the rate of re-operation following L'Episcopo transfer is significantly higher than for the modified Hoffer, suggesting an advantage of the Hoffer over L'Episcopo technique.

Characteristics of modified Hoffer tendon transfer patients

Gender	Age at Surgery (months)	Duration of Follow up (months)	Secondary procedure?	Time to 2nd procedure (years)
M	60.2	27	Elbow contracture release	2.7
M	94.3	121	No	
M	61.7	16	No	
F	66.9	18	No	
M	48.0	35	No	
F	35.1	42	No	
F	15.9	74	No	
M	82.3	10	No	
F	29.9	16	No	
F	29.2	36	No	
M	56.6	8	No	
F	19.0	29	No	
F	23.1	5*	No	
F	15.9	32	No	
M	172.9	3*	No	
M	54.3	19	No	
Average	54.1	30.6		
STDev	39.6	29.9		

*lost to follow up

Early Clinical Outcomes of the Depuy ACTIS Total Hip Arthroplasty Femoral Implant

Shane Tipton MD, Hunter Yancey MD, Samuel Rosas MD, MBA, PhD, Michael Seem MD, David Pollock MD, Johannes Plate MD PhD

Introduction: The direct anterior approach (DAA) is being used with increasing frequency for total hip arthroplasty (THA). This approach has demonstrated a unique complication profile that has invited innovation to the instrumentation and implants used. The Depuy ACTIS femoral stem was designed to accommodate for the needs of the DAA by incorporating a unique broaching system, triple taper, reduced lateral shoulder, and a medial collar. This stem was released in January 2017, and as such the outcomes remain largely unknown. The primary purpose of this study was to report the early clinical outcomes of patients who have undergone THA with the Depuy ACTIS femoral stem performed through the DAA. It is hypothesized that the early clinical outcomes of the Depuy ACTIS femoral stem will be comparable to that of other stems reported in the literature.

Methods: A retrospective review was conducted on 226 THAs on consecutive patients treated with the DePuy ACTIS femoral stem for primary osteoarthritis by two high volume total joints surgeons at a single academic center. Patients who had index surgery between May 2017 and August 2018 were reviewed and included in the study. Patients were required to have at least one year post-operative follow-up to be included. The primary outcome measure was all-cause revision rate, observing for failures related but not limited to dislocation, infection, or fracture. Additionally, pre and post-operative visual analog scale (VAS) pain scores were collected and analyzed. Evaluation for loosening and subsidence was also undertaken radiographically and clinically.

Results: Of the 226 THAs reviewed, 209 THAs in 197 patients met the inclusion criteria (follow-up rate 92.4%). The average follow-up time was 2.63 years (SD 0.83). Of those included, the all-cause revision rate was 1.91%. One patient (0.48%) presented with a dislocation requiring revision to a constrained liner, one patient (0.48%) developed aseptic loosening requiring revision of the femoral component, one patient (0.48%) underwent revision for persistent anterior hip pain, and one patient (0.48%) had a periprosthetic fracture-dislocation requiring revision. No patients were diagnosed with post-operative infection requiring revision. Four patients (1.91%) were either diagnosed with or treated for an abductor tear. Mean pre-operative VAS scores were 60.7 (SD 23.7) compared to 6.2 (SD 15) post operatively ($p < .001$).

Conclusion: The Depuy ACTIS THA femoral implant has demonstrated encouraging early clinical outcomes using the DAA. The overall revision rate is low, including the incidence of aseptic loosening and femoral fracture (< 1% each). The revision and complication rate is comparable to those cited in the literature using other instrumentation. Pain was reliably and considerably improved. Long term follow up is needed to fully characterize the potential benefits of this stem.

Inflammation and Fracture Healing:
A New Paradigm

Alejandro Marquez-Lara MD, Ian D. Hutchinson MD, Kerry Danelson PhD,
Anna N. Miller MD**,** Thomas L. Smith PhD

Introduction: The impact of non-steroidal anti-inflammatory drugs (NSAIDs) on fracture healing remains unclear. While the majority of pre-clinical studies have demonstrated a negative effect, there is great variability in the type of NSAID, length of exposure and fracture models, which limit its translation to clinical practice. Furthermore, among clinical studies the majority good-to-excellent quality studies have demonstrated no significant detrimental effect, particularly when given for a short course (2-4 weeks). With these limitations in mind, the aim of this study is to assess the impact of a short-course of NSAIDs on fracture healing in the setting of a novel translational fracture model. We hypothesize that NSAIDs will not be associated with delayed healing.

Methods: A closed mid-diaphyseal femur fracture was generated in the right femur of 40 young adult, Sprague-Dawley rats using the method described by Bonnarens and Einhorn. Half (n=20) underwent conventional, one-hit (OH), fixation with retrograde intramedullary pin placement (0.8mm) prior to the experimental fracture. The remaining rats (n=20) underwent fracture fixation 24 hours after the index injury [two hit, (TH)]. Half of the rats from each group were given meloxicam (1mg/Kg) daily for 7 days following experimental fracture. Plain film radiographs and weight (grams) were recorded on a weekly basis until sacrifice at 6 weeks. Four-point bend testing was performed to assess mechanical strength and physical properties after 6 weeks. Histomorphometric analysis was also performed to assess ratio of cartilage tissue in the healing callus in early and late time points. Analysis of Variance with post-hoc analysis was performed to compare differences between groups.

Results: A total of 38 rats were available for analysis. Analysis of the mechanical properties following biomechanical analysis demonstrated significant differences between groups. NSAID exposure was associated with a lower modulus of elasticity that was similar to intact bone, while those without NSAIDs were more brittle (higher modulus of elasticity). In contrast there were no differences in stress properties based on ultimate failure load between groups after adjusting for size of femur. Histomorphometric analysis demonstrated different healing patterns between groups where the non-NSAID groups had increasing callus size and proportion of fibrin compared to cartilage tissue between 7-21 days. In contrast NSAID groups callus size remained stable, demonstrated early cartilage formation and lower fibrin tissue over time. Neutrophil population was greater in the non-NSAID groups compared to the NSAID cohorts at day 7.

Discussion: A comprehensive assessment of the impact(s) of NSAIDs on bone healing must account for dose and length of exposure in an accurate experimental model. In the present study, a short course (7-days) of NSAID was not associated with delayed bone healing. NSAID exposure appeared to accelerate fracture healing compared to no NSAID exposure as noted by the differences in material properties at 6 weeks. Histomorphometric analysis supported a faster transition from inflammatory tissue to healing callus. These findings suggest that early exposure to NSAIDs may favorably modulate the inflammatory response to optimize the subsequent stages of the bone healing process. Overall, short term exposure to NSAIDs following a translational pre-clinical fracture model was associated with enhanced bone healing compared to no NSAID exposure.

Acknowledgments

The Department of Orthopaedic Surgery Research Team provides invaluable assistance to faculty, fellows, residents and students with funded and unfunded research initiatives. The team comprises a wide array of knowledge and expertise to assist researchers from the planning stage to the completion of research projects. Their contributions enable researchers to develop innovative procedures and processes that further the advancement of orthopaedic patient care and increase positive patient outcomes. Team members are:

Sharon Ayers; Administrative Secretary

Ariel Brotherton; Assistant Project Manager

Jiao Cai; Lab Tech IV

Ninoshka Cruz Diaz; Clinical Studies Coordinator – Sports Med

Eboni Drummond; Research Administrative Coordinator

Eileen Elsner; Lab Tech IV

Brett Goodman; Research Project Coordinator

Erica Hartzell; Clinical Studies Coordinator – Sports Med

Martha Holden; Research Laboratory Supervisor

Taylor Hill; Clinical Studies Coordinator

Kamryn King; Clinical Studies Coordinator – Spine

Amy Ma, MD, PhD; Assistant Professor

Kristen Nicholson, PhD; Assistant Professor

Regina Renegar; Data Collector

Karen Watson; Departmental Project Manager

Wendy Williams; Data Collector