



The Robert Larner, M.D.
College of Medicine

THE UNIVERSITY OF VERMONT

**Department of Orthopaedics and Rehabilitation
McClure Musculoskeletal Research Center**

***Research Day
Friday, June 24, 2022***

A Hybrid Event in Stafford 101 and via Zoom

<https://uvmcom.zoom.us/j/108497630>

**Research Day Program
7:00 am**

Visiting Professor:

Ethan Blackburn, MD

**Hand and Upper Extremity Surgery Surgeon,
Louisville Arm and Hand**

**Clinical Instructor, University of Louisville Department of
Orthopaedic Surgery**

UVM Resident Alumni 2007-2012

Program

7:00 AM **Keynote Presentation: Ethan Blackburn, MD**
Introduction: **Claude E. Nichols, III, MD**

7:05 – 7:35 Title: “Walking the tightrope: private practice academic medicine”
By: Ethan Blackburn, MD

7:35 – 7:45 Questions

SESSION 1 **PGY 5 Final Research Project Presentations**
Moderator: **Chason Ziino, MD**
Lead Discussant: **Ethan Blackburn, MD**

7:45 – 8:00 Title: “Donning gloves before surgical gown cross-contaminates the assistant”
By: Alec Sundet, MD, PGY-5 (Nelms/Michelson).....3

8:00 – 8:10 Questions

8:10 – 8:25 Title: “The Crippling Effects of a Cyberattack at an Academic Level 1 Trauma
Center: An Orthopedic perspective”
By: Mitch Tarka, MD, PGY-5 (Blankstein/Schottel).....4

8:25 – 8:35 Questions

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SESSION 2 **Departmental Research Presentations**
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11:35 ***Lunch and Awards: Stafford 4 Lobby***

Raymond F. Kuhlmann, MD Resident Research Award

-Awarded to the Outstanding Presentation by a Chief Resident

McClure Musculoskeletal Research Award

-Awarded to the Outstanding Presentation by a Researcher (non-faculty)

Donning gloves before surgical gown cross-contaminates the assistant

Alec Sundet, MD, Nathaniel J. Nelms, MD, James D. Michelson, MD

Background

Maintaining a sterile surgical environment is of the utmost importance in total joint arthroplasty. The surgical gown-glove interface is a frequent and known cause of bacterial contamination. A variation of the traditional staff-assisted open-gloving technique has been developed in an attempt to address this. In this method, the surgeon dons their undergloves before their gown. Although this has demonstrated improved sterility for the surgeon, no studies have considered the effects of this technique on the person assisting the surgeon. The present study was designed to investigate this. We hypothesize that the process of donning undergloves before the surgical gown leads to higher rates of contamination for the assistant.

Methods

We performed a comparative study between the traditional and a gloves-first scrubbing technique. We assessed the differences in gown and glove contamination of the surgical assistant following each scrubbing event. Two surgeons applied ultraviolet light disclosing lotion to their upper extremities and then performed each method in a randomized order with 40 surgical technologists/nurses. Blinded evaluators then quantified the amount of contamination on the surgical assistant's gown and gloves.

Results

The gloves-first technique resulted in increased contamination of the surgical assistant's gloves ($P=0.002$). There was no difference in contamination of the surgical gown ($P=0.982$).

Conclusions

Although the staff-assisted open-gloving technique may improve the sterility of the surgeon, it does so at the expense of the surgical assistant. Surgeons adopting this technique should consider donning their own undergloves or having the assistant rescrub before any further contact with the sterile environment.

The Crippling Effects of a Cyberattack at an Academic Level 1 Trauma Center: An Orthopedic perspective

Mitchell Tarka MD, Michael Blankstein MSc, MD, FRSC, Patrick Schottel MD

Background

Malicious cyberattacks are increasing in frequency and severity with healthcare institutions spending an average of \$2.2 million dollars to resolve the consequences of healthcare data breaches. This cost doesn't include the effect of a downtime event should a healthcare system electronic medical record (EMR) lose functionality.

Questions/purposes

Our Academic Level 1 trauma center suffered a cyberattack resulting in a total EMR downtime of 25 days. We used Orthopaedic operative time as a surrogate for OR functionality during such an event and offer a framework and specific examples for rapid adaptation during downtime events.

Patients and Methods

Operative time losses were identified by calculating a running average of weekday total in room operative time during a total downtime secondary to a cyberattack. This data was compared to week-of-the-year matched data from the year prior and the year after the attack. A framework for creating adaptations to a total downtime event was created by repeatedly interviewing different provider groups and understanding how they adjusted care to the challenges faced.

Results

Total weekday in room operative time decreased by 48.7% ($\pm 20.7\%$, $p < 0.05$) and 47.8% ($\pm 19.1\%$, $p < 0.05$) when comparing the matched period one year prior and one year after, respectively. Immediate challenges to patient care were identified by small groups of highly motivated individuals, with self-assigned agile teams formed. These teams sequenced system processes, identified failure points, and created real-time solutions.

Conclusions

Cyberattacks are expensive and their downstream affects, including downtime events, can be crippling. Agile team formation, process sequencing, and understanding EMR backup times were tactics employed to combat the challenges of a prolonged total downtime event.

Level of Evidence – Level IV

After Hour Calls among Orthopaedic Surgery Subspecialties at an Academic Level 1 Trauma Center-Understanding Frequency and Etiology

PGY5/4 Orthopaedic Surgery Residents:
Alec Sundet, Mitchell Tarka, Will Efird, Evan Boyd, Michael Roberts

Background

The frequency, timing, and etiology of after hour patient phone calls in Orthopaedic Surgery are not well defined. Furthermore, call frequency subdivided by orthopaedic subspecialties is unknown.

Question/Purpose

At our Academic Level 1 Trauma Center we sought to identify the frequency and etiology of after-hours phone calls received by Orthopaedic surgery residents on call. Additionally, we identified the outcomes of the calls, timing of the calls, and frequency of calls subdivided by subspecialty and day of the week.

Patients and Methods

All patient phone calls between 1/24/21 and 1/24/22 were documented through an electronic medical record template. Within the template was the time of the call, day of the call, Orthopaedic subspecialty associated with the call, etiology of the call, and the call outcome. During this period 438 calls were received, and aforementioned values documented. Subspecialty calls were normalized by cases per week to account for case number variability between services.

Conclusions

Patient phone call after-hour frequency was greatest on the weekends with 22% of calls fielded between 2300 and 0500. The majority of calls (25%) were due to a concern for new drainage, infection, DVT, or other post-operative complication and 36% of calls resulted in a formal recommendation for presentation to the Emergency Department.

ACLR-tourniquet study

Alexa Pius, MD

Background

Anterior cruciate ligament trauma and reconstruction (ACLR) is associated with the loss of strength and function of the muscles that span the knee joint. The underlying mechanism associated with this is not completely understood.

Purpose

To determine if the duration of tourniquet use during ACLR has an effect on knee extensor muscle contractile function and size at the cellular (i.e., fiber) level 3 weeks post-surgery and the whole muscle level at 6 months post-surgery.

Study Design: Cohort Study

Methods

Study participants suffered an acute, first-time ACL injury. All subjects underwent ACLR with the use of a tourniquet placed in a standardized location on the thigh that was inflated (pressure range: 250 to 275mm of Hg), and the time of tourniquet use during surgery was documented. Subjects were evaluated 1 week prior to surgery (to measure patient function, strength and subjective outcome with the KOOS and IKDC), at 3 weeks following ACLR surgery (to obtain muscle biopsy of the vastus lateralis and assess muscle fiber cross-sectional area, contractile function and mitochondrial content and morphometry), and at 6 months post ACLR (to evaluate patient function, strength, and subjective outcomes via KOOS and IKDC scores). Data were acquired on both the injured/surgical limb and the contralateral, normal side to facilitate the use of a within-subjects study design. Results are based on additional analysis of data acquired from prior research that had common entry criteria, treatments, and follow-up protocols.

Results

Three weeks following ACLR, the duration of tourniquet use at the time of surgery did not explain variation in single muscle fiber contractile function or cross-sectional area (MHC I and II fibers), or subsarcolemmal and intermyofibrillar mitochondrial content or morphometry. Six months following ACLR, the duration of tourniquet use was not associated with the peak isometric and isokinetic torque measurements, patient function, or patient reported outcomes.

Conclusion

The duration of tourniquet use at the time of ACLR surgery did not explain variation in muscle fiber size, contractile function or mitochondrial content at 3 weeks, nor strength of the quadriceps musculature or patient-reported function or quality of life at 6-month follow-up.

Test-Retest Reliability of T1 ρ and T2* in Small and Large Tube Phantoms and Left-Right of Isocenter Positional Dependence

Niccolo M. Fiorentino^{1,*}, Mack Gardner-Morse², **Andrew Borah²**, John Ramsdell, Jiming Zhang, Pamela Vacek, Mickey Krug², Matthew Geeslin, Timothy Tourville², Mathew Failla², and Bruce Beynon²

Departments of 1Mechanical Engineering and 2Orthopaedics and Rehabilitation, University of Vermont, USA

Introduction

Identifying changes in cartilage composition prior to cartilage loss may allow novel therapeutic interventions to prevent osteoarthritis onset and progress. Recent imaging advancements aim to capture changes in tissue composition using quantitative magnetic resonance imaging (qMRI) techniques [1], with qMRI metrics demonstrating a difference between healthy knees and those at increased risk of osteoarthritis [2]. Establishing the reliability of qMRI metrics is an ongoing challenge due to research-based acquisitions and newer metrics such as T2*.

The reliability of qMRI metrics is frequently assessed with an imaging phantom composed of liquid or gel placed at the center of the magnet (i.e. isocenter). Imaging phantoms consist of either an array of smaller tubes, usually arranged in a circular pattern, or one larger container. While the smaller phantoms permit simultaneous imaging of an array of qMRI values, the tube size is small compared to diarthrodial joints. Furthermore, phantoms imaged at isocenter may generate misrepresentative results, as diarthrodial joints in the extremities are located to the side (left and right) of isocenter during imaging.

Therefore, the purposes of this study were to quantify the variance in qMRI metrics T1 ρ and T2* in small and large imaging phantoms relative to:

- Test-retest (day-to-day variability)
- Image location (slice)
- Phantom position (left and right relative to magnet isocenter)

Methods

We conducted a test-retest reliability study of T1 ρ and T2* using two imaging phantoms. The ‘small tubes’ phantom consisted of three pairs of tubes (six total) of agarose gel (2, 3 and 4%) for T1 ρ imaging (The Phantom Laboratory, Inc.) [3], and six different tubes with three concentrations of MnCl₂ for T2* imaging (Fig. 1). The ‘large tube’ phantom was a single tube (Nalgene™) of 89 mm diameter and 285 mm length. Both phantoms were imaged 100 mm to the right of isocenter and 100 mm to the left on five separate days using a T1 ρ sequence (TSL = 0, 10, 40 and 80 ms, 500 Hz) [4] and a T2* sequence (TE = 1.42, 1, 5, 15 and 30 ms). Images were acquired on a Philips Achieva 3T MR Scanner with a 16-channel transmit-receive RF coil.

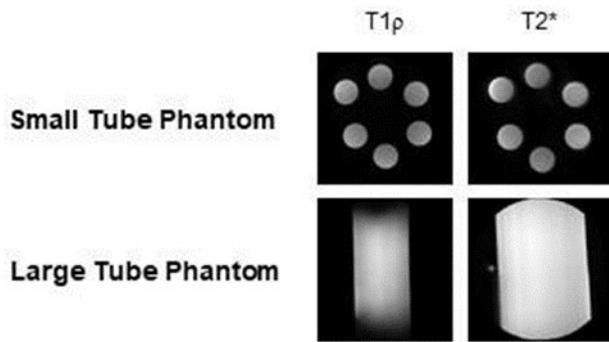


Figure 1: Representative phantom images used to calculate $T1\rho$ (images on the left, TSL = 0 ms) and $T2^*$ (images on the right, TE = 0.42 ms).

Each pixel was fit with a mono-exponential function using custom MATLAB software (The Mathworks Inc., Natick, MA). Variance component analysis estimated the amount of measurement error attributable to day, slice and side for the large phantom. For the smaller phantoms the variability between vials was also estimated. Paired t-tests tested for systematic differences between the right and left imaging locations relative to isocenter from the same slice and day ($p < .05$). Averaged data reported as mean \pm STD.

Results and Discussion

$T1\rho$ small tubes phantom: The average (total variance) across all days and both imaging positions relative to isocenter for $T1\rho$ was

34.1 ms (0.6), 66.0 ms (1.9), and 44.8 ms (0.6), for the three pairs of small tubes with different concentrations. Percentage variance was highest for ‘side’ at all concentrations (38%, 49%, 41%). All vials demonstrated a difference between the left and right imaging locations relative to isocenter (0.9 \pm 0.4 ms).

$T2^*$ small tubes phantom: The average (total variance) across all days and right and left imaging locations for $T2^*$ was 23.4 ms (7.0), 11.7 ms (1.1), and 3.1 ms (0.1), for the three pairs of small tubes with different concentrations. Percentage variance was highest for ‘slice’ (57%), ‘vial’ (93%) and ‘vial’ (71%), resp. Five of six vials demonstrated a difference between the left and right imaging locations (0.1 \pm 2.0 ms).

$T1\rho$ large tube phantom: The average (total variance) across all days and both scanning positions for $T1\rho$ was 42.6 ms (0.4). Percentage variance was highest for ‘day’ (97%). Measurements were different on the left vs. right locations (0.1 \pm 0.1 ms).

$T2^*$ large tube phantom: The average (total variance) across all days and both sides for $T2^*$ was 24.3 ms (0.9). Percentage variance was highest for ‘day’ (62%). Measurements were different on the left vs. right imaging locations (0.8 \pm 0.3 ms).

Our variance estimates were similar to previously reported $T1\rho$ values using the same small tubes phantom; however, our results showed a position dependence that was not observed previously [3].

Significance

To our knowledge our study was the first to quantify:

- Source of variability in $T1\rho$ and $T2^*$
- $T1\rho$ and $T2^*$ variability in small and large phantoms
- Effect of phantom size on left-right position dependence

Acknowledgments

We acknowledge technical support from the UVM MRI Center for Biomedical Imaging and statistical analysis by the UVM Biomedical Statistics Research Core.

References

- [1] Guermazi et al., 2015. Osteoarthritis Cartilage. 23(10): 1636. [2] MacKay et al., 2018. Osteoarthritis Cartilage. 26(9): 1140.
- [3] Kim et al., 2020. Osteoarthritis Cartilage. 28(12): 1539.
- [4] Li et al., 2008. Magn Reson Med, 59(2): 298.

Prevention of post-traumatic joint contractures with Ketotifen II (PERK2): Protocol, progress update and pandemic adaptations for the PERK2 trial at the University of Vermont

Michel Benoit, MD; Melissa Cuke, MSc

Evaluation of an oral medication in reducing elbow contracture after surgical treatment of elbow trauma, based on known pathophysiology of soft tissue contracture.

Primary Objective: Evaluate efficacy of ketotifen fumarate compared to placebo in reducing post-traumatic elbow joint contractures when administered for 6 weeks beginning within 7 days of elbow fracture and/or dislocation injury.

Design: Phase III, randomized, triple-blinded, placebo-controlled multicenter efficacy trial with three parallel groups. Stratified block randomization by site with allocation in a 1:1:1 ratio.

Intervention: Oral study medication (2 mg ketotifen fumarate, 5 mg ketotifen fumarate, or lactose placebo) twice daily for 6 weeks beginning within 7 days of injury.

Study population: Adults with elbow dislocations and/or fractures of the distal humerus (AO/OTA type 13), proximal radius (AO/OTA type 2R1) and/or proximal ulna (AO/OTA type 2U1) requiring operative treatment from 17 identified sites in Canada and the US. Participants are excluded for factors that predispose to elbow contracture, are expected to affect protocol adherence by participants, or medication contraindications.

Primary endpoint (efficacy): Change in elbow flexion-extension range of motion arc from baseline (week 12, post-randomization).

Secondary outcomes (efficacy): Change in elbow supination, pronation, flexion and extension (weeks 2-12 and weeks 2-52); Patient reported outcome measures (Disability Arm Shoulder Hand, Oxford Elbow Score, and the Pain Catastrophizing Scale, at each of weeks 12 and 52).

Secondary outcomes (safety): Radiographic evaluation of fracture healing/non-union and heterotopic ossification; Re-operation for contracture release (week 12, week 52); Composite re-operation for all elbow-related causes (week 12, week 52); Serious adverse events and suspected unexpected serious adverse reactions (through each of week 12 and week 52).

Status: Recruitment updates will be presented across sites. Adaptations to the COVID-19 pandemic will be discussed at the site level for the University of Vermont Medical Center (UVMCMC).

Prospective Registration: Clinicaltrials.gov, NCT03582176 (July 10, 2018)

Lead Investigator: Kevin Hildebrand (University of Calgary and Alberta Health Services)

Sponsors: United States Department of Defense; University of Calgary

Investigators at UVMCMC: Michel Benoit (Principal), Kevin Lutsky, Patrick Schottel; Adam Shafritz

Haglund's Deformity and its Association with Achilles Tendinitis

Tonya Conley, MS2, James Michelson, MD (Mentor)

Background

Haglund's deformity was first described in 1928 by Patrick Haglund as a posterosuperior osseous prominence of the calcaneal tubercle. Haglund's syndrome is defined as the additional symptoms of Achilles bursitis and tendinitis. The pathology has since been observed by many with attempts made to define parameters for clear, objective diagnosis with predictive accuracy of symptomatology; all without reproducibility or statistical significance.

Purpose

This paper intends to assess existing criteria and propose new parameters to define and predict Haglund's pathology with relation to pathomechanics.

Methods

Electronic medical records were used to identify diagnosed Haglund's deformity using ICD10 codes M92.60, M92.61, M92.62. 50 patients with diagnosed Haglund's deformity and 55 randomly selected controls from the Foot and Ankle clinic PACS system were obtained, deidentified and imported into ImageJ software for data collection. Existing parametric attempts including Calcaneal pitch angle (CPA), Fowler-Philip angle, Chauveaux-Liet angle, parallel pitch line determination (PPL), and Tourné's X/Y ratio were analyzed. The proposed measurements of this study consist of obtaining an axis of rotation at the talocrural joint. From the axis, the angular height of the calcaneus defined as the calcaneal height angle (CHA) and the posterior calcaneus relative to the axis of rotation during dorsiflexion, defined as the posterior calcaneal slope angle (PCSA), were determined. The ratio of PCSA/CHA was analyzed as it captures both components of the deformity contributing to clinical prevalence; increased vertical alignment with dorsiflexion of a more prominent posterior tubercle (PCSA) and increased height of the posterior tubercle (CHA). The angle of rotation to align the posterior tubercle perpendicular to the weight bearing surface thus creating the greatest point of impact was then obtained trigonometrically. Statistical analyses were performed on collected data.

Results

Our results were congruent with prior studies indicating none of the previously published radiographic criteria reliably distinguished between those with clinically diagnosed Haglund's deformity from the control. PPL, most current in the practice of clinical diagnosis, revealed no utility in reliably differentiating between control and diagnosed Haglund's deformity. The proposed measures of this study, CHA and PCSA, did not indicate statistically significant difference as individual measurements. By ROC curve, the ratio PCSA/CHA was statistically significant in clinical diagnosis of Haglund's deformity with the area under the curve at 63.2% (95% CI 52.7%-73.7%, $p = .018$).

In terms of identifying an objective measure, this study found the ratio of angles PCSA/CHA to have greater predictive value than current measures to date. This has strong implications in the process of informed decision making toward intervention, outcome, and aid in preventative treatment.

Mid-Term Results of the Use of Structural Humeral Head Autograft to Correct Glenoid Bone Loss in Reverse Total Shoulder Arthroplasty

Jack Mangan, MS2, Adam Shafritz, MD (Mentor)

Objective: To report the mid-term clinical and radiographic outcomes of patients treated with structural humeral head autograft reconstruction of glenoid bone loss in the setting of reverse total shoulder arthroplasty.

Design: Retrospective review of prospectively collected data.

Patients/Participants: All patients treated with structural humeral head autografts to reconstitute glenoid bone loss.

Intervention: Humeral head autograft compressed into site of bone loss using commercially available implants.

Main Outcome Measurements: Statistical analysis to determine if humeral head autograft augmentation of glenoid bone loss is a viable solution for patients undergoing reverse total shoulder arthroplasty. Successful incorporation, complications, pre-and post-operative shoulder ROM, and PROMs (VAS, DASH, and SST scores) are reported. Medical comorbidities as potential risk factors for complication from surgery were also evaluated.

Results: 30 shoulders belonging to 28 patients were included in this study. The mean age at time of surgery was 73.5 ± 6.8 years. Preoperatively, 60% of patients presented with a glenoid insufficiency fracture. The mean preoperative glenoid bone stock measurement was 20.0 ± 4.3 mm, retroversion angle was 11.1 ± 17.3 degrees, and inclination angle was 1.7 ± 13.2 degrees. Postoperatively, the mean retroversion angle was found to be 8.6 ± 5.6 degrees, and the inclination angle was -19.3 ± 10.5 degrees. During the time period of this study 10 patients died for reasons not related to their shoulder surgery. Patients were followed for an average of 3.1 ± 2.7 years for the deceased cohort, and 3.7 ± 1.6 years for the alive cohort. Patient-reported outcome measures and range-of-motion testing including forward flexion, abduction, internal rotation, external rotation, VAS (pain score 0-10), DASH, and SST were all significantly improved post-operatively ($p < 0.0001$). No revision procedures were performed, and all patients were satisfied with their shoulder post-operatively. Bone grafts were found to incorporate into 100% of shoulders, with no prosthetics displaying signs of loosening or other structural concerns. Using radiographic evidence, two patients (6%) presented with scapular notching on follow-up.

Conclusions: The use of a humeral head autograft to reconstruct glenoid bone loss in patients undergoing reverse total shoulder arthroplasty is a safe and effective procedure. It allows for a local graft source to be utilized thus avoiding potential comorbidity and complications associated with the use of alternative site autografts or allografts and has the advantage of nearly congruent fit within the defect. The use of commercially available implants and 3D printed guides may be associated with increased technical ease of the procedure.

Prevalence of Vitamin D deficiency and its effect on healing of fractures

Ian Guertin, MS2 Trevor MacDonald, MS2, James Michelson, MD (Mentor)

Background

Vitamin D plays a known role in calcium metabolism in the human body. A primary function it serves is to maintain calcium homeostasis, consequently ensuring proper bone growth and management. Vitamin D deficiency leads to reduced serum calcium and phosphorus levels, both of which are important for proper bone mineralization. Additionally, binding of vitamin D to its receptor increases vascularization in areas of endochondral ossification. Severe deficiency of vitamin D leads to osteomalacia in adults and rickets in children and adolescents. Animal studies have also demonstrated impaired fracture healing with vitamin D deficiency, which can be observed histologically as delayed bone maturation of a fracture repair and biomechanically as decreased ultimate load of the repair. The evidence supporting the need for normal levels of vitamin D in human fracture healing is limited to small case studies in which patients with nonunions were given vitamin D supplements and subsequently healed their nonunion. Theoretically, vitamin D deficiency in humans would be expected to negatively influence fracture repair. However, there are no large clinical studies that have demonstrated this effect. This study aims to both observe the prevalence of vitamin D deficiency in patients with traumatic fractures and to observe any effect this deficiency may have on healing.

Methods

This is a retrospective study evaluating the healing status of orthopedic trauma patients at the University of Vermont Medical Center between 2010 and 2020. Patients were selected for inclusion in this study if they were operated on by an attending in the orthopedic trauma service during this timeframe and had vitamin D levels drawn on admission. Patients were excluded if the operative treatment was not for a fracture, if initial treatment was arthroplasty, if initial treatment was performed at an outside institution, or if follow-up notes were not available. From the initial group, 1,322 total fractures were identified from 1,151 unique patients. Of these 1,322 fractures, 617 remained included in the study. These fractures were additionally subdivided into high or low energy fractures for the analysis. Follow-up clinic notes for patients remaining in the study were analyzed and categorized by clinical outcome. Associated clinical data including demographics, vitamin D level, and other comorbidities were obtained from the patients' electronic medical records. Patients with vitamin D levels below 30 ng/mL were considered to have low vitamin D. Statistical analyses were performed to evaluate for differences in healing outcomes in patients with low or normal vitamin D as well as other comorbidities. Additionally, differences between the patients with high and low energy fractures were evaluated. A significance level of $P < 0.05$ was used.

Results

Within our study population, 385 patients (62.4%) were found to have low vitamin D. The mean vitamin D level was 27.2 ng/mL.

Of the fractures that healed, time to healing was faster in low energy fractures and longer in high energy fractures. Femur and pilon fractures took the longest to heal while hip fractures were the quickest to heal. Time to heal was no different between patients with sufficient or low vitamin D levels.

Being male, having an open fracture, having a post-op infection, having complications, being younger in age, having a higher BMI, and having a lower Charlson index were all more commonly seen among patients with high energy fractures. The prevalence of renal disease was lower among patients with

high energy fractures. Higher rates of healing and a greater percentage of patients with low vitamin D were both observed with high energy fractures.

Vitamin D levels were not associated with healing outcomes. Having an open fracture, complications, diabetes, and being a current smoker were associated with reduced rates of healing. Prealbumin levels were lower in patients with nonunions compared to patients whose fractures healed.

Conclusions

Our study of 617 orthopedic trauma patients who were operated on between 2010 and 2020 found an overall prevalence of hypovitaminosis D of 62.4%, which is consistent with existing literature.

Contrary to our hypothesis, no relationship was found between vitamin D levels taken on admission and healing outcomes or time to healing. Factors that were associated with healing status include having an open fracture, having complications, having diabetes, and being a current smoker.

Additionally, prealbumin levels were significantly lower in patients with nonunions compared with patients whose fractures healed.

Flexor Hallucis Longus Tenosynovitis: An Assessment of Successful Operative Treatment

Rachel Carpenter, BS Chemistry, MS Medical Science, **Stephen Brand**, BS, Biomedical Sciences, MS Biomedical Sciences, James Michelson, MD (Mentor)

INTRODUCTION: Though often treated successfully with non-operative measures, many patients with flexor hallucis longus (FHL) tenosynovitis (49.5%) fail conservative management (immobilization, medication, stretching) and progress to surgical FHL release. Additionally, literature on refractory FHL tenosynovitis is limited to specialty athletic populations and lacks generalizability. This study demonstrates the efficacy of operative treatment for FHL tenosynovitis across a diverse patient population and elucidates those conditions when surgery can be most beneficial.

METHODS: Retrospective analysis was performed on electronic medical data from all 236 patients (71 male; 165 female) between April 2009 and December 2020 who underwent surgery for FHL tenosynovitis. All had failed previous conservative management. Patients were categorized into three surgical cohorts: FHL release 1. with or without os trigonum resection (71.6%), 2. with hallux cheilectomy (22.9%), and 3. with bunionectomy (5.5%). Outcomes were evaluated via three post-operative measures: patient-reported visual analog scale (VAS) pain score, ability to return to previous activity, and primary pain resolution.

RESULTS: All surgical cohorts had a significant reduction in VAS scores following surgery. When able to resume previous activities, primary pain resolved 90.8% of the time and resolved 9.1% of the time when they could not resume activities. Of those patients asked, 88.7% reported resumption of previous activities and 78.3% of patients with presenting symptoms experienced resolution of primary pain. Surgery type did not affect these outcome measures, but pre-operative therapeutic FHL stretching was associated with improved VAS scores for all populations.

DISCUSSION and CONCLUSION: Overall, we found surgical management to be an effective treatment option for refractive FHL tenosynovitis in a generalized patient population. The incorporation of pre-operative stretching regimens significantly improved outcomes and demonstrated their importance in the management of this disease at multiple treatment stages.