

ORTHOPAEDIC

OUTCOMES & RESEARCH



Jefferson Health®

HOME OF SIDNEY KIMMEL MEDICAL COLLEGE



REMEMBERING RICHARD H. ROTHMAN, MD, PHD

Richard H. Rothman, MD, PhD, founder of the Rothman Orthopaedic Institute, was a great friend, mentor and colleague. It's not an exaggeration to say that Jefferson would not be what it is today without his inspired leadership. Dr. Rothman died on October 21, 2018 after a long and quiet battle with cancer.

For more than 30 years, Dr. Rothman and his team of exceptional physicians have served as Jefferson Health's Department of Orthopaedics. And Dr. Rothman, for many years, served as the Department's Chair. During that time, he changed the face of orthopaedics with his groundbreaking treatments and his discipline around service excellence and innovation. Today, Rothman Orthopaedic Institute, with offices in Pennsylvania, New Jersey and New York, ranks second among orthopaedic groups in the number of research grants awarded from the National Institutes of Health.

"In anyone's lifetime, if you are fortunate, you might meet one or two people larger than life," said Stephen K. Klasko, MD, MBA, President, Thomas Jefferson University and CEO, Jefferson Health. "Dr. Rothman will be remembered for his amazing accomplishments, his surgical skill, his entrepreneurial spirit, and his inspirational mentorship. But beyond all those aspects of his life, there are thousands of doctors and patients whose lives have been positively altered because of Dr. Rothman's presence."

Dr. Rothman was a true pioneer and icon, and many at Jefferson had the distinct pleasure of working side by side with him and witnessing firsthand, the evolution of his vision – Rothman Orthopaedic Institute – into one of the nation's largest orthopaedic organizations. His commitment to his field and to delivering outstanding patient outcomes is evident in the consistently high rankings Thomas Jefferson University Hospital and the Department of Orthopaedics have received from *U.S. News & World Report*. We have been ranked among the nation's Best Hospitals for Orthopaedics for many years, and in the past two have ranked fourth in the nation.

Anyone who knew Dr. Rothman immediately recognized that he was a rarity. He was a doctor who excelled at teaching, research, clinical care – and business. Just five months ago, after 50 years in the operating room and performing as many as 50,000 knee and hip replacements, he decided to stop operating at age 81. Many of us didn't think he would ever stop. This was his passion, his life's work.

We have lost one of the most talented physicians many of us have ever known. Our thoughts and prayers are with his family.



A MESSAGE FROM THE CHAIR

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Dear Colleagues,

With another new year upon us, I am pleased to update you on the advances in patient care and research achieved at Jefferson Health's Department of Orthopaedic Surgery.

But before doing so, I must convey how deeply saddened we all are with the passing of Richard H. Rothman, MD, PhD, founder of the Rothman Orthopaedic Institute, and long-time colleague, friend, board member and supporter of Jefferson. Words cannot express how profound this loss is to the Jefferson family and to the field of orthopaedic surgery.

Dr. Rothman was a great friend, mentor and colleague. Jefferson would not be what it is today without his inspired leadership. I invite you to read more about Dr. Rothman at the beginning of this report.

Every year is a busy one, but 2018 was especially exciting as we expanded our reach both locally and globally, from a broader network of clinical sites to a growing portfolio of research studies and clinical trials that are defining orthopaedic care worldwide.

This latest *Orthopaedic Outcomes & Research* report provides a look at what has been accomplished. Our combined team from Rothman Orthopaedic Institute at Jefferson Health, Philadelphia Hand to Shoulder Center at Jefferson Health, 3B Orthopaedics at Jefferson Health, the Abington Orthopedic & Spine Institute – Jefferson Health, and the orthopaedic services of Jefferson Health hospitals in New Jersey, published more than 320 papers in leading journals,

presented findings at numerous national and international medical meetings, and hosted hundreds of orthopaedic surgeons from around the globe who came to Jefferson in search of ways to enhance the care of their patients.

Jefferson Health is at the forefront of research in the specialties of spine, hip and knee, foot and ankle, hand and wrist, shoulder and elbow, sports medicine, musculoskeletal oncology and trauma, all supported by a robust basic science program that is furthering the understanding of the molecular and genetic underpinnings of orthopaedic diseases.

Jefferson Health researchers are finding solutions to some of the most important orthopaedic issues of the day, including helping to curb opioid addiction through judicious prescribing of narcotic painkillers, and improved prevention and detection of costly periprosthetic joint infections. As you are aware, the use of stem cells for a variety of orthopaedic conditions is growing quickly, with little scientific evidence of efficacy. Jefferson Health is establishing a patient registry of stem cell recipients to support our rigorous research efforts into whether stem cell implantation provides benefits and, if so, for what specific orthopaedic conditions and subgroups of patients. Jefferson Health is also a leader in spinal cord injury research and is involved in every FDA-approved protocol for such injuries. Research into neurodegeneration and neuroprotection is giving hope that the devastating effects of spinal cord injury can be minimized.

One of our guiding principles for patient care is to follow a triad approach that includes physical therapy, the use of anti-inflammatory medication and local injections as needed to manage pain and swelling, and, only if it then makes sense, a surgical procedure conducted at a center that matches a patient's level of need. Providing value-based care is good for the patient and the healthcare system overall. This research-informed care generates excellent feedback from our patients, some of whom travel to Jefferson from around the country and world because of our reputation for dealing with complex and rare conditions. We appreciate the validation of our efforts from *U.S. News & World Report*, which ranked Rothman Institute at Thomas Jefferson University Hospitals fourth in the country in 2018 for orthopaedic care.

You can learn more about our research and clinical services by going to our website, JeffersonHealth.org/Ortho. To refer a patient please call **215-503-8888**, or have your patient call **1-800-JEFF-NOW**.

I hope that 2019 brings you joy and fulfillment.



Alexander R. Vaccaro, MD, PhD, MBA

Richard H. Rothman Professor and Chair

Department of Orthopaedic Surgery at Jefferson Health

Sidney Kimmel Medical College at Thomas Jefferson University

GLOBAL IMPACT

Regional Orthopaedic Care with a Global Reach: An Overview

The research findings published over the past year by Jefferson Health's Department of Orthopaedic Surgery would be enough to fill a hefty book. The global reach of Jefferson's clinical researchers and scientists continued to be broad and deep, from spine to sports medicine, from innovative surgical techniques to novel theories emerging from the laboratory.

Researchers tackled some of the toughest issues facing orthopaedic surgeons, including the judicious prescribing of opioids to ward off potential abuse and the prevention of debilitating periprosthetic joint infections.

The Department of Orthopaedic Surgery benefits from the combined energy and scientific curiosity of clinicians from Rothman Orthopaedic Institute at Jefferson Health, Philadelphia Hand to Shoulder Center at Jefferson Health, 3B Orthopaedics at Jefferson Health, the Abington Orthopedic & Spine Institute – Jefferson Health, and the orthopaedic services of Jefferson Health hospitals in New Jersey, with each group committed to translating their research into even better outcomes and satisfaction for patients.

Jefferson Health's orthopaedic specialists are experts at handling both common and complex cases involving the spine; hip and knee; shoulder and elbow; hand and wrist; foot and ankle; sports injuries; orthopaedic trauma; and musculoskeletal oncology. Patients benefit from a multidisciplinary approach to their medical and surgical needs and are supported by the latest diagnostic imaging and operative technology.

That intense focus is reflected in Rothman Institute at Thomas Jefferson University Hospitals' designation as the fourth best orthopaedic program in the nation by *U.S. News & World Report*. An indication of the global impact of Jefferson Health's orthopaedic program came in a review article published in *World Neurosurgery*, which noted that a

study on thoracolumbar fracture by its department chairman, Alexander Vaccaro, MD, PhD, MBA, and colleagues, had been cited 237 times in the medical literature. Dr. Vaccaro was one of two most-cited authors in the review, which set out to identify the top 50 most-cited articles in the literature focusing on thoracolumbar spine fractures.

The combined research efforts of Jefferson Health's orthopaedic team are helping to reduce disability and save lives of patients around the globe. The staff of the Department of Orthopaedic Surgery last year published 323 research articles, and oversaw the training of 30 residents, 30 clinical fellows, 27 research fellows and visiting surgeons from many countries. Jefferson was the site for an international gathering of hundreds of orthopaedic surgeons and scientists tasked with devising an evidence-based plan for preventing orthopaedic infections.

Jefferson Health's clinical reach extends well beyond the Philadelphia region, attracting patients from throughout the U.S. and overseas who want access to the latest surgical methods and clinical trials involving new medical therapies, surgical techniques and implant materials.

Among the many research projects:

Joint. Researchers analyzed the use of next-generation sequencing to diagnose periprosthetic joint infection.

Spine. A study identified predictive risk factors for mortality following spinal cord injury.

Hand and Wrist. As part of research into the scarring process, researchers analyzed the patterns of collagen-rich deposits that form in response to peripheral nerve injury.

Shoulder and Elbow. Researchers studied the effect of preoperative patient education on opioids regarding the amount of narcotic medication consumed following arthroscopic rotator cuff repair.

Sports Medicine. Researchers utilized a comprehensive injury surveillance system to examine elbow injuries in professional baseball players.

Musculoskeletal Oncology. A study examined the effectiveness of Mitomycin C on recurrent plantar fibromas.

Foot and Ankle. A study investigated the use of a dual catheter compared to a single catheter in postoperative pain management after ambulatory foot and ankle surgery.

Basic Science. Researchers focused on developing a diagnostic DNA test for developmental dysplasia of the hip.

The pages ahead provide more details on these and other research initiatives from Jefferson Health's Department of Orthopaedic Surgery. See how Jefferson's global impact is leading to new insights in orthopaedic care and improving outcomes for patients.

SURGICAL VOLUMES AT JEFFERSON HEALTH:

Close to
14,300
JOINT REPLACEMENT
PROCEDURES

Almost
7,000
SPINE
PROCEDURES

Over
4,500
SHOULDER AND ELBOW
PROCEDURES

More than
7,300
HAND AND WRIST
PROCEDURES

Over
4,800
SPORTS MEDICINE
PROCEDURES

950
MUSCULOSKELETAL ONCOLOGY
PROCEDURES

More than
2,600
FOOT AND ANKLE
PROCEDURES

Almost
3,300
TRAUMA
PROCEDURES

Close to
830
GENERAL ORTHOPAEDIC
PROCEDURES

*Surgical volumes include all procedures performed at Jefferson Health hospitals and ambulatory surgery centers.
Source: Jefferson internal data, September 2017 – August 2018*



323
research
publications



56
physicians
with national
or board titles



6
countries visited
for educational
and mission trips



76
active funded
clinical trials

COLLABORATIVE CARE



The Department of Orthopaedic Surgery is proud to work closely and collaboratively with our colleagues across several other top departments at Jefferson Health.

DEPARTMENT OF NURSING

Our nurses are renowned for the extraordinary care and compassion they provide to each and every patient who comes through our door for orthopaedic and spine care. Highly regarded for their knowledge and expertise, they are sought after as presenters at national and international conferences, as contributors to nursing journals and as leaders of professional nursing organizations. Seven Jefferson Health hospitals are proud to be MAGNET®-recognized in 2018, including Thomas Jefferson University Hospital for the third time.



DEPARTMENT OF ANESTHESIOLOGY

Jefferson Health's Department of Anesthesiology is a national leader in acute pain management for patients with conditions of the hand, wrist, arm, elbow and shoulder. The anesthesia team specializes in ultrasound-guided upper extremity regional nerve blocks and performs more than 2,000 surgical and invasive procedures annually. Our anesthesiologists also commonly perform lower extremity nerve blocks to manage acute pain in patients with conditions of the leg, knee, ankle or foot. The Department of Anesthesiology is home to the Anesthesiology Research Laboratory, which conducts timely, state-of-the-art research, often in partnership with the Department of Orthopaedic Surgery, on topics like managing prolonged post-operative pain and the role of opioids.



DEPARTMENT OF REHABILITATION MEDICINE

Jefferson Health physiatrists and therapists have been leaders in rehabilitation medicine for more than 30 years. Our comprehensive team of occupational therapists, physical therapists, speech language pathologists, rehabilitation nurses, therapeutic recreation specialists, social workers and psychologists support a staff of board-certified physiatrists to treat both non-surgical and post-operative orthopaedic patients. The Department of Rehabilitation Medicine is also home to the Regional Spinal Cord Injury Center of the Delaware Valley. Thomas Jefferson University Hospital – in affiliation with Magee Rehabilitation Hospital, now a part of the Jefferson Health system – is designated as one of the nation's 14 Model Spinal Cord Injury Centers by the National Institute on Disability and Rehabilitation Research.



SIDNEY KIMMEL CANCER CENTER – JEFFERSON HEALTH

A leading center for practice-changing discovery and comprehensive cancer treatment, Jefferson's Sidney Kimmel Cancer Center (SKCC) has been known as a Designated Center by the National Cancer Institute since 1996, and is one of only 70 institutions in the nation to hold this prestigious recognition. Our multi-disciplinary teams at SKCC bring together specialists for treatment planning, resulting in some of the highest survival rates in the nation. The Jefferson Sarcoma and Bone Tumor Center combines the oncology services of SKCC with the expertise of the Department of Orthopaedic Surgery, and is focused on providing the highest quality oncologic resections of extremity bone and soft tissue malignancies while preserving maximal function.



DEPARTMENT OF RADIOLOGY

The Musculoskeletal Radiology Division of the Department of Radiology is one of the largest and best-known groups in the country. Our physicians serve as consultants to Philadelphia's four major sports teams and numerous visiting professional athletes. In addition to internationally recognized expertise in musculoskeletal imaging, our clinicians offer a wide variety of minimally invasive procedures, some of which are not offered by anyone else in the region, such as thermal radiofrequency ablation of tumors including osteoid osteomas. The Division is one of a few centers in the country to provide a full range of diagnostic musculoskeletal ultrasound.



VICKIE & JACK FARBER INSTITUTE FOR NEUROSCIENCE – JEFFERSON HEALTH

At the Vickie & Jack Farber Institute for Neuroscience, we bring together the cross-disciplinary expertise of Jefferson Health physicians, clinicians and researchers specializing in spine disorders to collaborate as never before. Faculty are drawn from more than a dozen departments throughout Jefferson. Together, our neurosurgeons and orthopaedic spine surgeons work to research, treat, prevent and find cures for spine disorders. Jefferson Health has the nation's top spine surgeons and researchers – physicians who perform thousands of surgical procedures each year, and have pioneered breakthrough procedures that set the clinical standards for surgical techniques nationwide.



ORTHOPAEDIC TRAUMA SERVICES

Since 1987, Thomas Jefferson University Hospital has been an accredited Level I Regional Resource Trauma Center and a referral center for multiple suburban communities and trauma centers in the region to treat a wide variety of trauma-related conditions. With one of the highest transfer volume rates in Pennsylvania, our Emergency Department provides immediate surgical services and care to critically injured patients. Our orthopaedic experts collaborate with emergency physicians to provide immediate specialized care for limb-threatening or life-altering orthopaedic injuries. Our surgeons are available in house 24/7 to perform immediate surgical procedures to critically injured patients.

COMPLEX SPINE

SERVICES

Treatment for cervical, thoracic and lumbosacral spine conditions

Treatment for scoliosis, spine deformities, spondylolisthesis, spinal cord injuries/trauma, spinal infections and spinal tumors

Minimally invasive techniques and image-guided technology

Comprehensive treatment of disc disease, including disc replacement



PHILADELPHIA, PENNSYLVANIA

Thomas Jefferson University Hospital is now equipped with a pioneering robotic navigation system that offers real-time visualization of instrument positioning and screw placement, customized to the patient's anatomy. Less than four miles down Broad Street, Jefferson Methodist Hospital in South Philadelphia is home to the Jefferson Advanced Spine Center.



The spine team is a leader in the treatment of spine injuries and diseases, with a particular focus on complex cases. Thomas Jefferson University Hospital is a much sought-after referral center for complicated spine cases, including ones not routinely treated in the community setting. In emergency situations, patients reap the advantages of Thomas Jefferson University Hospital's designation as both a Level 1 Trauma Center and a federally designated Regional Spinal Cord Injury Center, in affiliation with Magee Rehabilitation Hospital. In both urgent and non-urgent situations, spine surgeons draw on the expertise of specialists throughout Jefferson.

Jefferson Health spine surgeons are also recognized as leading researchers on degenerative disc disease, spinal fractures, spinal cord injury, spinal tumors and other conditions that cause significant morbidity and decline in quality of life. Publications by the spine team help set the standards for how spine care is practiced around the world. One recent review of the medical literature on thoracolumbar fractures, published in *World Neurosurgery*, found that one article on that topic by Alexander R. Vaccaro, MD, PhD, MBA, Richard H. Rothman Professor and Chair, Department of Orthopaedic Surgery, and colleagues at Jefferson, had been cited 237 times.

Here is a look at research by Jefferson Health spine surgeons that is helping to inform the care of patients with potentially devastating spinal cord injuries and for those undergoing spinal fusion.

Preinjury Patient Characteristics and Postinjury Neurological Status are Associated with Mortality Following Spinal Cord Injury

Spinal cord injuries (SCI) are one of the most severe conditions encountered in the acute trauma setting. The annual incidence of SCI in the United States is approximately 54 cases per one million people, an increase from 40 cases per million in 2012. Patients are predominantly male, with a median age of 42, a number that has been steadily increasing as the U.S. population ages. With SCI patients trending older, more comorbidities that might affect recovery would be expected.

SCI patients typically require lengthy and complex inpatient hospitalization because of neurological deficits, unstable spinal columns, multiple operative interventions and associated injuries. Although attention is directed to initial stabilization and addressing the acute spinal injury, patients' baseline comorbidities play a significant role in the treatment process and may lead to less favorable outcomes if managed incorrectly.

Previous studies have identified increased age, injury or hospital-acquired infection, injury severity and mechanism of injury, among other things, as factors that may contribute to overall quality of life post injury. Despite increased awareness of these predictive factors, life expectancy for SCI patients has remained unchanged over the past decade and remains hard to predict for any individual patient.

COMPLEX SPINE

Spinal Cord Injury Patient Demographics, Neurologic Status, Mechanism of Injury and Treatment			
Variable	5-y Mortality (n=76)	5-y Survival (n=350)	P
Age	65.2	43.6	0.001
Male sex	56 (73.7%)	262 (74.9%)	0.831
Charlson Comorbidity Index	0.91	0.36	0.001
Congenital stenosis	2 (2.6%)	5 (1.4%)	0.44
Neurologic deficit (AMS)	37.8	54.7	<0.001
Injury Severity Score	29.77	23.70	0.001
Glasgow Coma Scale	12.2	13.5	0.01
Cervical injury	62 (84.9%)	245 (70.2%)	0.03
Fall from standing	51 (67.1%)	158 (45.1%)	0.10
Central cord	11 (14.5%)	69 (19.7%)	0.29
Extension/distraction	12 (30.8%)	27 (7.7%)	0.03
Surgical intervention	51 (67.1%)	287 (82.0%)	0.004

AMS indicates American Spinal Injury Association Motor Score.

A prospectively maintained database of SCI patients treated at a single regional SCI referral center was reviewed, resulting in 426 patients who were treated for SCI between 2004 and 2009. Source: Christopher Kepler, MD, MBA

To further examine the factors influencing SCI outcomes over time, Jefferson Health researchers, led by Christopher Kepler, MD, MBA, and Gregory Schroeder, MD, conducted a prospective review of a spinal cord injury database including 426 cases. The patients, all

treated at Jefferson from 2002 to 2009, were 47.5 years old on average and about three-quarters of them were men. Half of the patients had a low-energy mechanism of injury.

Among the key findings reported in *Spine*:

- Substantial mortality is associated with SCI at 1 year and 5 years. The mortality rates were: 6.6% at 30 days; 9.2% at 90 days; 12% at 1 year; 15% at 2 years; and 17.8% at 5 years.
- A significant proportion of the deaths occurred acutely after injury.
- Independent predictors of mortality at 5 years were older age at time of injury, longer hospital stay, lower motor score at presentation and lack of surgical intervention.

"Mortality was associated with neurological deficit and severity of injury, as well as with preinjury patient characteristics. To combat the higher rate of death, efforts are needed to address the concomitant disease processes associated with neurological deficits," the researchers concluded.

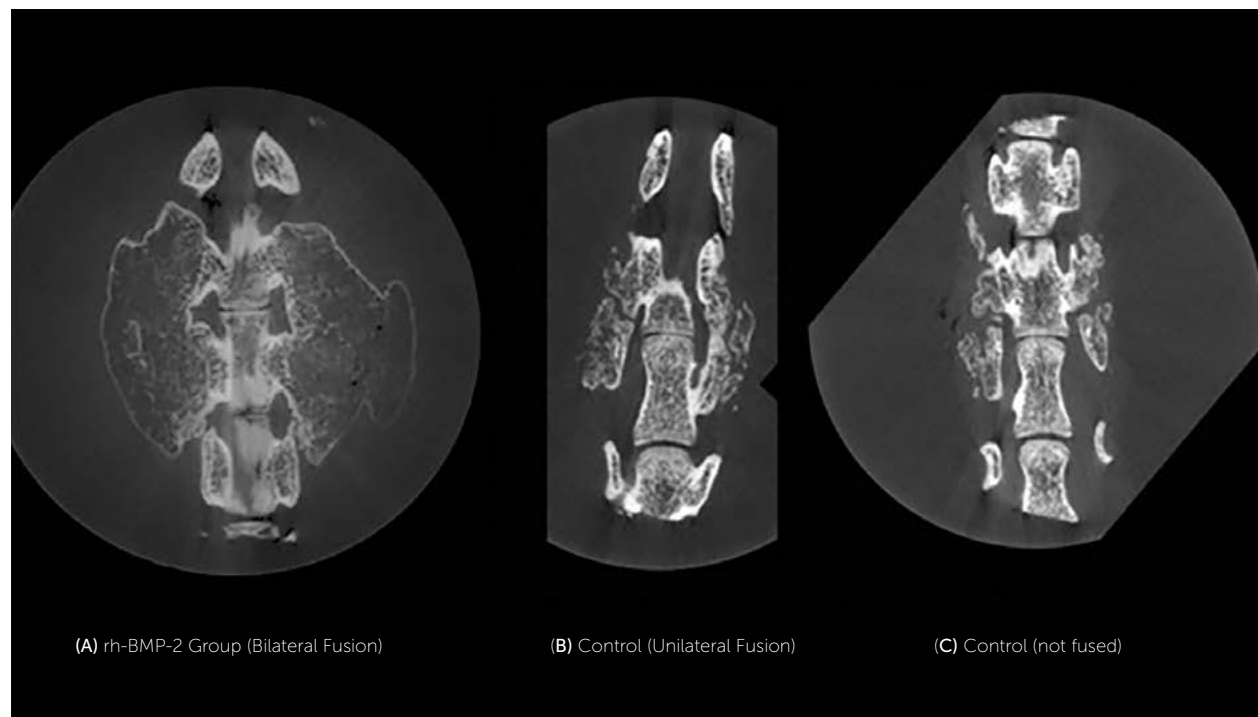
Researchers said that developing new guidelines could help in the assessment and treatment of high-risk SCI patients. They said further research is needed to examine the role of early surgical intervention for various injury pathologies and whether it has an effect on mortality.

The Local Cytokine and Growth Factor Response to rhBMP-2 after Spinal Fusion

Pseudarthrosis is an unfortunate but relatively common complication of spinal fusion procedures. It can lead to poor outcomes, revision surgery and increased medical costs.

Augments to enhance spinal fusion, such as recombinant human Bone Morphogenetic Protein-2 (rhBMP-2) have become popular to improve fusion, though the approach adds cost to the procedure. The mechanism of action of rhBMP-2 has been studied in rat models, as has the local soft tissue and systemic response of cytokine expression, but not much is known about the local response at the fusion site. Understanding the cytokine and growth factor expression at the fusion site where rhBMP-2 is applied will help elucidate the role of those molecules in the fusion process and provide added information on rhBMP-2's workings.

In a study partially funded by a physician-sponsored grant from Medtronic (maker of rhBMP-2, a commercial product), rhBMP-2 was evaluated in 135 laboratory rats. The animals underwent L4-L5 posterolateral intertransverse lumbar fusion with demineralized bone grafts. Some rats received 10 micrograms of rhBMP-2 at the fusion site, others got 100 micrograms and a control group underwent surgery without the use of rhBMP-2. Cytokine and growth factor response was then measured at different points in time. Jefferson Health researchers, led by Christopher Kepler, MD, MBA, found differences in patterns of expression between the rats that got rhBMP-2 at the fusion site and the controls that did not.



Coronal MicroCT image of a high dose rhBMP-2 specimen, which was considered fused bilaterally (A), Coronal MicroCT image a control specimen with unilateral fusion (B) and not fused (C). Source: Christopher Kepler, MD, MBA

"There is significant variability in the expression of cytokines throughout the fusion process after treatment with rhBMP-2," the researchers reported in *The Spine Journal*. "The inflammatory response appears to peak early (1 and 6 hours) followed by a significant decrease with rhBMP-2 treatment. However, the growth factor expression appears to be suppressed early (1 and 6 hours) followed by a peak at 24 hours, and a second peak at day 7."

While rhBMP-2 is judiciously used both at Jefferson and across the U.S. to help vertebrae fuse together, it has rare complications associated with its use that are largely related to inflammation. Characterization of the way that rhBMP-2 works and affects the body may facilitate the identification of other molecules, which would work in a similar manner to promote spinal fusion with reduced rates of associated inflammatory complications.

HAND AND WRIST

SERVICES

Hand and wrist surgery

Microvascular surgery

Joint replacement and reconstruction for hand arthritis

Treatment of carpal and cubital tunnel syndrome

Treatment of Dupuytren's disease





NEW ORLEANS, LOUISIANA

Physicians from Philadelphia Hand to Shoulder Center at Jefferson Health and Rothman Orthopaedic Institute at Jefferson Health participated in over 150 poster and paper presentations, instructional courses, panel discussions and scientific exhibits at the 2018 AAOS Annual Meeting.

Jefferson Health's Department of Orthopaedic Surgery draws on the expertise and experience of hand and wrist specialists from Philadelphia Hand to Shoulder Center at Jefferson Health and Rothman Orthopaedic Institute at Jefferson Health. The surgeons are highly sought for medical and surgical treatment of simple and complex fractures, osteoarthritis, complex nerve conditions, sports injuries, carpal tunnel syndrome and other disorders. Physical and occupational therapy and judicious use of pain medication are important components of patient care plans.

In addition to providing outstanding patient care, the hand and wrist specialists conduct an array of research that is helping to improve surgical techniques and enhance post-operative recovery. Their published studies provide valuable contributions to the field of hand and wrist surgery worldwide.

Here is a look at some of the latest clinical and laboratory findings by Jefferson Health's hand and wrist team:

Late Reconstruction of the Interosseous Membrane with Bone-Patellar Tendon-Bone Graft for Chronic Essex-Lopresti Injuries

Philadelphia Hand to Shoulder Center at Jefferson Health

The term Essex-Lopresti injury describes the uncommon triad of concomitant radial head fracture, distal radioulnar joint disruption (DRUJ) and forearm interosseous membrane (IOM) rupture that generally follows a high-energy axial loading injury.

Jefferson Health researchers, headed by Randall W. Culp, MD, and A. Lee Osterman, MD, designed a study to evaluate long-term outcomes following reconstruction of the forearm IOM with bone-patellar tendon-bone (BPTB) graft for treatment of chronic Essex-Lopresti injuries. They identified 33 patients who underwent the procedure from January 1992 through December 2011. There were 20 men and 13 women, with a mean age of 42.1 years. IOM reconstruction was performed at a mean interval of 44.9 months from the time of initial injury.

The minimum follow-up was five years. Preinjury clinical examination and radiographic measurements were obtained from records for comparison with prospectively collected data. Additional functional outcome data collected postoperatively included QuickDASH (an abbreviated version of the Disabilities of the Arm, Shoulder and Hand), modified Mayo wrist (MMW), and Broberg-Morrey elbow function scores.

Results of the analysis were published in *The Journal of Bone and Joint Surgery*. They included:

- At a mean follow-up of 10.9 years, significant improvements were observed in mean elbow flexion-extension arc (+13°), wrist flexion-extension arc (+19°), forearm pronation-supination (+23°) and grip strength (+25% of that of the contralateral side).
- Improvements in ulnar variance were sustained over the long term from +3.9 mm preoperatively to -1.6 mm immediately postoperatively and -1.1 mm at the time of the final follow-up. The mean QuickDASH, MMW, and Broberg-Morrey scores were 29.8, 82.7 and 91.6, respectively.

HAND AND WRIST

"IOM reconstruction with a BPTB graft is an effective treatment option for chronic Essex-Lopresti injuries, with satisfactory clinical and functional outcomes over the long term," the researchers concluded. They said that patients who have the procedure more than a year after the initial injury are likely to have worse outcomes, as are smokers.

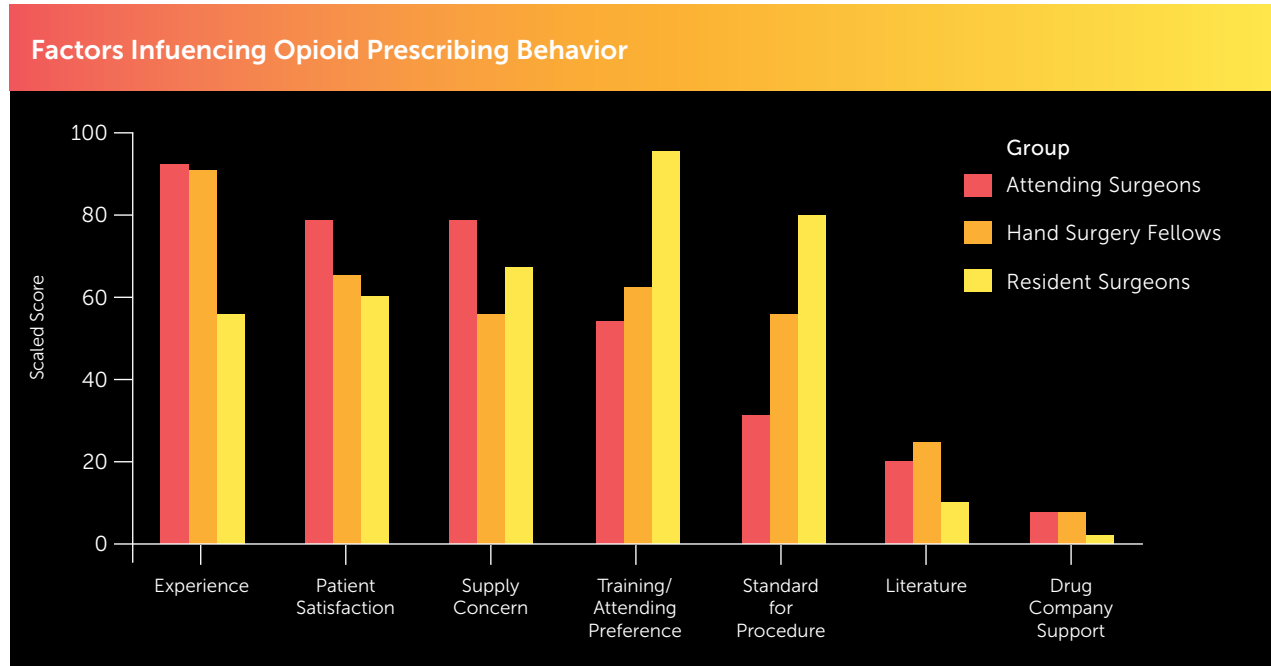
Self-Reported Postoperative Opioid-Prescribing Practices Following Commonly Performed Orthopaedic Hand and Wrist Surgeries: A Nationwide Survey Comparing Attending Surgeons and Trainees

Philadelphia Hand to Shoulder Center at Jefferson Health

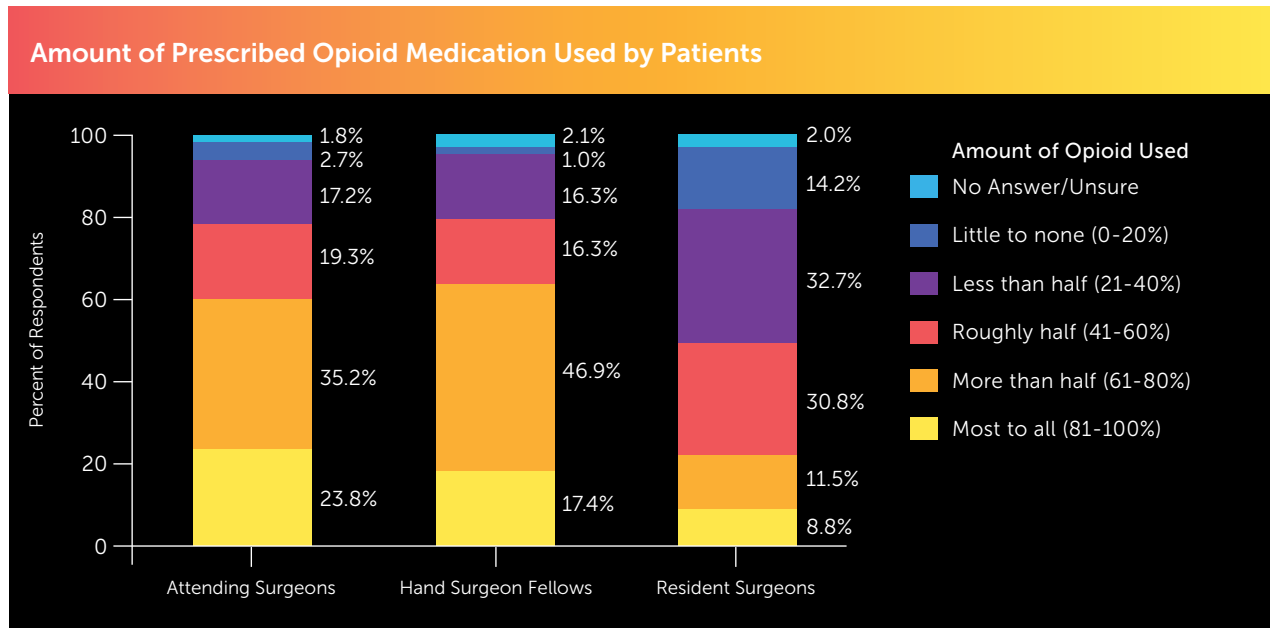
Although orthopaedic surgeons have been shown to prescribe excessive amounts of opioid analgesics postoperatively, the degree to which surgical trainees contribute to this trend is unknown.

To understand the issue better, Jefferson Health researchers led by Patrick M. Kane, MD, did a comparison between hand surgeons and trainees when it came to self-reported opioid prescribing, factors influencing this behavior and perceptions of patient opioid utilization and disposal.

Attending hand surgeons and trainees in hand, orthopaedic and plastic surgery programs were invited to participate in a web-based survey. The questionnaire included demographic information, prescribing behavior specific to four procedures (open carpal tunnel release, trigger finger release, thumb carpometacarpal arthroplasty and distal radius fracture open reduction internal fixation) and perceptions and influencing factors around prescribing. Analgesic medications were converted to morphine milligram equivalents (MME).



Personal experience was weighed as the most influential factor for prescribing behavior for both attending surgeons and hand surgery fellows. Source: Patrick M. Kane, MD



Resident surgeons were most likely to prescribe pain medication according to the preferences of their supervising attendings. Source: Patrick M. Kane, MD

A total of 1,300 responders to the survey (266 attendings, 98 fellows, 708 orthopaedic residents and 228 plastic surgery residents) were included in the analysis.

The researchers reported their findings in *The Journal of Bone and Joint Surgery*.

Surgeons reported prescribing less total MME compared to residents for all four procedures. For example, in carpal tunnel release surgery, attending surgeons reported prescribing 112.7 MME compared with residents who reported prescribing 148.9 MME. Personal experience was the most influential factor for prescribing behavior by attendings and fellows. Although residents

reported that attending surgeon preference was their greatest influence, most reported no direct opioid-related communication with attending surgeons.

“Poor communication between residents and attendings may contribute to the higher prescribing patterns among residents,” the researchers concluded. “Residents may benefit from education on opioid prescription, and training programs should encourage direct communication between trainees and attending surgeons.”

They said attending surgeons and trainees alike should be encouraged to perform regular self-evaluations of their opioid prescribing behaviors.

Osteochondral Autograft Transplantation for Proximal Lunate Articular Defects

Philadelphia Hand to Shoulder Center at Jefferson Health

The medical literature contains no consensus on how best to treat focal osteochondral defects of the proximal lunate. Surgical management to date has been limited to salvage procedures such as proximal row carpectomy and partial arthrodesis.

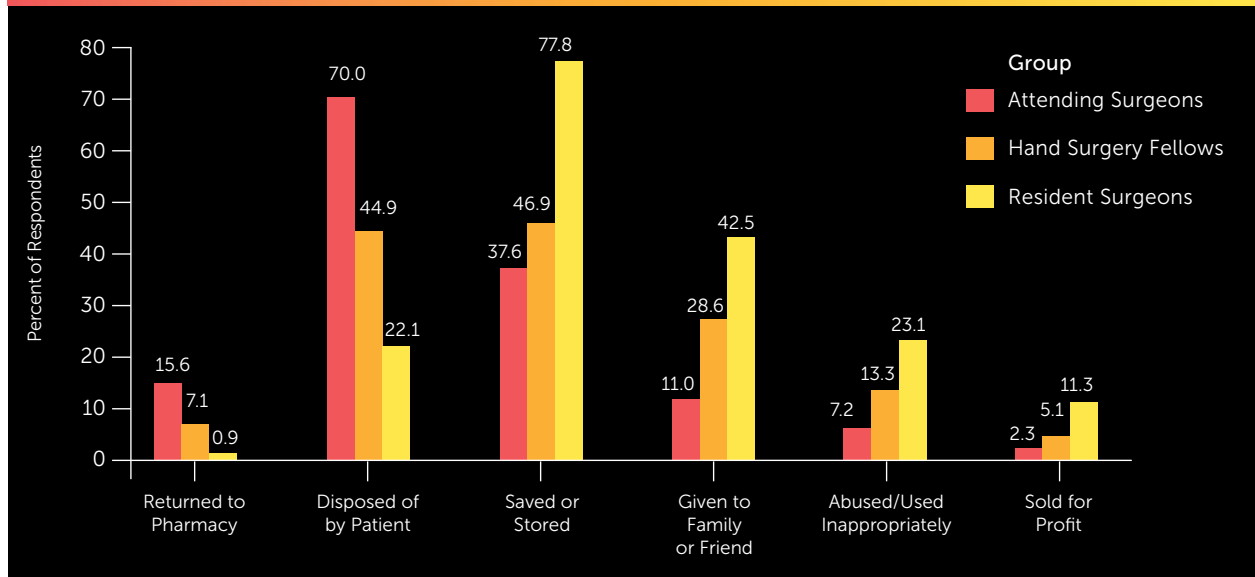
A surgical team led by Randall Culp, MD, reported in the *Journal of Wrist Surgery* on two cases using osteochondral autograft transplantation surgery (OATS) for proximal lunate chondral defects. The cases involved a 20-year-old college student and a 40-year-old executive, both active patients whose alternative treatment options were limited.

The researchers described an innovative method of harvesting healthy cartilage from the contralateral knee and transplanting it to the osteochondral defect in the lunate of the wrist.



Intraoperative image of focal area of arthrosis on the proximal lunate. Source: Randall Culp, MD

Patient Actions with Unused Opioid Medication



Compared to residents, attendings and fellows were more likely to believe that patients disposed of opioid medications responsibly by returning or disposing of unused pills, while residents were significantly more likely to believe that patients misuse their surplus of opioid medications compared to attending surgeons. Source: Patrick M. Kane, MD

The journal article additionally reported on outcomes of the procedure. At a mean follow-up of six years, both patients had sustained improvements in pain, motion and function, the researchers said. The patients also reported high levels of satisfaction and neither experienced any complications from the surgery.

"We feel that the potential advantages of this procedure warrant its use, particularly in patients whose age or activity level makes salvage procedures undesirable," the researchers reported. "Based on our encouraging results in this small report, future studies in more patients and those with other carpal defects may offer additional insight into the utility of this procedure."

Patterns of Production of Collagen-Rich Deposits in Peripheral Nerves in Response to Injury: A Pilot Study in a Rabbit Model

Rothman Orthopaedic Institute at Jefferson Health

Peripheral nerve injury (PNI) occurs in an estimated 2% to 2.8% of patients with upper and lower extremity trauma, causing a significant burden of disease and disability.

The morbidity associated with PNI is compounded by a high rate of incomplete recovery, with studies reporting good or excellent motor recovery rates as low as 75% for isolated upper extremity nerve laceration in an ideal setting, and as low as 67% for lower extremity PNI. Many of the persistent functional deficits are attributed to neural fibrosis and scarring, which present a mechanical barrier to peripheral nerve regeneration.

Although collagen-rich deposits are the main component of neural scars, the patterns of their formation are ill defined. Essential to the biosynthesis of collagen fibrils are enzymes catalyzing posttranslational modifications and chaperones that control the formation of the

collagen triple helix. Prolyl-4-hydroxylase (P4H) and heat shock protein-47 (HSP47) play a key role, and their production is upregulated during scar formation in human tissues. Alpha smooth muscle action (α SMA) is also produced during fibrotic processes in myofibroblasts that participate in fibrotic response. In injured peripheral nerves, however, the distribution of cells that produce these markers is poorly understood.

Jefferson Health researchers led by Andrzej Fertala, PhD, conducted a study to determine the distribution of the α SMA-positive, HSP47-positive and P4H-positive cells to better understand the formation of collagen-rich fibrotic tissue (FT) in response to peripheral nerve injury. They used a rabbit model of crush-injury and partial-transection injury of sciatic nerve.

The study demonstrated that α SMA is expressed in a relatively small number of cells seen in neural FT. In contrast, cells producing P4H and HSP47 are ubiquitously present in sites of injury of the sciatic nerves, according to a report in *Brain and Behavior*.

"We contemplate that these proteins may serve as valuable markers that define fibrotic activity in the injured peripheral nerves," the researchers reported. They said further studies are needed to study the proteins' expression patterns during early post-injury stages.

Geographic Distribution of Hand Surgeons Throughout the United States

Rothman Orthopaedic Institute at Jefferson Health

In the U.S., hand surgery is now the second largest specialty within orthopaedics. From 2011-2016 there was a 12.3% increase in hand fellowship programs and a 12% increase in hand fellowship positions offered. In spite

of these increases, it is unclear whether graduates are practicing in areas of the country with the greatest need for hand surgeons.

Jefferson Health researchers led by Kevin F. Lutsky, MD, conducted a study to determine the distribution of hand surgeons and pinpoint areas that may be in need of the specialists.

Hand surgeon practice location data were obtained from the American Association for Hand Surgery and the American Society for Surgery of the Hand. Population data for the 50 states and the District of Columbia were obtained from the U.S. Census for 2014, and the population data were further broken down into congressional districts.

A total of 2,202 hand surgeons were identified through the professional associations. The mean number of surgeons per state was 53, but there was great variation from state to state. The most populous states, California (298), Texas (183), New York (185) and Florida (145) also had the highest numbers of hand surgeons. The least hand surgeons were found in Wyoming (3) and Alaska (6).

The researchers used the ratio of one hand surgeon per 125,000 population as the ideal proportion. By that measure, 16 states were underserved, 11 states had an optimal number of hand surgeons and 24 states had a greater-than optimal number.

When the number of hand surgeons was analyzed using the boundaries of 436 congressional districts (CD), it was found that 231 CDs had a suboptimal proportion of hand surgeons based on the population, 30 had an optimal level and 175 had a greater-than-optimal share of hand surgeons.

The researchers also surveyed 20 hand surgeons to determine the degree to which six specified factors influenced their decision on where to practice (things such as population size, proximity to family, financial incentives). Not one factor emerged as key.

“The findings of our study indicate that hand surgeon proportions do not correlate with population proportions, and distribution is not skewed toward areas of higher population density,” the researchers reported. “Many areas of the United States are not optimally served, and surgeons may be choosing where to practice based on a combination of factors beyond population need,” the researchers concluded.

Thumb Basal Joint Arthroplasty: Prospective Comparison of Perioperative Analgesia and Opioid Consumption

Rothman Orthopaedic Institute at Jefferson Health

Pain control after hand surgery is multifactorial, affecting patient outcome and satisfaction and healthcare costs. Use of opioids to control postoperative pain could lead to overuse by patients or diversion of the pills to others.

Many variables influence postoperative pain, including the type of procedure and anesthesia, patient demographics and preoperative opioid consumption. Although perioperative anesthesia selection has been widely studied in other surgeries, such as total joint arthroplasty, there is no evidence that one type of anesthesia is superior to another for arthroplasty of the hand.

Jefferson Health researchers led by Andrew J. Miller, MD, conducted a study involving patients undergoing thumb basal joint arthroplasty to evaluate anesthesia approaches and the subsequent use of opioids for pain. Their theory was that peripheral nerve blocks would provide better pain control than local anesthesia with bupivacaine or liposomal bupivacaine, resulting in less postoperative pain and a lower need for narcotics.

The study enrolled 78 patients undergoing thumb basal joint arthroplasty to one of three groups: peripheral nerve block; local anesthesia with bupivacaine; or local anesthesia with liposomal bupivacaine. Total opioid consumption and visual analog scale (VAS) pain scores were reported for the first five postoperative days (POD).

The study, reported in *Orthopedics*, found that all patients reported an increase in opioid pill use and VAS scores from POD 1 to POD 2. Pain peaked on POD 2 for all groups, and then went down. An average of 17 opioid pills were consumed by patients who got the peripheral nerve block. That was not much different than the 19 pills on average taken by those who got local anesthesia plus bupivacaine. The lowest consumption, 11 pills, took place in the group that got local anesthesia plus liposomal bupivacaine.

“Overall, these findings did not support the authors’ hypothesis that peripheral nerve blocks are superior in terms of postoperative pain control and opioid consumption,” the authors wrote.

They urged surgeons to consider these points when prescribing opioids for thumb basal joint arthroplasty:

- Patients should be educated and warned to expect an increase in their pain on POD 1, but pain should begin to subside after POD 2.
- Average opioid consumption in each group in the study was fewer than 20 pills, so surgeons should use that number as a reference point to avoid over prescribing.
- Liposomal bupivacaine was associated with lower opioid consumption early on, but its use must be weighed against its increased cost.
- Peripheral nerve blocks do not seem to offer superior postoperative pain control compared with local anesthesia for thumb basal joint arthroplasty. Their routine use should be reconsidered relative to their added procedural risks and cost without added clear benefits.

SHOULDER AND ELBOW

SERVICES

Shoulder and elbow surgery, including replacement, arthroscopy and open

Treatment of rotator cuff injuries

Tendonitis treatment

Distal biceps and triceps rupture repair

Treatment of shoulder and elbow fractures and instability

Brachial plexus repair and reconstruction

KIGALI, RWANDA

Physicians and therapists from Philadelphia Hand to Shoulder Center at Jefferson Health embarked on a mission trip in April 2018 to offer brachial plexus repairs and to treat other upper extremity injuries and deformities.



Enhancing recovery from surgery is a key goal of the shoulder and elbow specialists at Jefferson Health. While surgical techniques and implant materials continue to be refined and improved, equally robust attention is being placed on getting patients back to full function, free of pain and reliance on potentially addictive medications.

Because the surgeons are also active researchers, their instinct is to always question assumptions and look with fresh eyes at surgical challenges. One recent key piece of research by Jefferson Health shoulder and elbow surgeons examined the usefulness of cerebral oxygenation monitoring during shoulder arthroscopy conducted in the beach chair position. Another study aimed to identify the optimal use of anesthesia during surgery with an eye to minimizing pain afterward.

The team is especially interested in finding solutions to the overuse and abuse of opioids. Research is looking at preventive measures that orthopaedic surgeons could adopt to help lessen the likelihood that their patients will get caught up in addiction.

In 2018, a team of shoulder physicians from Rothman Orthopaedic Institute at Jefferson Health received the coveted Charles S. Neer Award, presented for excellence in clinical research, for their work on opioid reduction strategies and pain management following rotator cuff repair. This award is presented once a year by the American Shoulder and Elbow Society during the American Academy of Orthopaedic Surgeons Annual Meeting.

Interscalene Block With and Without Intraoperative Local Infiltration with Liposomal Bupivacaine in Shoulder Arthroplasty

Rothman Orthopaedic Institute at Jefferson Health

Pain management after shoulder arthroplasty is an important variable in the perioperative period that can influence participation in physical therapy, discharge from the hospital or outpatient surgery center, and patient satisfaction.

Along with the nationwide opioid epidemic has come growing concern about the use and misuse of opioids in all areas of medicine. More attention is being placed on alternative pain management strategies that can reduce narcotic utilization after orthopaedic surgery.

Interscalene brachial plexus blockade (ISBPB) is an effective anesthetic technique for shoulder arthroplasty. However, “rebound pain” can increase the patient’s postoperative pain experience and narcotic usage. Exparel (liposomal bupivacaine) injected into the soft tissue at the surgical site has theoretical efficacy for up to 72 hours after administration. Jefferson Health researchers led by Surena Namdari, MD, MSc, conducted a randomized, controlled trial to evaluate postoperative pain scores and narcotic consumption following shoulder arthroplasty performed with either ISBPB alone or ISBPB and intraoperative soft-tissue infiltration with Exparel.

A total of 78 patients undergoing primary shoulder arthroplasty were randomized to receive an ISBPB and an intraoperative, local infiltration of Exparel (39 patients) or ISBPB alone (39 patients). The primary outcome was morphine equivalent units (MEUs) consumed over

SHOULDER AND ELBOW

the first 24 hours after surgery. Secondary outcomes included intraoperative narcotic administration and visual analog scale (VAS) scores for pain at 0, 8, 16, 24, 48 and 72 hours after surgery.

Results published in *The Journal of Bone and Joint Surgery* included:

- Total narcotic consumption over the first 24 hours after surgery was significantly lower in the ISBPB group compared with the ISBPB plus Exparel group (a mean of 18.9 MEU versus 35.3 MEU).
- VAS pain scores did not differ significantly between groups at any time point during the first 72 hours after surgery.

“Patients treated with Exparel required significantly more postoperative narcotics and demonstrated no significant reduction in pain scores over the first 72 hours after primary shoulder arthroplasty,” the researchers concluded. “Exparel does not appear to have substantial value when added to a pain protocol that includes an ISBPB.”

They said further research is needed to determine the optimal pain management strategy for shoulder arthroplasty.

The Effectiveness of Cerebral Oxygenation Monitoring During Arthroscopic Shoulder Surgery in the Beach Chair Position: A Randomized Blinded Study

Rothman Orthopaedic Institute at Jefferson Health

Beach chair positioning for shoulder surgery is associated with measurable cerebral desaturation events (CDEs) in up to 80% of patients. While the position is used for about

two-thirds of shoulder surgeries, critics of the position point to the increased risk of cerebral hypofusion.

Near-infrared spectrometry (NIRS) technology allows real-time measurement of cerebral oxygenation and may minimize the frequency of CDEs. Jefferson Health researchers led by Joseph Abboud, MD, conducted a study to investigate the incidence of CDEs when anesthetists were either aware of or blinded to NIRS

monitoring and to determine the short-term cognitive effects of surgery done in the beach chair position.

NIRS was used to monitor cerebral oxygenation in 41 consecutive patients undergoing arthroscopic shoulder surgery in the beach chair position. Patients were randomized to one of two groups: anesthetists aware of or blinded to the NIRS data. The Montreal Cognitive Assessment (MoCA) was used to assess cognitive

Cerebral Desaturation Events (CDEs), Hypotensive Events and Operative Data

Variable	NIRS aware	NIRS blinded	P value
Patients experiencing CDE	5 (25%) (mean ± SD)	2 (10%) (mean ± SD)	.212
CDE and hypotensive events, No.			
Right CDE	0.2 ± 0.5	0.2 ± 0.5	.766
Left CDE	0.7 ± 1.4	0.2 ± 0.7	.272
Bilateral CDEs	0.2 ± 0.5	0.2 ± 0.5	1.000
Hypotensive event	2.9 ± 3.4	2.3 ± 2.1	.493
CDE and hypotensive	0.8 ± 1.5	0.2 ± 0.7	.158
CDE without treatment	0.1 ± 0.2		
Operative time			
Surgery duration, min	78.1 ± 33.4	75.7 ± 27.2	.722
Anesthesia duration, min	129.8 ± 31.2	128.0 ± 32.3	.786
Surgeon ratings			
Case difficulty, VAS	4.0 ± 1.9	3.4 ± 1.9	.201
Bleeding problems, VAS	3.3 ± 1.4	2.1 ± 1.0	.016

NIRS, near-infrared spectroscopy; SD, standard deviation; VAS, visual analog scale (cm).

No patients required any other interventions, such as a return to the supine position or early extubation. Only 1 patient enrolled in the study required treatment for intraoperative hypertension and received 2 doses of metoprolol. Source: Joseph Abboud, MD

function preoperatively, immediately postoperatively, and at two and six weeks postoperatively.

Among the results reported in *Journal of Shoulder and Elbow Surgery*:

- Overall, 7 (17.5%) patients experienced a CDE, 5 (25%) in the aware group and 2 (10%) in the blinded group, numbers that were substantially lower than some prior findings.

- There was no significant difference in MoCA scores between the aware and blinded groups at any of the points measured: 27.9 versus 28.2 preoperatively; 26.1 versus 26.2 immediately postoperatively; 28 versus 28.1 at two weeks; and 28.5 versus 28.4 at six weeks.

- There was a correlation of NIRS with systolic blood pressure, diastolic blood pressure and mean arterial blood pressure.

Cognitive Function Assessments Using the Montreal Cognitive Assessment (MoCA)

Time point	NIRS aware (mean ± SD)	NIRS blinded (mean ± SD)	P value
Preoperative	27.9 ± 1.3	28.2 ± 1.1	.436
Before discharge	26.1 ± 1.4	26.2 ± 1.9	.778
Change from baseline	-1.8 ± 1.7	-2.0 ± 1.4	.762
2 weeks postoperative	28.0 ± 1.4	28.1 ± 1.4	.737
Change from baseline	0.1 ± 1.5	-0.1 ± 1.6	.758
6 weeks postoperative	28.5 ± 1.1	28.4 ± 1.1	.779
Change from baseline	0.6 ± 1.5	0.2 ± 1.0	.321
	CDE	No CDE	
Preoperative	28.1 ± 0.7	28.0 ± 1.3	.733
Before discharge	26.3 ± 1.6	26.1 ± 1.7	.781
Change from baseline	-1.9 ± 1.8	-1.9 ± 1.5	.974
2 weeks postoperative	28.0 ± 0.8	28.0 ± 1.5	.959
Change from baseline	-0.1 ± 0.7	-0.1 ± 1.6	.751
6 weeks postoperative	28.7 ± 1.0	28.3 ± 1.1	.414
Change from baseline	0.6 ± 1.0	0.4 ± 1.3	.697

NIRS, near-infrared spectroscopy; SD, standard deviation; CDE, cerebral desaturation event.

There were no significant differences in changes from baseline between groups postoperatively, at 2 weeks postoperatively, or at 6 weeks postoperatively. No patients required referral to a neurologist for significant cognitive impairment. Source: Joseph Abboud, MD



Top, photograph displaying sensor placement on patient. Bottom, photograph displaying monitor during cerebral desaturation event. Source: Joseph Abboud, MD

SHOULDER AND ELBOW

Correlation of Blood Pressure and Cerebral Tissue Oxygenation Saturation

Blood pressure, mm Hg	Correlation coefficient, <i>r</i>
SBP	0.448
DBP	0.708
MAP	0.608

SBP, systolic blood pressure; DBP, diastolic blood pressure; MAP, mean arterial pressure.

There was a positive correlation between all blood pressure readings and cerebral tissue oxygenation saturation.
Source: Joseph Abboud, MD

“In our series, the incidence of CDEs was much lower than previously reported and was not lowered by use of NIRS. Patients did not have significant cognitive deficits after arthroscopic surgery in the beach chair position, and there was a correlation between NIRS and intraoperative brachial blood pressure,” the researchers concluded.

Neer Award 2018: The Effect of Preoperative Education on Opioid Consumption in Patients Undergoing Arthroscopic Cuff Repair: A Prospective, Randomized Clinical Trial

Rothman Orthopaedic Institute at Jefferson Health

Opioids are commonly administered for the treatment of acute and chronic pain and are among the most prescribed drugs in the U.S. Between 2002 and 2011, opioid prescriptions increased from 149 million to 238 million.

The healthcare system is now struggling to deal with increasing medication abuse and rising mortality rates from opioid overdose. Preoperative patient-targeted education on opioid use is an avenue yet to be explored. Jefferson Health researchers led by Luke Austin, MD, conducted a study to determine whether preoperative narcotic education reduces narcotic consumption after arthroscopic rotator cuff repair (ARCR).

Patients undergoing primary ARCR at Jefferson Health facilities were randomly assigned to receive preoperative education or not. The education consisted of a two-minute video with a handout detailing the risks of narcotic use and recommending discontinuing narcotics within two weeks of surgery.

The 140 patients in the study filled out preoperative questionnaires on medical history and a visual analog scale (VAS) for pain. They then completed questionnaires on opioid consumption and pain at their two-week, six-week and three-month follow-up appointments. One limitation of the study is that narcotic use was based on self-reporting, though to minimize bias, patients were not told of the true nature of the study.

Encouraging results were published in *Journal of Shoulder and Elbow Surgery*:

- Patients in the study group consumed significantly less narcotics than the control group at the three-month mark. For instance, the group that received education took an average of 25 pills at two weeks, compared to 35 in the control group. At three months the difference was 51 pills versus 87 pills.
- Patients in the education group were 2.2 times more likely than controls to discontinue narcotic use by the end of follow-up.
- Patients with a history of preoperative narcotic use that received the education were 6.8 times more likely to discontinue narcotics by the end of follow-up compared to similar controls.
- Among the various patient factors queried, only the VAS score at three months and undergoing the educational intervention were significantly associated with narcotic consumption.

“We believe this intervention has broader applications in elective orthopaedic surgery and should be studied in further settings,” the researchers said.

Platelet-Rich Plasma Injection with Percutaneous Needling for Recalcitrant Lateral Epicondylitis: Comparison of Tenotomy and Fenestration Techniques

Philadelphia Hand to Shoulder Center at Jefferson Health

Recalcitrant lateral epicondylitis (LE), also referred to as tennis elbow, is a common debilitating condition that affects up to 3% of the adult population. There are numerous treatment options of varying success.

An injection of platelet-rich plasma (PRP) has been shown to improve LE, although it is unclear whether the method of needling used in conjunction with a PRP injection is of clinical importance.

Researchers led by Michael Gaspar, MD, conducted a study to determine whether percutaneous needle tenotomy is superior to percutaneous needle fenestration when each is combined with a PRP injection for the treatment of recalcitrant LE.

They studied outcomes for 93 patients with recalcitrant LE who were treated between January 2010 and December 2014 with a PRP injection and either one of the two needling methods. Preoperative patient data, including visual analog scale for pain (VAS-P), Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH), and Patient-Rated Tennis Elbow Evaluation (PRTEE) scores and grip strength were obtained from a chart review and compared with values obtained prospectively. Secondary outcomes included the incidence of complications, need for additional interventions, return to work and patient satisfaction.

The results were reported in *The Orthopaedic Journal of Sports Medicine*. They included:

- At a mean follow-up of 40 months, significant improvements in VAS-P, QuickDASH and PRTEE scores and grip strength were observed across the entire study cohort, with no significant differences noted between the fenestration and tenotomy groups.
- Nine of 45 patients (22%) in the fenestration group underwent additional procedures to treat recurrent symptoms compared with five of 48 patients (10%) in the tenotomy group.
- No complications occurred in any patients and no patients expressed dissatisfaction with their treatment course.

"A PRP injection with concomitant needling is an effective treatment for recalcitrant LE," the researchers reported. They noted that favorable results were observed up to six years after the procedure. "Although the method of concomitant needling does not appear to have a significant effect on treatment outcomes, more aggressive needle tenotomy is less likely to require conversion to open tenotomy than needle fenestration in the short term to midterm."

They said prospective randomized studies could further test this finding and are currently being planned.

HOSTING LOCALLY CONNECTING GLOBALLY

PHILADELPHIA, PENNSYLVANIA



Jefferson Hosts International Meeting Focused on Periprosthetic Joint Infection

More than 550 delegates from 98 countries convened at Jefferson last July for the 2018 International Consensus Meeting on Musculoskeletal Infection. The international gathering, co-hosted by Javad Parvizi, MD, Professor of Orthopaedic Surgery at Jefferson, considered the latest scientific evidence on orthopaedic infections, a debilitating and costly complication of orthopaedic surgery and issued a detailed plan on ways to prevent, diagnose and treat them.

“Three days of discussions, sometimes very passionate, and engagement led to the generation of a 2,300-page document covering 650 questions related to orthopaedic infections,” said Dr. Parvizi, Director and

The consensus meeting drew orthopaedic surgeons and researchers in the specialties of hip and knee, spine, shoulder and elbow, oncology, foot and ankle, sports medicine, pediatrics and trauma from around the world, as well as representatives from the Food and Drug Administration, the National Institutes of Health, and industries that develop and market products related to orthopaedic infections. The delegates addressed a wide range of issues, from the use of prophylaxis to minimize the potential for infection, to the pre-surgical identification of patients at elevated risk for PJI. Questions addressed included: Should patients be cleared by a dentist prior to total joint arthroplasty? Does the type of anesthesia increase PJI risk? Should cell phones be allowed in the operating room?

“Three days of discussions, sometimes very passionate, led to the generation of a 2,300-page document covering 650 questions related to orthopaedic infections.”

— Javad Parvizi, MD, Professor of Orthopaedic Surgery at Jefferson and Vice Chair of Clinical Research at Rothman Orthopaedic Institute

Vice Chair of Clinical Research at the Rothman Orthopaedic Institute at Jefferson Health. Prevention and treatment of periprosthetic joint infection (PJI) is one of Dr. Parvizi's research interests.

An exhaustive review of the medical literature by various committees and a drafting of guidelines preceded the three-day gathering in Philadelphia. Dr. Parvizi said the resulting document is being published in book form, first in English and then in more than a dozen languages,

including Chinese, Spanish, Arabic, Farsi, Russian and German. The questions and recommendations, with the vote from delegates, are also posted at icmphilly.com, along with a PJI risk calculator developed by Dr. Parvizi and colleagues that can be accessed on the App (ICMPHilly).

The 2018 Consensus Meeting followed a similar gathering that occurred at Jefferson in 2013. The goal is to keep surgeons up to date on the latest findings on issues around PJI and increase their awareness of the best evidence-based practices to enhance the care of patients.

While PJI is a rare complication of total joint arthroplasty, affecting about 20-30 of every 1,000 patients, they are estimated to cost over \$2 billion annually in the U.S. alone. Patients often have to undergo additional surgery to remove infected tissue or have the infected joint replaced.

“Every patient undergoing joint replacement and surgeons performing these procedures are aware and fearful of the dreaded infection that can occur after the procedure that will change the life of the patient forever,” said Dr. Parvizi.

The Philadelphia Symposia

In March 2018, the Hand Rehabilitation Foundation presented two symposia in Philadelphia, targeted at orthopaedic, plastic and general surgeons and rehabilitation therapists.

The 20th annual *Hand Surgery Symposium* provided a comprehensive exploration of tried-and-true as well as new treatments for the management of diverse upper extremity problems, presented by internationally renowned faculty. Didactic presentations provided the

CONNECTING LOCALLY AND GLOBALLY

framework and cadaver demonstrations provided the picture of anatomy and techniques of management. Training labs and hands-on experience with the latest technology in the field were offered.

Celebrating over 40 years of success, the *Surgery and Rehabilitation of the Hand Meeting* was offered to hand therapists, occupational and physical therapists, athletic trainers and rehabilitation nurses. Session topics ranged from hand basics and fractures and joint injuries of the hand, to tendon injuries, neurological conditions and hypermobility.

Backed by Philadelphia Hand to Shoulder Center's reputation as a world leader in hand and upper extremity care, these events continue to attract professionals in hand surgery and rehabilitation from nearly every state and numerous foreign countries.

For further information about the Hand Rehabilitation Foundation, or to register for upcoming conferences, visit handfoundation.org.

Philadelphia Sports Medicine Congress

The 19th Annual Philadelphia Sports Medicine Congress featured lectures by nationally recognized experts in their respective fields focusing on leading-edge topics in sports medicine. The event was hosted by 3B Orthopaedics at Jefferson Health on the Jefferson campus in downtown Philadelphia.

Chaired by Arthur R. Bartolozzi, MD, Medical Director of Sports Medicine at 3B Orthopaedics at Jefferson Health, this year's meeting included speakers on a number of sports medicine topics, including care of the spine-injured athlete; the multi-ligament knee; non-operative management of the throwing athlete; pain medication and the athlete; sudden cardiac death in athletes; and long-term outcomes of cartilage repair.

Attracting sports medicine professionals throughout Pennsylvania, New Jersey and Delaware, the Annual Philadelphia Sports Medicine Congress exemplifies the local impact and national expertise of Jefferson Health.

Backed by Philadelphia Hand to Shoulder Center's reputation as a world leader in hand and upper extremity care, the Philadelphia Symposia continue to attract professionals in hand surgery and rehabilitation from nearly every state and numerous foreign countries.

The Congress continued the tradition of honoring an outstanding team physician and athletic trainer with the Joe Torg and Ted Quedenfeld awards. This year's award winners were Peter DeLuca, MD, and Kenneth Rogers, PhD, ATC. Dr. DeLuca is Head Orthopaedic Surgeon for the Philadelphia Flyers and Associate Professor of Orthopaedic Surgery at Jefferson. Dr. Rogers is Director of Clinical Research – Orthopaedics at Nemours.

Lou Nolan, longtime public address announcer for the Flyers and author of *If These Walls Could Talk*, served as the event's keynote speaker.

"This course is dedicated to you – the athletic trainers, physical therapists, physicians and other professionals who assist in delivering the crucial and important care that our patients receive," Dr. Bartolozzi noted in the course program.

For further information, and photos of the meeting, visit phillysmc.org.

HIP AND KNEE

SERVICES

Hip and knee replacement, partial knee replacement

Joint revision surgery

Adult joint reconstruction and preservation procedures

Treatment of hip and knee disorders
in young adults

Pelvic reconstruction, osteotomy and
hip-impingement surgery

Posterior cruciate injury

Staphylococcus



PANAMA CITY, PANAMA

A team from 3B Orthopaedics at Jefferson Health recently joined an Operation Walk mission trip to Panama City, Panama to perform knee replacements for residents in need, and to educate local healthcare providers.



The demand for total joint arthroplasty (TJA) is increasing as the population ages, and along with that growth in TJAs comes an increased demand for revision surgery. Jefferson Health joint surgeons are continually refining surgical and medical management techniques to improve outcomes following joint arthroplasty and other procedures. A key focus is the prevention of periprosthetic joint infection (PJI), a troubling complication that can result in additional surgeries, longer and more costly hospital stays and poor outcomes for patients. Research by Jefferson Health surgeons is focused on identifying patients at risk for PJI and the best methods for preventing the infections. Jefferson was the site last summer for an international consensus meeting on musculoskeletal infection, with Javad Parvizi, MD, Professor of Orthopaedic Surgery and Director of Clinical Research, co-chairing the event. (See related article on page 25.)

Here is an overview of some of the important joint research going on at Jefferson Health:

Development and Evaluation of a Preoperative Risk Calculator for Periprosthetic Joint Infection Following Total Joint Arthroplasty

Total joint arthroplasty, including total hip arthroplasty (THA) and total knee arthroplasty (TKA), is one of the most successful procedures in modern medicine. However, infection continues to be a devastating complication of the surgery. Though relatively infrequent, periprosthetic joint infection (PJI) has an enormous impact on the health of the patient, often subjecting them to an increased risk for mortality and to multiple operations that can leave them with poor function and diminished quality of life.

While numerous studies have examined risk factors associated with PJI, having an effective, validated risk calculator to quantify preoperatively the risk of PJI in an individual patient could allow surgeons to implement preventive measures before surgery. It could even avoid operating on individuals for whom the risk of PJI may outweigh the potential benefits of TJA. Jefferson Health researchers, led by Dr. Parvizi, reviewed thousands of patient cases to devise such a preoperative PJI risk calculator that can be used to assess a patient's individual risk of developing any PJI, PJI caused by *Staphylococcus aureus* and PJI caused by antibiotic-resistant organisms.

A retrospective review was conducted of 27,717 patients (12,086 TKAs and 31,167 THAs), including 1,035 with confirmed PJI, who were treated at Jefferson between the years 2000 and 2014. A total of 42 risk factors, including patient characteristics and surgical variables, were evaluated to determine their influence on PJI risk. The most influential of the remaining 17 factors included a previous open surgical procedure, drug abuse, psychosis, a revision procedure and HIV/AIDS. Each risk factor was assigned a weighted numerical value and those numbers were then added together to calculate a risk score. For instance, a patient with a cumulative score of 160 has an estimated 19% risk of PJI.

External validation of the scoring system was performed using data on 29,252 patients who had undergone TJI at another institution.

"In general, the risk factors for any PJI were similar to those for PJIs with *S. aureus* and those with antibiotic-resistant organisms," though there were some variations, the researchers reported in *The Journal of Bone and Joint Surgery*.

HIP AND KNEE

The researchers said the risk calculator could be used by surgeons to counsel patients considering TJA and to put in place prevention strategies such as prophylactic antibiotics.

Dr. Parvizi said an app based on the scoring system has been developed (there is a web-based version and another for mobile phones) and is being used by many surgeons worldwide to calculate patient risk for PJI.

Diagnosis of Periprosthetic Joint Infection: The Potential of Next-Generation Sequencing

One of the most challenging facets of managing periprosthetic joint infection (PJI) is reaching a prompt and definitive diagnosis, along with identification of the causative organism. In up to 50% of cases, cultures fail to isolate the infecting organism, making it more difficult to decide which antimicrobial therapy to administer to the patient.

Next-generation sequencing is a well-established technique for sequencing DNA and has recently gained attention in many fields of medicine. Jefferson Health researchers, led by Javad Parvizi, MD, and Karan Goswami, MD, conducted a prospective study to evaluate the accuracy of next-generation sequencing in identifying causative organisms in patients with PJI.

Samples were collected from 65 revision arthroplasties (39 knees and 26 hips) and 17 primary arthroplasties (9 hips and 8 knees). Synovial fluid, deep tissue and swabs were obtained at the time of surgery and sent to a designated laboratory for next-generation sequencing. Deep-tissue samples were also sent to the hospital lab for culture. Sensitivity and specificity were calculated for next-generation sequencing using the Musculoskeletal Infection Society (MSIS) definition of PJI as the standard.

Infection Status of All Patients at a 6-Month Follow-up According to the Next-Generation Sequencing Result*

Infection Status	Number of Patients			
	Infection-Free	Retained Spacer	Reinfection	Lost to Follow-up
Culture-positive infections (n = 17)				
Positive next-generation sequencing	7	5	3	1
Negative next-generation sequencing	0	0	0	1
Culture-negative infections (n = 11)				
Positive next-generation sequencing	5	3	1	0
Negative next-generation sequencing	1	0	1	0
Aseptic revisions (n = 37)				
Positive next-generation sequencing	9	NA	1	0
Negative next-generation sequencing	23	NA	4	0
Primary arthroplasties (n = 17)				
Positive next-generation sequencing	6	NA	0	0
Negative next-generation sequencing	11	NA	0	0

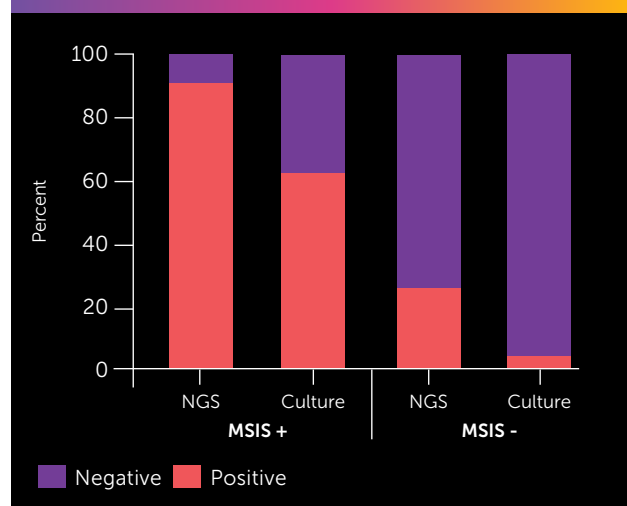
*NA = not applicable.

Source: Javad Parvizi, MD

Among the findings:

- In 28 revisions, the cases were considered to be infected; cultures were positive in 17 cases and next-generation sequencing was positive in 25 cases. There was concordance between the two methods in 15 of the cases.
- Among 11 cases of culture-negative PJI, next-generation sequencing was able to identify an organism in 9 cases. Next-generation sequencing identified microbes in 9 of 36 aseptic revisions with negative cultures and in 6 of 17 primary TJAs.
- Next-generation sequencing detected multiple organisms in most positive samples. However, in the majority of patients who were infected, one or two organisms were dominant.

Next-Generation Sequencing vs. Culture Results



Bar graph showing the comparison between next-generation sequencing (NGS) and culture results based on MSIS criteria. + = positive, and - = negative. Source: Javad Parvizi, MD

"Next-generation sequencing may be a useful adjunct in identification of the causative organism(s) in culture-negative periprosthetic joint infection," the researchers reported in *The Journal of Bone and Joint Surgery*. "Our findings suggest that some cases of monomicrobial periprosthetic joint infections may have additional organisms that escape detection when culture is used."

They said further study is needed to determine the clinical implications of isolated organism in samples from patients who are not thought to be infected. A large multicenter study is underway with over 1,000 patients already recruited into the study.

Increased Postoperative Glucose Variability Is Associated with Adverse Outcomes Following Total Joint Arthroplasty

Increased glucose variability during hospitalization has been associated with a longer length of stay in the hospital and a higher mortality rate following non-orthopaedic procedures. Jefferson Health researchers led by Javad Parvizi, MD, and Noam Shohat, MD, a visiting scholar from Israel, conducted a study to investigate whether there was a similar association between glucose variability and postoperative complications following total joint arthroplasty (TJA).

They analyzed data on 21,487 patients who had undergone total hip arthroplasty (THA) or total knee arthroplasty (TKA) at Jefferson from 2001 to 2017. Patients with a minimum of two postoperative values per day or greater than three values overall were included in the study. Glucose variability was assessed using a coefficient of variation. Adverse outcomes included an increased length of hospital stay, 90-day mortality, reoperations, periprosthetic joint infection (PJI, as defined by Musculoskeletal Infection Society criteria) and surgical site infection.

The final cohort included 2,360 patients who had undergone THA and 2,698 who had undergone TKA. Of them, 1,007 (almost 20%) had diabetes. Higher glycemic variability was associated with an increased hospital stay, 90-day mortality, PJI and surgical site infection. Adjusted analysis indicated that for every 10 percentage point increase in the coefficient of variation, the length of stay increased by 6.1%, the risk of mortality increased by 26% and the risks of PJI and surgical site infection increased by 20%. These associations were independent of year of surgery, age, body mass index, Elixhauser comorbidity index, a diagnosis of diabetes, in-hospital use of insulin or steroids and mean glucose values during hospitalization.

"Efforts should be made to control glucose variability in the early postoperative period," the researchers reported in *The Journal of Bone and Joint Surgery*. "Patients with rapid swings in glucose levels in the immediate postoperative period should be followed more closely and may benefit from continuous glucose measurement in an effort to reduce these deleterious oscillations."

The Mark Coventry, MD, Award: Oral Antibiotics Reduce Infection After Two-Stage Exchange: A Multicenter, Randomized Controlled Trial

Many patients develop recurrent periprosthetic joint infection (PJI) after two-stage exchange arthroplasty of the hip or knee. One potential but insufficiently tested strategy to decrease the risk of infection is to administer additional antibiotics after the second-stage reimplantation.

The Knee Society Research Group, including Javad Parvizi, MD, undertook a multicenter study to determine whether three months of oral antibiotics was beneficial.

The study, which is ongoing, involves patients undergoing two-stage revision arthroplasty of the hip or knee for a PJI at the first stage and who have a negative culture at the time of the second implantation. They are randomly assigned to either a three-month course of antibiotics tailored to the original infecting organism or no additional antibiotic therapy. Patients are evaluated at the three-week, six-week, three-month, 12-month and 24-month marks.

An interim analysis of 107 patients in the study was reported in *Clinical Orthopaedics and Related Research*:

- Failure from infection occurred less commonly in the treatment group (three cases) than in the control group (nine cases). That represents a risk of infection of 5% versus 19%. Ten of the 12 infections occurred before one year.
- Three patients had to stop taking their antibiotics because they developed adverse reactions including gastrointestinal upset and nausea. Three others reported mild adverse reactions, but continued taking the antibiotics.
- There was no difference between the antibiotic group and the controls when it came to the likelihood that an infection after treatment would be a new organism.

"The multicenter randomized trial suggests that at short-term follow-up, the addition of three months of additional antibiotic appeared to improve infection-free survival," the researchers concluded. They cautioned that the results are based on an interim analysis and may change as the study reaches closure.

FOOT AND ANKLE

SERVICES

Total ankle replacement surgery

Complex deformity reconstruction

Achilles tendon rupture and tendonitis treatment

Treatment of ankle sprains and fractures

Treatment of foot and ankle arthritis

Talus and Lisfranc fracture/dislocation repair

Posterior tibial tendonitis treatment

Treatment of tarsal tunnel syndrome

Hallux valgus surgery

Hallux rigidus surgery

Flat foot reconstruction

Treatment of various foot conditions

AMBALA, INDIA

Physicians from Rothman Orthopaedic Institute at Jefferson Health have worked with the Leprosy Mission Trust, an organization that helps those affected by leprosy and other neglected tropical diseases in marginalized communities.





Foot and ankle surgeons at Jefferson Health are leaders in performing total ankle replacement and are highly sought out for complex revision procedures due to previous surgical failure. No matter the extent of the surgery, the aim is to get patients back on their feet, free of restrictions and pain.

The team's broad research portfolio results in patients benefitting from the latest diagnostic, surgical and rehabilitation techniques. As more and more foot and ankle surgery moves to the outpatient setting, researchers are exploring the optimal use of anesthesia to allow patients to be comfortable during and after the procedure, allowing them to return home quickly. Another important research area involves the use of opioids for pain management after surgery. The goal is to provide patients with needed medication to relieve pain while not overprescribing narcotic pills that could be misused or abused by patients or their families.

Here is a look at some recent research.

Combined Popliteal Catheter with Single-Injection vs. Continuous-Infusion Saphenous Nerve Block for Foot and Ankle Surgery

The increasing scope and complexity of foot and ankle procedures performed in an outpatient setting require more intensive perioperative analgesia. Regional anesthesia (popliteal and saphenous nerve block) has been proven to provide satisfactory pain management, decreased postoperative opioid use and earlier patient discharge. It can be further augmented with the placement of a continuous-flow catheter, typically inserted into the popliteal nerve region.

To identify the ideal approach, Jefferson Health researchers led by Steven Raikin, MD, investigated

the use of a combined popliteal and saphenous continuous-flow catheter compared to a single popliteal catheter and single injection saphenous nerve block in postoperative pain management after ambulatory foot and ankle surgery. The prospective cohort study included 60 patients.

Demographic data; degree of medial operative involvement; American Society of Anesthesiologists physical classification system; anesthesia time; and post-anesthesia time were recorded. Outcome measures included pain satisfaction; numeric pain scores (NPS) at rest and with activity; and opioid intake. Patients were also classified by degree of saphenous nerve involvement in the operative procedure by the surgeon blinded to the anesthesia randomization.

In results published in *Foot & Ankle International*, the researchers reported that patients in the dual-catheter group took significantly less opioid medication on the day of surgery and postoperative day 1 (POD 1) compared to the single-catheter group. The dual-catheter group reported significantly greater satisfaction with pain at POD 1 and POD 3 and a significantly lower NPS at POD 1, 2 and 3. This trend was observed in all three subgroups of medical operative involvement.

"Patients in the single-catheter group reported more pain, less satisfaction with pain control, and increased opioid use on POD 1, suggesting dual-catheter use was superior to single-catheter nerve blocks with regard to managing early postoperative pain in outpatient foot and ankle surgery," the researchers concluded.

Dr. Raikin said the approach is being used for patients with larger surgeries, which are increasingly being done on an outpatient basis.

Driving After Hallux Valgus Surgery

The question of when a patient undergoing orthopaedic surgery can safely return to driving is an important one, especially when the procedure involves the right lower extremity. Various studies have considered procedures such as total knee arthroplasty, hip arthroplasty and ankle fracture open reduction and internal fixation, but little is known about driving after elective foot and ankle procedures.

Average Braking Reaction Times at 6 Weeks Postoperatively

	Pass (n = 51)	Fail (n = 9)	P Value
Braking reaction time, s	0.64	1.36	.02
Age, y	51.5	57.4	.280
AOFAS-HV score	73.9	67.1	.803
VAS	1.2	3.3	.02
MTP plantarflexion (degrees)	22.3	19.0	.350
MTP dorsiflexion (degrees)	18.4	14.4	.232

Above, the average BRT of the passing group was 0.64 seconds as compared to 1.36 seconds in those who failed the test. There was a tendency toward younger age, but no statistical difference in the age of the patients who passed the BRT test, compared to those who did not pass. Source: Steven Raikin, MD



Photograph demonstrating brake reaction time testing setup. Source: Steven Raikin, MD

Jefferson Health researchers led by Steven Raikin, MD, conducted a study to determine when patients can safely return to driving after first metatarsal osteotomy for hallux valgus (bunion) correction. They prospectively recruited 60 patients undergoing the procedure. Patients' brake reaction time (BRT) was tested at six weeks and repeated until they achieved a passing BRT. A control group of 20 healthy patients was used to establish a passing BRT. Patients were also given a novel driver readiness survey to complete.

Results were reported in *Foot & Ankle International*. At six weeks, 51 of the 60 patients had BRT less than 0.85 seconds and were considered safe to drive. At six weeks, the passing group average was 0.64 seconds. (The control's average BRT was 0.55 seconds, with a range of 0.45 seconds to 0.85 seconds.)

At eight weeks, 59 patients (100% of those who completed the study) achieved a passing BRT. Patients who failed at six weeks had a statistically greater visual analog scale (VAS) score and diminished first metatarsophalangeal (MTP) range of motion (ROM). On the novel readiness survey, eight of the nine patients who did not pass at six weeks said they disagreed or strongly disagreed with the statement, "Based on what I think my braking reaction time is, I think I am ready to drive."

"Most patients may be informed that they can safely return to driving eight weeks after right metatarsal osteotomy for hallux valgus correction," the researchers concluded. "Some patients may be eligible to return to driving sooner depending on their VAS, first MTP ROM and driver readiness survey results."

Influence of Depressive Symptoms on Hallux Valgus Surgical Outcomes

The relationship between depressive symptoms and patient outcomes after hallux valgus surgery has not been well studied. Jefferson Health researchers led by Steven Raikin, MD, set up a study to examine the issue.

A total of 239 adult patients who had surgical hallux valgus correction over a two-year period were retrospectively enrolled. Patient-reported outcomes had been collected at baseline and at least 11 months postoperatively using these tools: visual analog scale (VAS); Short Form 12 (SF-12) mental (MSC) and physical components (PCS); and Foot and Ankle Ability measure (FAAM) with Activities of Daily Living (ADL) and Sports subscales. Personal history of depression and current medications were recorded on the standard intake form for new patients. Thirty-six of 239 patients exhibited depressive symptoms (based on SF-12 MSC of less than 45.6 points) at baseline.

A telephone survey was administered prospectively at 11 months postoperatively to inquire about overall satisfaction with surgery and satisfaction with postoperative pain level. (A scale of 0 to 6 was used, with 0 indicating complete dissatisfaction and 6 indicating complete satisfaction.) Of the 239 patients, 160 completed the satisfaction survey at an average of 23 months after surgery.

Findings were published in *Foot & Ankle International*. They included:

- Patients with depressive symptoms had greater pain at baseline and less pain postoperatively when compared to patients without depressive symptoms. However, patients with depressive symptoms showed lesser functional improvement and lower satisfaction levels

Pre- and Postoperative Functional Scores and Satisfaction Levels in Patients With and Without Depressive Symptoms

	Not Depressed†	Depressed†	P Value
Pre-Op VAS	6.6	7.0	.650
Post-Op VAS	4.1	3.0	
Pre-Op SF-12 MCS	57.8	38.5	<0.001*
Post-Op SF-12 MCS	56.1	49.3	
Pre-Op SF-12 PCS	45.3	41.0	.042*
Post-Op SF-12 PCS	47.6	44.1	
Pre-Op FAAM	74.1	67.7	.064
Post-Op FAAM	80.7	66.3	
Pre-Op FAAM ADL	78.6	72.7	.046
Post-Op FAAM ADL	84.8	73.6	
Pre-Op FAAM Sport	62.9	54.8	.067
Post-Op FAAM Sport	69.9	48.3	
Satisfied with Surgery? 1 - very dissatisfied to 6 - very satisfied	4.4	3.9	.251
Satisfied with Pain? 1 - very dissatisfied to 6 - very satisfied	4.5	3.6	.042*

Abbreviations: ADL, Activities of Daily Living; FAAM, Foot and Ankle Ability Measure; MCS, Mental Component Score; PCS, Physical Component Score; SF-12, Short Form-12; VAS, visual analogue scale. The depressed patient group was defined as patients with baseline SF-12 MCS of ≤ 45.6 points. *Statistically significant. Source: Steven Raikin, MD

with postoperative pain after surgical correction when compared with patients without depressive symptoms.

- Most functional scores were lower in patients with depressed symptoms, with the exception of the MCS.
- Reported history of depression was not associated with any statistically significant difference in functional outcome scores or satisfaction with the outcome of surgery.

"Further study is warranted to determine why patients with depressive symptoms fare worse after surgical hallux valgus correction by most subjective measures," they wrote.

Prospective Evaluation of Utilization of Patterns and Prescribing Guidelines of Opioid Consumption Following Orthopaedic Foot and Ankle Surgery

Overprescribing of narcotic pain medication is a major culprit in the opioid epidemic plaguing the U.S. Research on the extent of opioid use for lower extremity surgery is limited.

Jefferson Health researchers led by Joseph Daniel, DO, conducted a prospective study to assess opioid consumption patterns following outpatient orthopaedic foot and ankle procedures. The study prospectively enrolled 1,027 patients who underwent outpatient surgery at a Jefferson Health facility from September 2016 to September 2017. Information was collected on patient demographics, preoperative health history, patient-reported outcomes, anesthesia types, procedure types, opioid prescription and consumption details. The morphine equivalent dose was calculated for each prescription and then converted to the equivalent of a 5-mg. oxycodone pill. (Opioid use was reported for 988 patients.)

Complete data were available on 1,009 of the patients for analysis. The results were reported in *Foot & Ankle International*. They included:

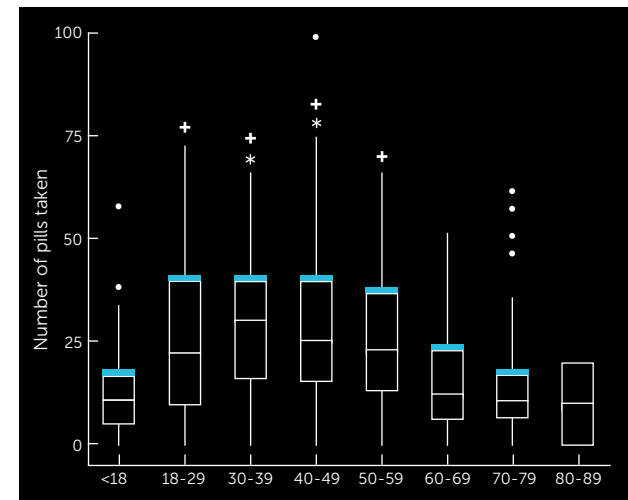
- Patients consumed a median of 20 pills, though they were prescribed a median of 40 pills. That means 20,631 pills were left unused.
- Independent factors associated with opioid use were anesthesia type (patients requiring local anesthesia only used fewer pills), preoperative visual analog scale (VAS) pain score of greater than 6, and bony procedures.

"Our study found that patients who underwent orthopaedic foot and ankle procedures were overprescribed narcotic medication by nearly twice the amount that was actually consumed," the researchers wrote. Excess pills could result in patient abuse, or the pills could end up in the wrong hands.

The researchers said that while the study identified four factors related to opioid use, "there remains a substantial degree of unexplained variance of opioid consumption observed in the patient population."

"Physicians face a challenging task of setting appropriate protocols when balancing pain relief and generalizable guidelines."

Dr. Daniel said the study has increased surgeons' awareness around the issue of how many pills to prescribe and has prompted "frank discussions between the surgeon and the patient regarding safe alternatives to narcotics for pain management."



Boxplots summarizing number of pills consumed as a function of patients' age at time of surgery. Patients 18-59 years old consumed significantly more opioids than 60- to 79-year-olds (tP < .02). Source: Joseph Daniel, DO



ON A MISSION TO EXTEND OUR GLOBAL REACH

TEGUCIGALPA, HONDURAS

A team of clinicians led by Philadelphia Hand to Shoulder Center physicians traveled to Tegucigalpa, Honduras and performed over 100 upper extremity surgeries on local patients in need of care.

Around the world and right here in the Greater Philadelphia region, millions of people suffer from life-altering medical conditions, lower quality of life and shortened life spans. Clinicians from Philadelphia Hand to Shoulder Center at Jefferson Health, 3B Orthopaedics at Jefferson Health and Rothman Orthopaedic Institute at Jefferson Health are doing their share to change that.

Two senior partners exemplify the essence of Philadelphia Hand to Shoulder Center through their work in countries with limited health care and few medical resources. Randall W. Culp, MD, and A. Lee Osterman, MD, recently led missions to Honduras and Rwanda.

For the Honduras mission, which he has been making for the last 15 years, Dr. Culp was joined by two other hand surgeons and 18 additional clinicians including physicians, therapists, hand surgery fellows and residents. About half of their Honduran patients had defensive wounds from a machete, a weapon carried by many in the country. Other cases included thumb and finger deformities, amputations and burn contractures. The team's goal during this trip was to help as many as they could with the limited time they had. They saw between 200-300 patients in a week, with roughly 120 of them needing surgery.

For his work, Dr. Culp was honored by the Honduran government for his years of service to the country. His award, the first of its kind, was presented by the Second Vice President of the National Congress of Honduras.

During his acceptance remarks, Dr. Culp expressed gratitude to his team, and pointed out that his reason for coming is more than just hand surgery. "The people are so wonderful," he said. "When I see the faces of Honduran patients who can finally have surgery, I feel a sense of accomplishment I can't get anywhere else."

At the request of a local physician, Dr. Osterman led a mission team to Kigali, Rwanda in April 2018. Among those who joined him on his first mission to Rwanda included Adam B. Strohl, MD, a Philadelphia Hand to

Shoulder Center orthopaedic/plastic surgeon, along with a team of physicians, hand therapists, hand surgery fellows and surgical nurses. While the team primarily focused on treating brachial plexus injuries and conditions during their week's stay, they also carried out numerous complex procedures including wrist reconstruction, tendon reconstruction and bone realignment.

Clinicians from Rothman Orthopaedic Institute and 3B Orthopaedics have lent their services to Operation Walk, founded by Lawrence D. Dorr, MD. A world-renowned leader in joint replacement surgery, Dr. Dorr recognized while on a teaching trip to Russia that he could better teach physicians by demonstrating — rather than describing — surgery. He also realized that he could

“When I see the faces of Honduran patients who can finally have surgery, I feel a sense of accomplishment I can't get anywhere else.”

— Randall W. Culp, MD, Philadelphia Hand to Shoulder Center

bring surgical skills and healing processes to the world's poorest while teaching in-country physicians. Thus originated the idea for Operation Walk.

Recently, a team from 3B Orthopaedics led by Robert Booth, MD, and Michelle Anderson, PA-C, joined Operation Walk on a trip to Panama City, Panama to perform knee replacements for those in need, and to provide education and training to local healthcare providers.

"Aside from the sheer humanity of it, the overwhelming gratitude of these people is a refreshing comparison to the encumbrances and restrictions of American medicine," Dr. Booth said. "It allows us to remember the

altruism that enticed us to become healthcare providers in the beginning of our careers, and it sustains us through our subsequent surgeries when we return home."

Rothman Orthopaedic Institute physicians regularly assist with local Operation Walk efforts — often during the holiday season — by performing pro bono knee replacements in the Philadelphia area for low-income individuals who qualify through the program.

"They're truly stuck and debilitated," noted Eric Smith, MD, one of the Rothman Orthopaedic Institute surgeons involved. "They can't work because of the pain of arthritis, and this way we can branch out at least once a year and give people a holiday gift and get them back to a great life."

Several Rothman physicians also recently traveled abroad, including Robert Franks, DO, a sports medicine specialist who traveled to Germany for teaching and to conduct treatments, and David Pedowitz, MD, who trekked to India to present at an educational conference. Asif Ilyas, MD, also traveled to India to work with the Leprosy Mission Trust, an organization that works with people affected by leprosy and other neglected tropical diseases in marginalized communities.

Through the efforts of these dedicated clinicians, hundreds of less fortunate people living in underserved populations here and abroad are living healthier lives.

MUSCULOSKELETAL ONCOLOGY

SERVICES

Limb salvage surgery and complete reconstruction

Osteosarcoma treatment

Soft tissue sarcoma treatment

Myeloma treatment

Evaluation and treatment of spinal tumors

Treatment of metastatic disease

Prophylactic fixation

Imaging and interventional services

Bone and soft tissue resection

Radiation and chemotherapy treatment



PHILADELPHIA, PENNSYLVANIA

The Sidney Kimmel Cancer Center – Jefferson Health, located in the heart of Jefferson’s campus, is one of only 70 NCI-designated cancer institutions in the country.



Jefferson Health’s Musculoskeletal Oncology program is a prime example of how patients benefit from the expertise of specialists in various fields of medicine. Experts in musculoskeletal surgery, radiology, medical oncology, radiation oncology, pathology and other specialties come together to devise a comprehensive treatment plan, from diagnosis on through rehabilitative care.

With the combined experience of clinicians in Jefferson Health’s Department of Orthopaedic Surgery as well as those in the Jefferson Sarcoma and Bone Tumor Center, which brings together experts from Rothman Orthopaedic Institute at Jefferson Health and the NCI-designated Sidney Kimmel Cancer Center, no patient’s case is too rare or too complex. The program routinely sees patients with uncertain diagnoses who are referred from centers with limited experience in dealing with complicated musculoskeletal oncology cases.

Among the cancers regularly treated here are soft tissue sarcomas, primary bone cancers, including osteosarcoma, Ewing sarcoma and chondrosarcoma, as well as metastatic disease that has spread to the bone from other sites. Cases are reviewed by a multidisciplinary team, including orthopaedic oncology, musculoskeletal radiologists, medical oncologists, radiation oncologists and pathologists, all specially trained in musculoskeletal disease.

The musculoskeletal team is also deep into research that is improving many aspects of clinical care, including imaging, surgical techniques and adjunct therapy. Here is a look at some of their recent publications:

Effect of Mitomycin C on Recurrence of Plantar Fibromas

Plantar fibromas are slow growing, benign but locally aggressive soft tissue tumors of the foot. Although certainly not the first-line treatment for plantar fibromas, surgical resection is a treatment option for some patients who have failed exhaustive non-surgical treatment. However, the average rate of recurrence after excision has been reported to be approximately 60%.

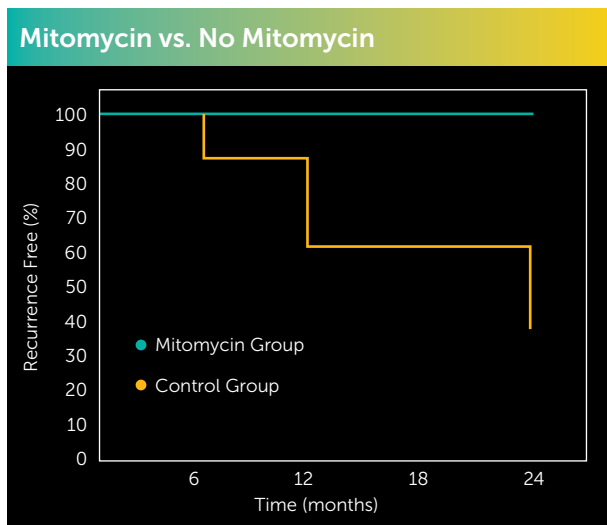
The use of topical Mitomycin C, an antitumor antibiotic, has recently been shown to reduce the recurrence rate of plantar fibromas after excision. Jefferson Health researchers conducted a retrospective analysis of information from a prospectively gathered database of 50 consecutive patients who underwent surgical resection for plantar fibroma. The study group included 29 patients who had surgery only and 21 patients who had surgery plus adjuvant therapy with Mitomycin C. The primary endpoint was local recurrence after surgery. Secondary endpoints were complications and toxicity related to the medication.

The results were reported in *Journal of Orthopaedic Research*. They included:

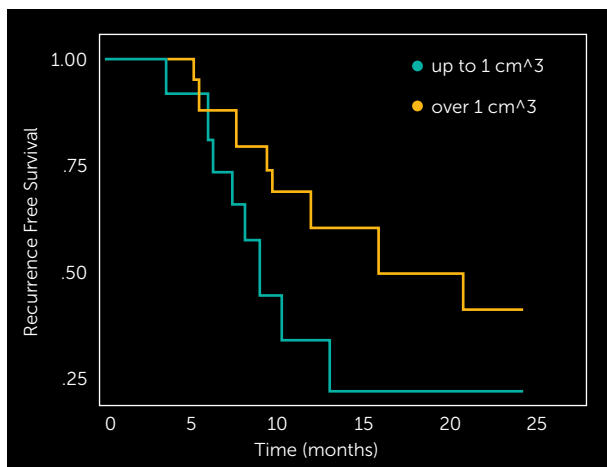
- In the surgery plus Mitomycin C group, no patients had local recurrence. In comparison, 58.6% (17 of 29) of patients in the surgery-only group had recurrence of plantar fibroma at a mean follow-up of 9.1 months.
- No complications or side effects were associated with Mitomycin use. The medication did not cause wound complications or delay wound healing.

MUSCULOSKELETAL ONCOLOGY

“The results demonstrate that the topical application of Mitomycin C to the tumor bed after surgical resection of plantar fibromas reduced the risk of recurrence,” they concluded. They said further study of the novel approach is warranted.



This figure illustrates the Kaplan-Meier graph comparing recurrence rates between the two cohorts. Source: Scot A. Brown, MD



This figure illustrates the Kaplan-Meier graph for tumor size versus time to recurrence. Source: Scot A. Brown, MD

Second Opinions in Orthopaedic Oncology Imaging: Can Fellowship Training Reduce Clinically Significant Discrepancies?

Requests for second-opinion consultation by subspecialty radiologists is common in radiology departments, particularly in tertiary and quaternary care referral centers. Although referred patients arrive with reports for imaging studies performed at a variety of outside centers, many clinicians continue to request formal second-opinion interpretations from their own institution’s subspecialty radiologists. With a growing emphasis on reducing unnecessary repeat studies and ultimately curbing the cost of imaging, it is important for hospitals to define formal policies regarding the use of second-opinion consultation.

To gain insight on the issue as it relates to orthopaedic oncology patients, Jefferson Health researchers led by Adam C. Zoga, MD, conducted a study to identify factors that led to significant discrepancies on second-opinion consultation. They wanted to understand whether having fellowship training in musculoskeletal radiology can decrease the incidence of clinically significant discrepancies.

An imaging (X-ray, CT, MRI) database was queried for secondary reads on outside cross-sectional imaging studies, as requested by orthopaedic oncology at Jefferson from 2014 to 2017. A comparison of original and secondary reports was performed using a published seven-point scale that defines clinically significant discrepancies. An online search was performed for each original radiologist to record if that person had completed a fellowship in musculoskeletal imaging.

Additionally, years of post-residency experience, number of Medicare part B patients billed per year (a marker of patient volume) and average hierarchical condition category for each radiologist (a marker of practice complexity) were recorded.

A total of 571 patients met the inclusion criteria for the study, with 184 cases initially interpreted by an outside fellowship-trained musculoskeletal (MSK) radiologist and 387 cases initially interpreted by a non-MSK trained radiologist. The researchers then compared the rate of discrepancies and reported their findings in *Skeletal Radiology*.

The rate of clinically significant discrepancy was 9.2% when images were initially interpreted by a MSK radiologist, compared with 27.9% discrepancy when a non-MSK radiologist did the initial interpretation. After the researchers made statistical adjustment for patient characteristics and radiologist characteristics, the likelihood of clinically significant discrepancies was 1.36 times greater for initial interpretations by non-MSK radiologists compared to MSK radiologists.

The researchers said the findings underscore the value of MSK fellowship training for radiologists.

“The results suggest that even in practice settings outside tertiary referral centers, fellowship-trained radiologists generate a lower discrepancy rate in an orthopaedic oncological patient population,” the researchers reported. “Specifically, with accurate interpretation or appropriate referral, subspecialty radiologists can prevent unnecessary invasive interventions or be the first to suggest more aggressive therapeutic procedures.”

Clinical Impact of Second-Opinion Musculoskeletal Subspecialty Interpretations During a Multidisciplinary Orthopaedic Oncology Conference

Jefferson Health researchers led by Adam C. Zoga, MD, conducted a study to analyze the impact on clinical management when musculoskeletal radiologists render second-opinion consultations during multidisciplinary orthopaedic oncology conferences.

An imaging database was searched for cases involving secondary interpretations on outside MRI studies reviewed in such a setting from January 2014 to December 2016. Reports were compared with original interpretations, when available.

Reports were categorized using a 7-point scale: no discrepancy (I); undetected clinically insignificant abnormality (II); clinically insignificant difference in interpretation (III); difference in imaging follow-up recommendation (IV); equivocal initial interpretation with subsequent definitive subspecialty interpretation (V); clinically significant difference in interpretation (VI); and failure to detect a clinically significant abnormality (VII).

A total of 409 patients met inclusion criteria. Results were published in *Journal of the American College of Radiology*:

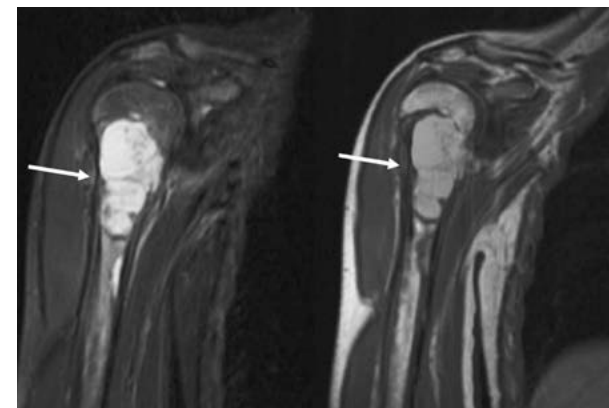
- There were 91 (22.2%) instances of discrepant interpretations resulting in clinically significant differences in management; 67 (16.4%) were category VI and 24 (5.9%) were category VII.

- An additional 72 cases (17.6%) were identified as category IV and 28 (6.8%) as category V.
- In total, there were clinically relevant discrepancies between the original and secondary interpretations in 191 (46.7%) of the cases analyzed.
- When pathology was available, the secondary consultations were concordant in 57 of 61 cases (93.4%) and the outside interpretations were concordant in 39 of 61 cases (63.9%).

The researchers noted that the high rate of discrepancy identified in the study is not surprising given that interpreting complex musculoskeletal studies is challenging and radiologists may have limited experience with orthopaedic oncologic conditions.

“By defining a substantial rate of clinically relevant discrepancies in orthopaedic oncology cases, our results demonstrate that second interpretations can often change diagnosis and clinical management,” the researchers said. “By participating in a multidisciplinary approach to patient care, subspecialty radiologists have a unique opportunity to help direct appropriate treatment plans.”

The musculoskeletal division of Jefferson Health’s Department of Radiology routinely holds multidisciplinary conferences with the orthopaedic oncology division. Such conferences are held weekly and are important for the proper interpretation of tumor cases and for planning biopsy approaches on upcoming patients.



Case study: Fourteen-year-old boy with a history of chronic right shoulder pain. Coronal short T1 inversion recovery and coronal T1 images demonstrate a T2 hyperintense and a T1 hypointense unicameral bone cyst in the proximal humerus with associated fluid levels and pathologic fracture (white arrow). Outside interpretation incorrectly raised concern for an aggressive malignancy with cortical erosion. Source: Adam Zoga, MD

Discrepancy Category of Outside Interpretations Compared with Subspecialty Consultations

Discrepancy Category	Number of Patients	% of Total
No discrepancy	175	42.8
Failure to detect clinically insignificant abnormality	6	1.5
Clinically insignificant difference in interpretation	37	9.0
Difference in imaging follow-up recommendation	72	17.6
Equivocal initial interpretation with subsequent definitive interpretation	28	6.8
Clinically significant difference in interpretation	67	16.4
Failure to detect a clinically significant abnormality	24	5.9

Source: Adam Zoga, MD

SPORTS MEDICINE

SERVICES

Arthroscopy of the hip, knee and shoulder

Cartilage restoration procedures: microfracture, osteochondral allograft transplantation and autologous chondryte implantation

Knee ligament reconstruction – ACL surgery

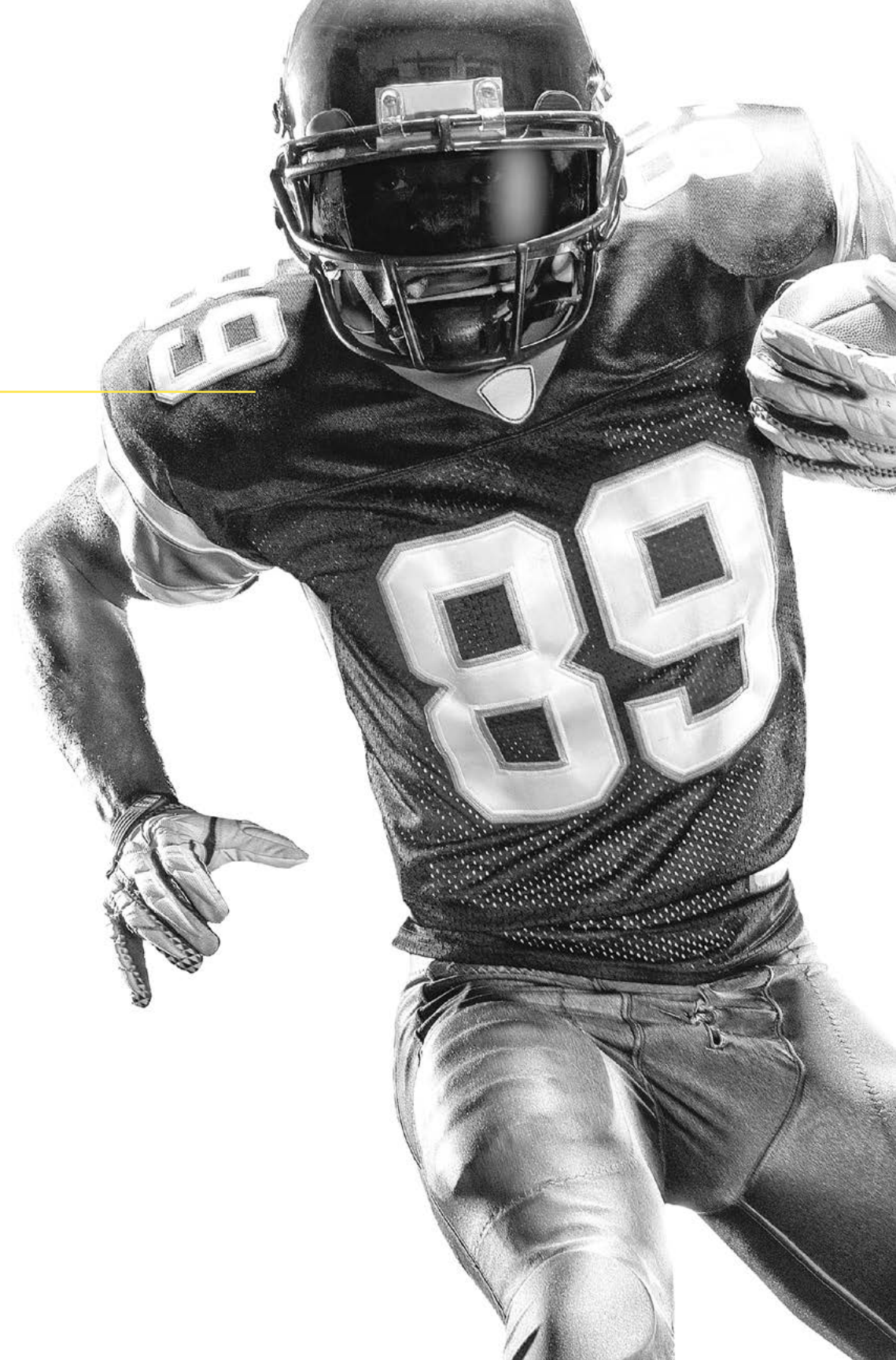
Meniscal transplantation

Patellofemoral joint instability

PCL injury

Rotator cuff repair

Repair and reconstruction of the knee, shoulder and elbow





LONDON, ENGLAND

Physicians from Rothman Orthopaedic Institute at Jefferson Health were on the sidelines of the Philadelphia Eagles' first international game in London in October 2018. Rothman Orthopaedics at Jefferson Health is the official orthopaedic and healthcare partner of the world champion Philadelphia Eagles, and serves as the team's physicians.



The Sports Medicine team at Jefferson Health appreciates all kinds of athletes – younger kids discovering the joy of mastering a sport, high school players determined to do their best for the team, professional athletes whose livelihood depends on turning in a peak performance at every game, and athletes of all ages who run, golf or play tennis for the sheer fun of it – or because they love to compete.

The Sports Medicine program includes surgeons who serve as team physicians for the Philadelphia Eagles, Philadelphia Phillies, Philadelphia Flyers and Philadelphia 76ers. Physicians with the program also work with numerous high school and university teams. No matter the level of athlete they are caring for, the doctors strive to get athletes safely back to play following treatment of an injury and help them adopt preventive measures that will keep the injury from recurring.

Acute injuries, overuse injuries and normal wear and tear that comes with aging are all areas of focus of the Sports Medicine program. The specialists are leaders in the treatment of frequent sports injuries, such as anterior cruciate ligament injuries and rotator cuff tears, as well as less common conditions. The treating team's understanding of body mechanics means that patients not only are restored to good function through surgery or medical management, but they also return home with a recovery plan designed to enhance their mobility, flexibility and strength.

The clinicians are also dedicated to research that is advancing surgical techniques and injury prevention. Here is a look at some of their research:

Contact Versus Noncontact Anterior Cruciate Ligament Injuries: Is Mechanism of Injury Predictive of Concomitant Knee Pathology?

Anterior cruciate ligament (ACL) injuries are among the most common knee injuries in young athletes. Ligament reconstruction is generally recommended for active patients with functional instability. Unfortunately, ACL injuries are often accompanied by some form of concomitant pathology, which may or may not be picked up on imaging and physical examination. Knowing the risk factors for concomitant pathology could help surgeons with operative planning and counseling of patients about expected outcomes for ACL surgery.

Jefferson Health researchers led by Steven Cohen, MD, conducted a study to determine if mechanism of injury is predictive of concomitant knee pathology found at the time of ACL reconstruction.

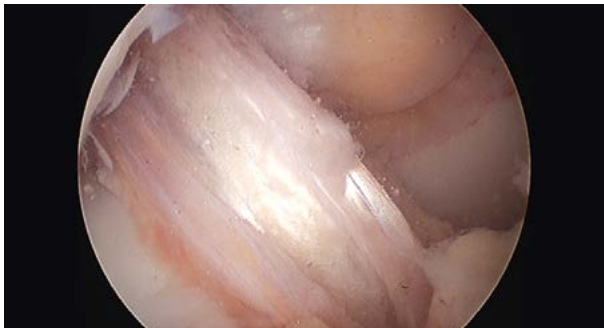
Cases for all patients aged 16 to 35 who underwent ACL reconstruction at Jefferson Health facilities between 2009 and 2015 were retrospectively reviewed. Mechanism of injury was determined from patient history.

The presence of meniscal or chondral damage was determined from operative records, while collateral ligament injuries were determined by the treating surgeon's diagnosis after physical examination and review of magnetic resonance imaging findings. Patients with inadequate documentation, history of a subsequent instability episode following the initial injury, or prior history of knee pathology were excluded from the study.

In all, 687 patients (169 contact injuries and 518 noncontact) were included in an analysis of ACL injuries due to contact compared to those that were noncontact in nature. It found:

- The incidence of collateral ligament injury was double in the contact group, 67.5% in the contact group versus 33.8% in the noncontact group.
- Grade III collateral injury was found in 15.4% of the contact group compared to 1.7% of the noncontact group.
- Chondral injury was identified in 24.3% of the contact group versus 16.8% of the noncontact group, with more grade IV lesions in the contact group as well (5.3% versus 0.8%).
- Chondral injury to the lateral femoral condyle was found in 6.5% of the contact group and 2.9% of the noncontact group.

“Although we found no difference in the incidence or types of meniscal tears, we found a significant increase in the incidence of grade IV chondral injury, chondral injury to the lateral femoral condyle, and grade III collateral ligament damage in the setting of contact



An arthroscopic image of an anterior cruciate ligament (ACL).
Source: Steven Cohen, MD

ACL injuries,” the researchers reported in *Arthroscopy: The Journal of Arthroscopic and Related Surgery*. “This knowledge can aid surgeons in preoperative planning and patient counseling.”

Biomechanical and Clinical Comparison of Suture Techniques in Arthroscopic Rotator Cuff Repair

Numerous single-row and double-row repair suture techniques are used for arthroscopic rotator cuff repair. However, there is no clear consensus on which approach works best.

To gain some clarity on the issue, Jefferson Health researchers led by Kevin Freedman, MD, reviewed the medical literature to evaluate what has been reported on the biomechanical and clinical outcomes of various arthroscopic suture repair techniques.

They compared reported outcomes for single-row techniques (simple sutures, mattress configuration, Modified Mason-Allen, rip-stop, and massive cuff stitch techniques) and double-row techniques (classic double-row, transosseous equivalent and knotless transosseous equivalent techniques). They evaluated results of biomechanical studies on those techniques and also performed a systematic review of Level I and II studies to compare clinical outcomes of single-row and double-row rotator cuff repair suture techniques. They then considered whether biomechanical results related to clinical outcomes.

Among their findings reported in *The Journal of Bone and Joint Surgery*:

- Even though biomechanical studies have found double-row fixation to be stronger than single-row fixation techniques and massive cuff stitch or Mason-Allen techniques to have the strongest fixation of the single-row methods, the majority of clinical studies have shown no difference in outcomes scores.
- Rotator cuff healing rates vary between studies, but repairs commonly fail by tendon pullout of suture regardless of repair technique.
- These findings suggest that the quality of the tendon itself and proper reduction of the tendon to the footprint based on tear pattern may be more important than suture configuration for repair.

“Obtaining healing in rotator cuff repair is multifactorial, and future research is needed to help determine these factors,” the researchers concluded. “Specific suture technique is one of many elements that may play a role in obtaining rotator cuff healing and successful clinical outcomes with arthroscopic rotator cuff repair.”

Elbow Injuries in Professional Baseball: Epidemiological Findings from the Major League Baseball Injury Surveillance System

Elbow injuries cause significant disability for the throwing athlete. Scant data are available on the distribution and characteristics of these injuries in elite baseball players. No study exists that focuses solely on the epidemiological characteristics of elbow injuries in professional baseball players using a comprehensive injury surveillance system.

Jefferson Health researchers led by Michael Ciccotti, MD, tested the hypothesis that high occurrence of elbow injuries among professional baseball players are likely due to length of time playing, time period within the annual baseball season, and specific position played.

Data on elbow injuries occurring during the 2011-2014 seasons were collected from Major League Baseball's Health Injury and Tracking System, a comprehensive injury surveillance system. Each specific type of elbow injury was evaluated, with respect to overall injury rate, years as a professional player, mechanism of injury, treatment, average time lost, and return to play.

During the study period, there were 3,185 elbow injuries (430 Major League, 2,755 Minor League). The mean number of days missed and percentage requiring surgery were similar between Major and Minor League players.

Overall, 20% of the injuries required surgical treatment. Pitchers were most likely to have an elbow injury (they made up 40% of injured), were the most likely to require surgery (34.2% of those undergoing surgery) and had the greatest number on average of days missed when treated nonsurgically (33.2 days). Medial injuries comprised 42.1% of all elbow injuries. Of all elbow surgeries performed during the study period, the highest percentage involved ligaments (57.2%), most commonly the ulnar collateral ligament.

"This study represents the only investigation to date using a comprehensive injury surveillance system to examine elbow injuries in professional baseball players,"

the researchers reported in *The American Journal of Sports Medicine*. "It provides a basis for injury prevention and treatment recommendations, establishes the most thorough framework for determining elbow injury risk, and focuses continued research on elbow injury prevention in the elite baseball player."

Early Single-Sport Specialization: A Survey of 3,090 High School, Collegiate and Professional Athletes

Youth participation in organized sports in the U.S. is rising, with many athletes focusing on a single sport at increasingly younger ages.

Sport specialization at a young age is seen by some members of the public as a way to boost a child's sports performance and help ensure that a young player goes on to participate at a college or professional level, but whether that is the case is not clear. At the same time, medical professionals are raising concerns about the potential downsides of early single-sports specialization. Injuries may be a problem, and burnout is a concern, too.

Jefferson Health researchers led by Michael Ciccotti, MD, retrospectively compared single-sports specialization in current high school, collegiate and professional athletes with regard to the rate and age of specialization, the number of months per year of single-sports training and the athlete's perception of injury related to specialization. They surveyed 3,090 athletes (503 high school, 856 college and 1,731 professional) at the time of their yearly preseason physicals.

Some of the survey results, as published in *The Orthopaedic Journal of Sports Medicine*, include:

- 45.2% of high school players, 67.7% of college players and 46% of professional players specialized in a single sport during childhood/adolescence.
- The mean age of specialization in a single sport was statistically earlier for high school players (12.7 yrs.) as compared to college players (14.8 yrs.) and the professionals (14.1 yrs.).
- A greater incidence of sports-related injury was recalled by high school players (39.9%) and college athletes (42.1%) than professional athletes (25.4%).
- More high school (79.7%) and college players (80.6%) believed early sports specialization provided a long-term advantage, compared to only 61.7% of the pros.
- Only 22.3% of professional athletes said they would want their child to specialize in only one sport during childhood/adolescence.

"This study provides a foundation for understanding current trends in single-sport specialization in all athletic levels," the researchers reported. "Current high school athletes specialized, on average, two years earlier than current collegiate and professional athletes surveyed. These data challenge the notion that success at an elite level requires athletes to specialize in one sport at a very young age."

BASIC SCIENCE



ROME, ITALY

Jefferson, in collaboration with Catholic University of the Sacred Heart in Rome, signed an agreement in November 2018 to launch the world's first-ever dual-medical degree program, enabling a cohort of physicians to practice medicine in both the U.S. and the European Union.



From the Laboratory of Christopher Kepler, MD, MBA, Associate Professor of Orthopaedic Surgery; Dessislava Z. Markova, PhD, Research Assistant Professor of Orthopaedic Surgery; and David G. Anderson MD, Professor of Orthopaedic Surgery

Low back pain is a major cause of disability throughout the world and is often a result of degenerative spine changes.

The lab is exploring associations between intradiscal cytokine expression levels and clinical outcomes after spinal surgery, particularly with respect to axial neck and low back pain.

Another major current research focus is to determine if co-culture of human mesenchymal stem cells will prevent human intervertebral disc cells from expressing an inflammatory phenotype.

Achieving spinal fusion is critical to a successful outcome after many types of spinal surgery. The lab has an interest in using animal models to study gene expression in the local environment after spinal fusion surgery.

From the Laboratory of Ryan Tomlinson, PhD, Assistant Professor of Orthopaedic Surgery

Bone is continually sensing and converting mechanical cues into biochemical signals, which subsequently direct and mediate both anabolic and catabolic processes in the skeleton.

As a result, new bone is formed at sites of high strain and removed in areas of low strain. This process, referred to as strain adaptive bone remodeling, enables bone to efficiently adapt to functional demands by generating bone where it is needed and eliminating bone that is underutilized – a process that has been shown to greatly increase the fatigue strength of bone.

Dr. Tomlinson's research focuses on characterizing the inflammatory signals generated immediately after skeletal loading that direct and organize the subsequent osteogenic processes. In one project, the lab is investigating the role of NGF-TrkA signaling in sensory nerves. Nearly all of the nerves in bone express TrkA, the high-affinity receptor for nerve growth factor (NGF).

Furthermore, sensory nerves blanket the surfaces of bone in a mesh-like network, a privileged location for the acquisition of mechanical signals.

Using both in vivo and in vitro methods, the lab has demonstrated that NGF is robustly expressed by mature osteoblasts in response to non-damaging mechanical loads. Inhibition of NGF-TrkA signaling impairs load-induced bone formation whereas administration of exogenous NGF increases relative bone formation rates.

These effects appear to be facilitated through altered Wnt/ β -Catenin signaling, which the lab is investigating by using mice that lack NGF in the osteoblast lineage. The lab also has identified a compound that may provide long-term activation of TrkA to increase load-induced bone formation without the painful side effects of NGF.

In related work, the lab is investigating the role of non-steroidal anti-inflammatory drugs (NSAIDs) on stress fracture risk and repair. In both clinical and preclinical investigation, the lab has clarified a link between overall NSAID usage and stress fracture risk.

Research in mice showed that NSAIDs may increase stress fracture risk through two independent mechanisms – diminished load-induced bone formation and decreased bone toughness. The lab also identified NSAIDs that can provide analgesia without affecting

stress fracture risk or repair. Upcoming work will involve using unbiased transcriptomics and proteomics to identify potential pharmaceutical targets for the next generation of musculoskeletal pain medication.

In total, the lab's research suggests that modulation of inflammatory signaling may be an attractive target for improving skeletal response to loading and reducing overall fracture risk.

From the Laboratory of Theresa Freeman, PhD, MS, Associate Professor of Orthopaedic Surgery

Dr. Freeman is working in the field of Plasma Medicine to develop therapeutic applications using cold (non-thermal) atmospheric plasmas (CAP) and cold plasma activated liquids (PAL). The generation of both ionized species and electric fields by CAP induces the generation of intracellular reactive oxygen and nitrogen species, which initiate signaling cascades that can stimulate multiple bioelectrochemical effects in tissues. Using CAP treatment, the lab has induced enhanced differentiation of mesenchymal cells, mouse limb growth and extracellular matrix calcification. Together these techniques could be used to promote regeneration of cartilaginous tissues and increase bone formation.

Dr. Freeman also is exploring how CAP treatment can be used to destroy biofilms on the surface of titanium implants and together with PAL be used to treat orthopaedic infections. CAP treatment may not only destroy the biofilm and kill the bacteria but modify the bacterial debris and make it more immunogenic to stimulate an immune response. The CAP treatment can be tuned to be used for both killing at high powers and stimulation of regeneration at lower power. Through these studies a better understanding of plasma/cell and tissue interactions can be discovered to increase

the potential medical applications of this technology, especially as viable clinical solutions to a wide range of orthopaedic issues.

Repair and regeneration of tissues after injury or wounding is an important area of study that impacts multiple diseases. In addition to plasma activation of these processes, Dr. Freeman is also studying how inhibition of a protein called Apoptosis signal regulated kinase (ASK1) can reduce tissue damage by decreasing cell death and pro-inflammatory cytokine production.

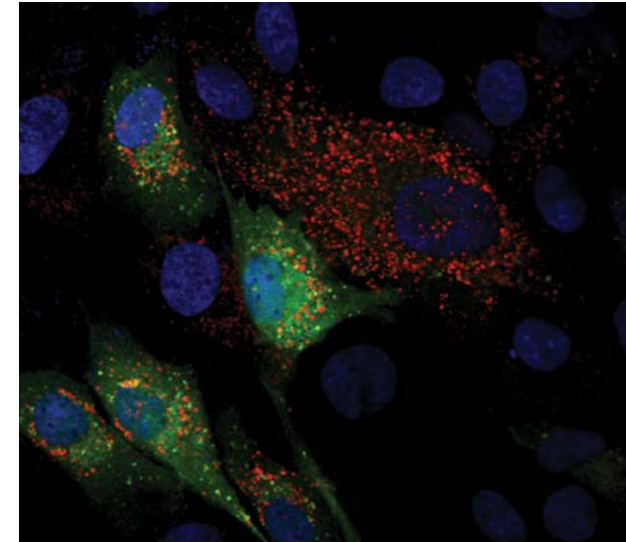
This will not only limit cartilage degeneration by reducing tissue destruction, but could also stimulate endogenous cells to activate repair cascades to generate a more robust healing/regenerative response.

Dr. Freeman has several collaborations investigating other aspects of tissue repair. In collaboration with Millicent Sullivan, PhD, from the University of Delaware, she studies non-viral gene delivery to promote fracture healing, and with Mý Mahoney, PhD, from the Jefferson Department of Dermatology and Cutaneous Biology, she explores the role of the epithelium in regeneration and wound healing.

From the Laboratory of Makarand V. Risbud, PhD, Professor of Orthopaedic Surgery, and Irving M. Shapiro, PhD, Professor of Orthopaedic Surgery

The intervertebral disc is a complex structure that separates opposing vertebrae and permits a range of motions allowing accommodation of high biomechanical forces on the spine.

Drs. Risbud and Shapiro study specific conditions that enhance disc cell survival as well as elucidating factors that dysregulate the local microenvironment and

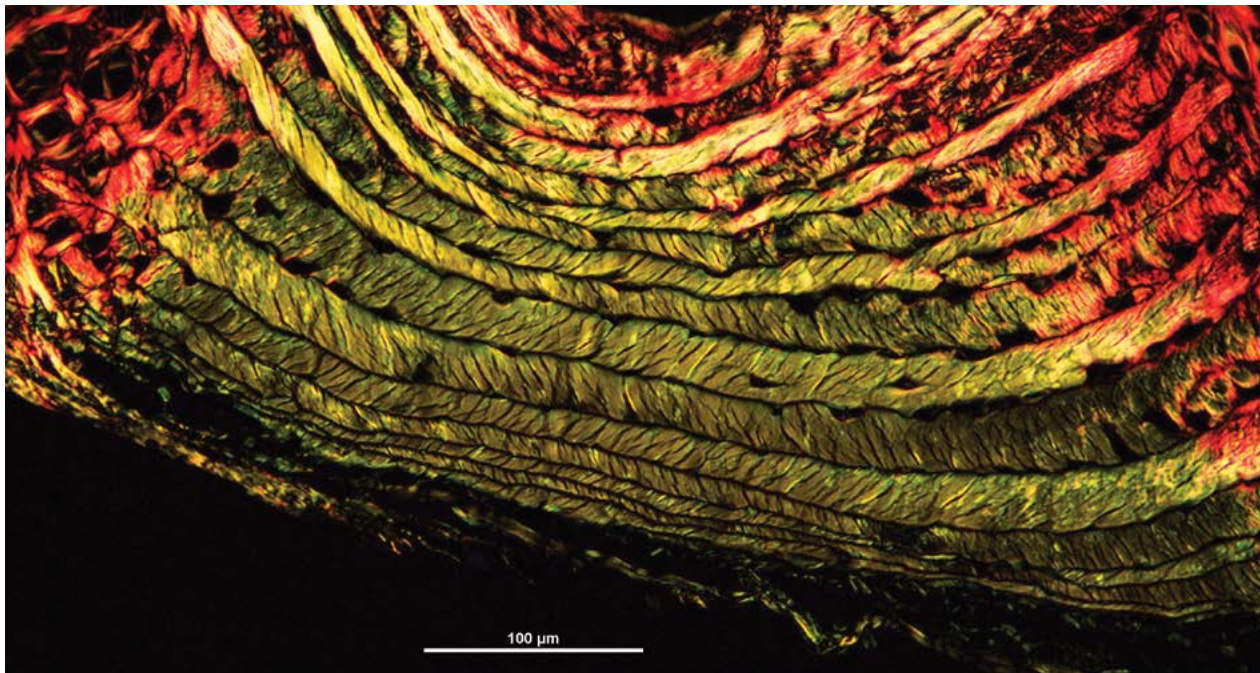


Nucleus Pulposus - Cells within the intervertebral disc.
Source: Makarand V. Risbud, PhD

promote degenerative disc disease. Intervertebral disc degeneration and associated low back and neck pain is a ubiquitous health condition that affects millions of people worldwide, and causes high incidence of disability and opioid addiction, and results in enormous medical and societal costs.

One ongoing project is the characterization of a mouse model of spontaneous, early onset disc degeneration. The lack of appropriate small animal models with spontaneous disease onset has impeded the ability to understand the pathogenetic mechanisms that characterize and drive the degenerative process.

The lab's work clearly demonstrates that the SM/J mouse strain recapitulates many salient features of human disc degeneration, such as compromised cell survival, loss of cell phenotype, hypertrophic differentiation of nucleus



Polarized microscopic image of Annulus Fibrosus. Source: Makarand V. Risbud, PhD

pulposus (NP) cells and extracellular matrix changes that lead to compromised biomechanical function. These mice represent a novel small animal model to understand pathogenesis of disc degeneration.

The lab is also focused on understanding the role of different molecules involved in homeostasis of intervertebral disc cells. The lab recently demonstrated for the first time that carbonic anhydrases are key contributors in regulating NP cell function and pH homeostasis. It was observed that the expression of both CA9 and 12 was dependent on HIF-1 activity in vitro and in vivo.

Both these enzymes played a critical role in generation of bicarbonate that maintains intracellular pH. Likewise, lab research has seen that an RNA binding protein, HuR, controls CA12 expression in NP cells in an HIF-1 independent manner and contributes to pH homeostasis.

In contrast to CA9 and 12, hypoxia sensitive CA3 does not participate in pH homeostasis but rather plays a role in antioxidant defense of cells and maintains their survival.

Another major focus of the laboratory has been to understand contribution of osmo-sensing protein tonicity-responsive enhancer-binding protein (TonEBP) in NP function.

Recent studies have shown that the activation of TonEBP occurs by non-osmotic stimuli, including proinflammatory molecules, in cells involved in immune response. However, whether inflammatory stimuli activate TonEBP in NP cells and whether TonEBP controls inflammation during disc degeneration is unknown.

The lab showed for the first time that some of the TNF response in NP cells was TonEBP dependent, implying the possibility of a novel drug target. However, therapeutic strategies targeting this transcription factor for treatment of disc disease must spare osmoprotective, prosurvival, and matrix homeostatic activities.

The lab has also shown that COX-2, a molecule traditionally thought to be only pro-inflammatory, is a TonEBP target and plays a cytoprotective and homeostatic role in NP cells for their adaptation to dynamically loaded hyperosmotic niches. These studies once again highlight the unique niche of the intervertebral disc and underscores the importance of basic research to further the understanding of this tissue.

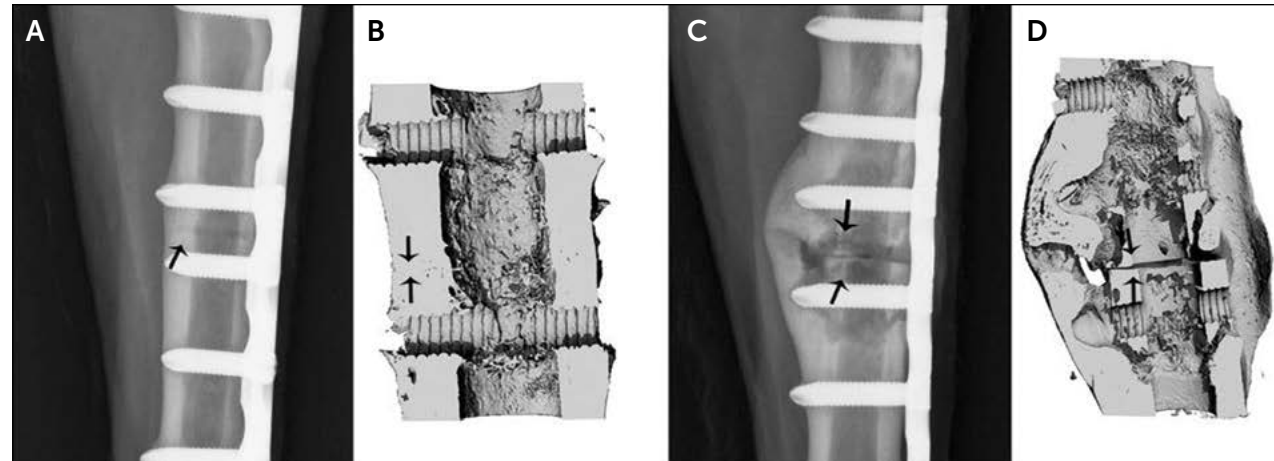
From the Laboratory of Andrzej Fertala, PhD, Professor of Orthopaedic Surgery

Increased tendon pain and tendon damage are clinically significant potential complications related to hyperlipidemia. Unlike the well-established pathogenesis associated with increased serum concentrations of total cholesterol (TC), triglycerides (TG), and low-density lipoprotein (LDL) in atherosclerotic cardiovascular disease, the role of hyperlipidemia in promoting tendon damage remains controversial and requires mechanistic clarity.

Various studies in humans indicate a possible association between hyperlipidemia and increased risk for tendon damage. Also, studies in various animal models have demonstrated a link between hyperlipidemia and significant alterations of the mechanical properties of tendons.

A recent study by Dr. Fertala and colleagues aimed to define the pathomechanisms of tendon damage by analyzing the consequences of excess cholesterol on the integrity of the fibrillar architecture of the tendon in an Achilles tendon rabbit-based model of hypercholesterolemia. The Achilles tendons from rabbits fed with normal-cholesterol (nCH) and high-cholesterol (hCH) diets were harvested and analyzed using histological, spectroscopic, biochemical, and biomechanical assays.

Histologically, hCH tendons and tenosynovium demonstrated hypercellular areas with increased numbers of macrophages infiltrating the tendon structure as compared to nCH tendons. While Oil red staining revealed lipid-rich deposits in hCH tendons, hybridization of tendon tissue with collagen-hybridizing-peptides demonstrated damage to the collagen fibers.



(A, B) Antibiotic covalent bonded to titanium implant. (C, D) Infected bone. Source: Noreen Hickok, PhD.

Fourier-transform infrared spectroscopy analyses of the tendons showed the presence of distinct peaks consistent with the presence of cholesterol ester.

The hCH tendons displayed regions of poor collagen content that overlapped with lipid-rich regions. The hCH tendons had a significant 4-fold increase in the collagen III:collagen I ratio as compared to nCH tendons. Tendons from the hCH rabbits showed poor biomechanical characteristics in comparison to control. The biomechanical changes were evident at the macro and the nano-level of tendon structure.

The study results support the hypothesis that high-cholesterol diets lead to a weakening of tendons via a mechanism that involves damage to the collagen fibrils. The finding opens a possibility for targeting lipid-binding sites on collagen molecules as a treatment strategy to avoid the harmful consequences hyperlipidemia may have on tendon structure, function and healing.

From the Laboratory of Noreen Hickok, PhD, Associate Professor of Orthopaedic Surgery

Dr. Hickok's research on orthopaedic infection focuses on interactions between pathogens and bone tissues and implant surfaces in order to allow eradication of bacteria. The lab's work spans the fields of bioengineering, tissue engineering, biochemistry and biology to develop translational products that can improve the outcome of implantations. Areas of investigation include:

- Permanently attaching antibiotics to implant surfaces. Her lab is testing these implants in pre-clinical models and further developing them for cancer patients who may be prone to infection due to chemotherapy.
- Prophylactic treatment of the spinal sheath that surrounds the spinal stabilization rod. Infections occur in as many as one in 20 elective spinal surgeries and one in 10 spinal surgeries resulting from traumatic injury. When activated by ultrasound, the spinal sheath would release high concentrations of antibiotics directly to the infection site.

- Biofilms within the joint fluid to combat septic arthritis. Infections of this kind are extremely dangerous and can travel through the bloodstream and infect other sites in the body. Removing the large fibrous bacteria-filled clots is often not enough to prevent septic arthritis from recurring, so Dr. Hickok's team is investigating the use of ultrasound-activated microbubbles of antibiotics to eliminate infections within the joint fluid.
- Research to learn how compromised oral health influences other degenerative conditions. Based on the lab's findings that dental and oral bacteria are present in osteoarthritis and degenerative disc disease samples, the lab is exploring through inflammatory reactions, the progression of those conditions.

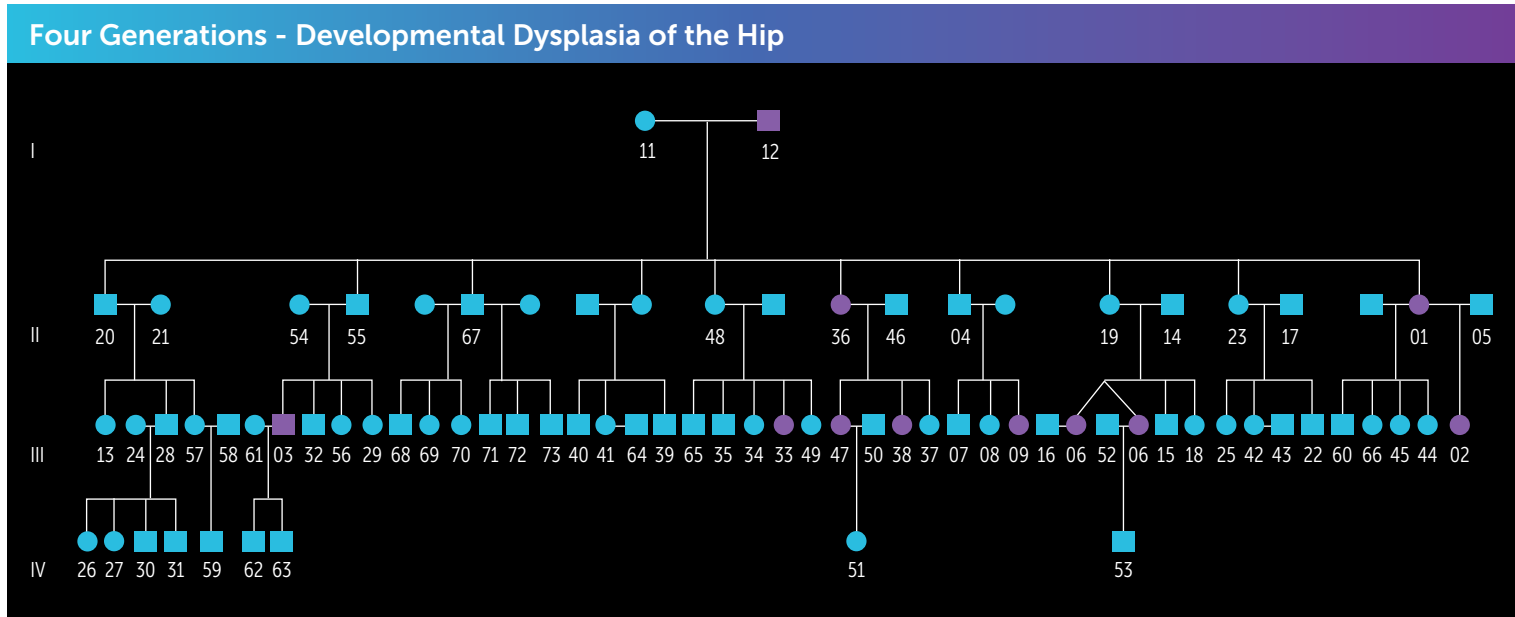
From the Laboratory of George Feldman, DMD, PhD, Research Assistant Professor of Orthopaedic Surgery

Developmental Dysplasia of the Hip (DDH), a debilitating condition characterized by incomplete formation of the bones of the hip joint, can lead to dislocation of the femur and crippling arthritis.

Research is aimed at identifying the genetic mutation(s) and developing a diagnostic DNA test to identify individuals at risk for this disorder. Dr. Feldman's studies of the DNA of a four-generation family have found a potentially harmful mutation in the gene encoding an important cell receptor, CX3CR1. In another family, a second potentially harmful mutation was found in the teneurin3 gene.

Both of these DNA changes are thought to delay the maturation of stem cells in forming the cartilage of the hip bone. Identification of these mutations may lay the foundation for an accurate diagnostic test in newborns, while treatment of DDH would prevent hip dysplasia from developing into osteoarthritis.

A second focus of the lab is to find a cause-based treatment to remedy the morbid side effects of nitrogen containing bisphosphonates (NBPs), which are used to prevent osteoporosis and to stop the spread of metastatic cancer to bone. NBPs in high doses cause fracture of the femur and osteonecrosis of the jaw bone. The lab is developing a cause-based drug and local delivery system to prevent these side effects while allowing bisphosphonates to continue their systemic bone-sparing actions.



Source: George Feldman, DMD, PhD

CLINICAL TRIALS

FUNDED CLINICAL TRIAL

INVESTIGATOR(S)

A Phase 2b, Randomized, Double-Blind, Placebo-Controlled Study to Evaluate the Safety and Efficacy of a Staphylococcus aureus 4-antigen Vaccine (SA4Ag) in Adults Undergoing Elective Posterior Instrumented Lumbar Spinal Fusion. <i>Pfizer</i> (01/2015–ongoing)	Christopher Kepler, MD, MBA; Alexander R. Vaccaro, MD, PhD, MBA
Post Market Clinical Follow-Up Study of the Titan Reverse Shoulder System Used in Primary or Revision Total Shoulder Arthroplasty. <i>Zimmer Biomet</i> (06/2014–ongoing)	Surena Namdari, MD; Matthew L. Ramsey, MD
A Retrospective and Prospective Data Collection Study of the TITAN Modular Total Shoulder System Integra (03/2015–ongoing)	Surena Namdari, MD; Matthew L. Ramsey, MD
Retrospective and Prospective Clinical Outcomes of the Zimmer Nexel Total Elbow. <i>Zimmer Biomet</i> (06/2015–ongoing)	Surena Namdari, MD; Matthew L. Ramsey, MD
Prospective Post Market Clinical Follow-Up Study of the Zimmer Trabecular Metal Humeral Stem. <i>Zimmer Biomet</i> (04/05/2012–ongoing)	Joseph A. Abboud, MD; Surena Namdari, MD
Post-Market Clinical Follow-Up Study of the Zimmer Vivacit-E Highly Crosslinked Polyethylene Liner Used with the Continuum Acetabular Shell. <i>Zimmer Biomet</i> (10/1/2013–ongoing)	Javad Parvizi, MD; William V. Arnold, MD, PhD
Prospective Post-Market Clinical Follow-Up of the Zimmer Biomet Trabecular Metal Reverse; Shoulder System. <i>Zimmer Biomet</i> (08/2011–ongoing)	Bradford S. Tucker, MD; Luke S. Austin, MD; Matthew D. Pepe, MD
Prospective Clinical Evaluation Treating Subchondral Bone Marrow Lesions with Subchondroplasty for Pain Relief. <i>Knee Creations LLC</i> (03/15/2012–ongoing)	Steven Cohen, MD
Trabecular Metal Femoral Hip Stem Used within the Zimmer Biomet Hip Registry. <i>Zimmer Biomet</i> (02/09/2012–ongoing)	Carl Deirmengian, MD
Prospective Post-Market Clinical Follow-up of the Zimmer Biomet Trabecular Metal™ Reverse Shoulder System. <i>Zimmer Biomet</i> (08/23/2011–ongoing)	Matthew L. Ramsey, MD; Charles L. Getz, MD
Ascension Radial Head. <i>Integra Life Sciences</i> (09/2012–ongoing)	Charles L. Getz, MD; Matthew L. Ramsey, MD; Joseph A. Abboud, MD
Multi-Center Trial of the Sidus Stem Free Shoulder Arthroplasty System. <i>Zimmer Biomet</i> (07/18/2013–ongoing)	Charles L. Getz, MD; Joseph A. Abboud, MD
Post-Market Study of the Stryker Orthopaedics Triathlon TS Total Knee System. <i>Stryker</i> (04/01/2012–ongoing)	Fabio R. Orozco, MD; Alvin C. Ong, MD
Persona Outcomes Knee Study (POLAR). <i>Zimmer Biomet</i> (03/01/2013–ongoing)	Matthew S. Austin, MD
Retrieval of Discarded Surgical Tissue. <i>National Disease Registry Institute</i> (01/12/2004–ongoing)	James J. Purtill, MD; William J. Hozack, MD; Richard H. Rothman, MD, PhD
Retrospective and Prospective Data Collection Study of the TITAN Modular Total Shoulder System (TSS) <i>Integra</i> (08/2014–present)	Surena Namdari, MD; Matthew Ramsey, MD; Joseph Abboud, MD; Mark Lazarus, MD; Gerald Williams, MD; Charles Getz, MD
Prospective Post Market Clinical Follow-Up Study of the Zimmer Trabecular Metal™ Total Ankle System. <i>Zimmer Biomet</i> (08/2014–present)	Steven Raikin, MD; David Pedowitz, MD

FUNDED CLINICAL TRIAL

INVESTIGATOR(S)

Triathlon Tritanium Knee Outcomes Study. <i>Stryker</i> (4/2014–present)	Fabio Orozco, MD; Alvin Ong, MD; Zachary Post, MD
Post Market Study of the Stryker Orthopaedics Triathlon PKR Knee System. <i>Stryker</i> (11/2013–Present)	Fabio Orozco, MD; Alvin Ong, MD; Zachary Post, MD
Clinical Study Protocol for the Investigation of the Simplify Cervical Artificial Disc. <i>Simplify Medical</i> (04/2016–present)	Kristen Radcliff, MD; Barrett Woods, MD
A Prospective, Multi-Center Study of Instrumented Posterolateral Lumbar Fusion (PLF) with OsteoAMP® to Evaluate Long-Term Safety and Efficacy in Patients Requiring 1-2 Level Instrumented PLF. <i>Bioventus, LLC</i> (01/2016–present)	Barrett Woods, MD; Kristen Radcliff, MD
Use of Autologous Adipose-Derived Stromal Vascular Fraction to Treat Osteoarthritis of the Knee; A Controlled, Randomized, Double Blinded Trial. <i>GID Group</i> (04/2016–present)	Bradford Tucker, MD
A Phase 2b/3, Double-blind, Randomized, Placebo-Controlled, Multi-Center Study to Assess the Efficacy and Safety of VX-210 in Subjects with Acute Traumatic Cervical Spinal Cord Injury. <i>Vertex Pharmaceuticals, Incorporated</i> (04/2016–present)	Alexander Vaccaro, MD, PhD, MBA; Chris Kepler, MD; Greg Schroeder, MD; Alan Hilibrand, MD
One Stage Versus Two Stage for Periprosthetic Hip and Knee Infection. <i>Orthopaedic Research and Education Foundation</i> (05/2016–present)	Javad Parvizi, MD; Matthew Austin, MD, Greg Diermengian, MD
Evaluation of Post-Operative Pain Following Primary Total Knee Arthroplasty with Intraoperative Subanesthetic Ketamine Administration and Spinal Anesthesia. <i>Sharpe-Strumia Research Foundation</i> (06/2016–current)	Eric Levicoff, MD; Robert Good, MD
Clinical Outcomes Reporting Study. <i>Stryker Orthopaedics</i> (10/2013–current)	Javad Parvizi, MD; William Hozack, MD; Richard Rothman, MD; Matthew Austin, MD; Gregory Diermengian, MD; James Purtill, MD; Alvin Ong, MD; Fabio Orozco, MD; Zachary Post, MD; Eric Smith, MD; Robert Good, MD; Eric Levicoff, MD; Peter Sharkey, MD
Manipulation Under Anesthesia (MUA) to Treat Postoperative Stiffness after Total Knee Arthroplasty: A Multi-Center Randomized Clinical Trial. <i>The Knee Society</i> (09/2016–current)	Matthew Austin, MD; Javad Parvizi, MD; Antonia Chen, MD; Gregory Diermengian, MD; James Purtill, MD; William Hozack, MD; Richard Rothman, MD
The Effect of Cytokine Levels on the Clinical Outcomes in Patients Undergoing Anterior Cervical Discectomy and Fusion. <i>Orthopaedic Research and Education Foundation</i> (07/2016–current)	Gregory Schroeder, MD
Short, Medium, and Long Term Survivorship of the Attune Primary Total Knee Prostheses. <i>DePuy Synthes</i> . (09/2013–current)	Andrew Star, MD
Dynesys Post Market Clinical Outcome Study. <i>Zimmer Biomet</i> (06/2014–current)	Michael Gratch, MD
Joint Registry – General Outcomes DePuy Tracking System (DOTS). <i>DePuy Synthes</i> . (08/2010–current)	Andrew Star, MD
MIS-ReFRESH – Multi-Center, Partially Randonmized, Controlled Trila of MIS Robotic Versus Freehand in Short Adult Degenerative Spinal Fusion Surgeries. <i>Mazor Robotics, Ltd.</i> (09/2016–current)	Victor Hsu, MD
A Prospective, Single Blinded, Multi-Center, Randomized, Controlled, Pivotal Study to Assess the Safety and Effectiveness of the Inspace Device for Treatment of Full Thickness Massive Rotator Cuff Tears. <i>Orthospace, Ltd.</i> (01/2016–current)	Joseph Abboud, MD
Influence of Lateralization on Outcomes After Reverse Arthroplasty? A Randomized Controlled Trial. <i>DJO Surgical</i> (10/2016–current)	Joseph Abboud, MD; Surena Namdari, MD; Gerald Williams, MD

CLINICAL TRIALS

FUNDED CLINICAL TRIAL

INVESTIGATOR(S)

Investigator Driven: FlexiGraft Rotator Cuff Study. <i>Arthrex, Inc.</i> (09/2016–current)	Joseph Abboud, MD; Surena Namdari, MD; Charles Getz, MD
Arthrex Shoulder Arthroplasty Registry Protocol. <i>Arthrex, Inc.</i> (09/2016–current)	Joseph Abboud, MD; Surena Namdari, MD; Charles Getz, MD
A Prospective, Randomized, Multi-Center Study to Evaluate the Safety and Efficacy of Arthrex Eclipse Shoulder Arthroplasty System. <i>Arthrex, Inc.</i> (04/2016–current)	Joseph Abboud, MD; Surena Namdari, MD; Charles Getz, MD
Tornier Shoulder Outcomes Study. <i>Tornier, Inc.</i> (10/2014–current)	Joseph Abboud, MD; Mark Lazarus, MD; Gerald Williams, MD; Surena Namdari, MD
Pyrocarbon IDE study. <i>Tornier, Inc.</i> (03/2016–current)	Joseph Abboud, MD; Surena Namdari, MD; Charles Getz, MD; Mark Lazarus, MD
Post-Market Study of Robotic-Arm Assisted Total Knee Arthroplasty. <i>Stryker, Corp.</i> (7/2016–current)	Antonia Chen, MD; William Hozack, MD; Fabio Orozco, MD
A Post-Market, Prospective, Multi-Center, Open-Label, Single Arm Clinical Evaluation of Integra Cadence Total Ankle System in Primary Ankle Joint Replacement. <i>Integra</i> (10/2016–present)	David Pedowitz, MD
Thoracolumbar Burst Fractures (AOSpine A3, A4) in Neurologically Intact Patients: An Observational Multi-Center Cohort Study Comparing Surgical Versus Non-Surgical Treatment. <i>AO Foundation</i> (10/2016–current)	Alexander Vaccaro, MD, PhD, MBA; Chris Kepler, MD, MBA
Prospective, Multi-Center, Randomized Concurrently Controlled Trial to Evaluate the Safety and Effectiveness of the Altum Pedicle Osteotomy System for Use in Lumbar Spinal Stenosis <i>Innovative Surgical Designs</i> (08/2017–current)	Mark Kurd, MD
Longitudinal Outcomes Study of the Subchondroplasty Procedure in the Foot/Ankle. <i>Zimmer Biomet</i> (09/2017–current)	David Pedowitz, MD
Efficacy of Amniotic Tissue (CLARIX™100 & CLARIX™ CORD 1K) in Pain Reduction and Improvement of Function in the Low Back & Leg Pain in Dissectomy Patients. <i>TissueTech</i> (07/2015–current)	D. Greg Anderson, MD
A Phase 2b, Randomized, Double-Blind, Placebo-Controlled Study to Evaluate the Safety and Efficacy of a Staphylococcus aureus 4-antigen Vaccine (SA4Ag) in Adults Undergoing Elective Posterior Instrumented Lumbar Spinal Fusion. <i>Pfizer</i> (09/2017–ongoing)	Guy Lee, MD
Efficacy of the BioWick SureLock Implant for the Reattachment of Soft Tissue to Bone in Subjects Undergoing Rotator Cuff Repairs. <i>Zimmer Biomet</i> (07/2017–current)	Surena Namdari, MD; Charles Getz, MD; Joseph Abboud, MD
A Post-Market, Prospective, Non-Randomized, Multi-Center, Open-Label Clinical Evaluation of the Integra Titan Modular Shoulder System 2.5 for Primary Shoulder Joint Replacement. <i>Integra</i> (03/2017–current)	Matthew Ramsey, MD; Surena Namdari, MD
Can Intravenously Administered Indocyanine Green Visualize Rotator Cuff Vascularity? <i>Stryker</i> (07/2017–current)	Matthew Ramsey, MD
A Multi-Center, Prospective, Comparative Study of Anterior Versus Posterior Surgical Treatment for Lumbar Isthmic Spondylolisthesis. <i>AO Foundation</i> (11/2016–current)	Alexander Vaccaro, MD, PhD, MBA; Chris Kepler, MD; Gregory Schroeder, MD
A Retrospective Study of the Navio Robotic-Assisted Surgical System. <i>Smith and Nephew</i> (07/2017–current)	Jess Lonner, MD

FUNDED CLINICAL TRIAL

INVESTIGATOR(S)

Intermediate Clinical and Radiographic Outcomes of Isolated Patellofemoral Arthroplasty and Modular Bicompartamental Knee Arthroplasty. <i>Zimmer Biomet</i> (09/2017–current)	Jess Lonner, MD
A Multi-Center, Prospective, Randomized, Subject and Evaluator Blinded Comparative Study of Nerve Cuffs and Avance Nerve Graft Evaluating Recovery Outcomes for the Repair of Nerve Discontinuities (RECON). <i>Axogen</i> (05/2017-current)	Asif Ilyas, MD; Chris Jones, MD; Fred Liss, MD; Michael Rivlin, MD; Jonas Matzon, MD; Charles Leinberry, MD; Mark Wang, MD
The Use of Barbed Sutures in Total Hip Arthroplasty: A Prospective, Randomized, and Controlled Clinical Trial. <i>Johnson and Johnson</i> (12/2015–current)	Javad Parvizi, MD
Lateral Ankle Ligament Reconstruction with Internalbrace Augmentation: A Prospective Randomized Study. <i>Arthrex, Inc.</i> (09/2017–current)	Steven Raikin, MD; David Pedowitz, MD
A Multi-Center, Randomized, Pivotal Study Evaluating AMPLEX Compared To Autogenous Bone Graft in Subjects Indicated for Arthrodesis Surgery Involving the Hindfoot or Ankle. <i>Ferring Pharmaceuticals</i> (03/2017–current)	Steven Raikin, MD
A Prospective, Controlled, Multi-Center, Post-Approval Trial to Evaluate the Long-term Safety and Effectiveness of AUGMENT Bone Graft Compared to Autologous Bone Graft as a Bone Regeneration Device in Foot and Ankle Fusions. <i>Wright</i> (07/2017–current)	Steven Raikin, MD
Use of Cooled Radiofrequency for the Treatment of Hip Pain Associated with OA of the Hip Compared to Intra-Articular Steroid Injections. <i>Halyard Health</i> (05/2017–current)	David Stolzenberg, DO; Joshua Armstrong, DO; Arjun Saxena, MD; Ryan Pfeifer, DO
Evaluating the Efficacy of Bactisure Wound Lavage in Cleansing Orthopedic Surgical Wounds. <i>Zimmer Biomet</i> (08/2017–current)	Javad Parvizi, MD; Paul Max Courtney, MD
A Pivotal Study Comparing Two Injections of MONOVISC to Two Injections of Saline in Patients with Osteoarthritis of the Hip (15-MVH-01). <i>Mitek DePuy Synthes</i> (09/2017–current)	Chris Mehallo, DO; Michael Ross, MD; Adam Chrusch, MD; Tricia Beatty, DO; Peter Vitanzo, MD; Mark Harwood, MD; Barry Kenneally, MD; Joshua Okon, MD; Lindsey Szymaszek, DO; John Luksch, DO
A Multi-Center, Open-Label, Prospective Study of SpinalStim (MOP-SS) as Adjunctive Care Following Lumbar Fusion Surgery. <i>Orthofix</i> (06/2017–current)	Kris Radcliff, MD; Barrett Woods, MD
Clinical Study Protocol for the Investigation of the Simplify Cervical Artificial Disc Two Level. <i>Simplify Medical</i> (09/2017–current)	Kris Radcliff, MD; Barrett Woods, MD
A Prospective, Post-Market, Multi-Center Evaluation of the Clinical Outcomes of the Trident II Acetabular Shell. <i>Stryker</i> (09/2017–current)	Fabio Orozco, MD
Prospective Post Approval Clinical Follow-Up Study of the Commercially Available U2 Knee System. <i>United Orthopedic Corporation</i> (7/2018–current).	Arjun Saxena, MD
Post-Market, Randomized, Open-Label, Multicenter, Study to Evaluate the Effectiveness of Closed Incision Negative Pressure Therapy Versus Standard of Care Dressings in Reducing Surgical Site Complications in Subjects with Revision of a Failed Total Knee Arthroplasty (PROMISES). <i>Acelity</i> (8/2018–current).	Paul Courtney, MD; Arjun Saxena, MD; Javad Parvizi, MD
A Randomized, Double-Blind, Placebo-Controlled, Multi-Center, Phase 3 Study to Determine the Efficacy of TG-C in Subjects with Kellgren and Lawrence Grade 2 or 3 Osteoarthritis of the Knee. <i>TissueGene</i> (8/2018-current).	Javad Parvizi, MD; Marc Harwood, MD
Prospective, Non-Interventional, Long-Term Follow-Up Study for Subjects who Received Standard of Care, CLARIX™ 100, or CLARIX™ CORD 1K during Discectomy. <i>TissueTech</i> (7/2018-current).	Greg Anderson, MD

CLINICAL TRIALS

FUNDED CLINICAL TRIAL

INVESTIGATOR(S)

A Prospective, Multi-Center, Randomized Concurrently Controlled Trial to Evaluate the Safety and Effectiveness of the Altum® Pedicle Osteotomy System for use in Lumbar Spinal Stenosis. <i>Innovative Surgical Designs</i> (3/2018-current).	Mark Kurd, MD
A Prospective, Non-Comparative, Multi-Center, Post-Market Clinical Study to Evaluate the Safety and Performance of PEEK-OPTIMA™ HA Enhanced Interbody Cages for the Treatment of Degenerative Disc Disease and Spondylolisthesis in the Lumbar Spine. <i>Invibio, LTD</i> (8/2018-current)	Mark Kurd, MD
An Assessment of P-15L Bone Graft in Transforaminal Lumbar Interbody Fusion with Instrumentation. <i>Cerapedics</i> (6/2018-current).	Alexander Vaccaro, MD, PhD, MBA; Gregory Schroeder, MD
Randomized, Controlled Trial of Posterior C1-2 Fusion Versus Bracing Alone for Treatment of Type II Odontoid Process Fractures in the Elderly. CSRS grant (3/2018-current).	Chris Kepler, MD, MBA; Alexander Vaccaro, MD, PhD, MBA; Alan Hilibrand, MD, MBA; D. Greg Anderson, MD; Mark Kurd, MD; Gregory Schroeder, MD
A Multi-Center, Open-Label, Prospective Study of CervicalStim Device™ as Adjunctive Care following Cervical Fusion in Subjects with Degenerative Disc Disease (DDD). <i>Orthofix</i> (3/2018-current)	Mark Kurd, MD; Barrett Woods, MD
A Randomized Controlled Trial Comparing Intraoperative Surgeon-Performed and Anesthesiologist-Performed Adductor Canal Blockade after Primary Total Knee Arthroplasty. Sharpe-Stumia Research Foundation. (5/2018-current).	Jess Lonner, MD; Eric Levicoff, MD; Robert Good, MD
Prospective Randomized Controlled Double-Blinded Trial Comparing Oxycodone, Ibuprofen and Acetaminophen after Wide Awake Hand Surgery. American Foundation for Surgery of the Hand Clinical Grant (8-2017-current).	Asif Ilyas, MD



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