



Jefferson®



ORTHOPAEDIC OUTCOMES & RESEARCH



HOME OF SIDNEY KIMMEL MEDICAL COLLEGE



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A MESSAGE FROM THE CHAIR

Dear Colleagues,

I am pleased to introduce our latest **Orthopaedic Outcomes & Research** report, which highlights the many advances in clinical care and research made by the staff of Jefferson's Department of Orthopaedic Surgery.

"Teamwork" is a word that comes to mind as I review the accomplishments of our combined team of orthopaedic surgeons, scientists and other clinical-care experts from Rothman Institute at Jefferson and The Philadelphia Hand Center at Jefferson. Our lineup was made even stronger last year by the merger of Jefferson and Abington Hospital, an expansion that extended our reach into the Philadelphia region even further and reinforced our standing as one of the strongest orthopaedic programs in the country.

You'll notice on the pages ahead some striking images of athletes, which I believe symbolize the determination, focus and grit of both our staff and patients. Outstanding results earned Jefferson's Department of Orthopaedic Surgery a 2016 national ranking of No. 7 by *U.S. News & World Report*, the highest showing of any orthopaedic program in the Philadelphia region. On top of that honor, Jefferson was the first hospital in the nation to be awarded Advanced Certification for Total Hip and Total Knee Replacement by the Joint Commission.

Just as important is the positive feedback we get every day from patients who depend on us to get their lives moving again. We count among our patients professional athletes whose job it is to win, but equally inspiring to our staff are the ordinary men and women who work hard, along with us, to regain their function and strength.

This annual **Orthopaedic Outcomes & Research** report provides a look at the many ways that Jefferson Health excels in orthopaedics. Our team is committed to delivering the highest quality of care, while also promoting research that is leading to new approaches for surgery and nonoperative therapy. Last year my colleagues presented or published more than 225 papers, reporting on important findings that already are enhancing the care of our patients.

In the pages ahead you'll read about some of that exciting work by researchers in the specialties of spine, hip and knee, foot and ankle, hand and wrist and shoulder and elbow. You'll also get a glimpse at laboratory discoveries by Jefferson scientists that are furthering the understanding of orthopaedic diseases and injuries and pointing the way to new treatments.

I invite you to learn more about our clinical services by going to our website, Jefferson.edu/orthopedic. To refer a patient please call **215-503-8888** or have your patient call **1-800-JEFF-NOW**.

I wish you a happy and successful New Year filled with many memorable moments.



Alexander R. Vaccaro, MD, PhD, MBA
Richard H. Rothman Professor and Chair
Department of Orthopaedic Surgery
Jefferson Health
Sidney Kimmel Medical College at Thomas Jefferson University

SHEER ATHLETICISM

AN OVERVIEW

Lessons taught on the playing field inspire much of what we do at Jefferson's Department of Orthopaedic Surgery, which is why we chose the theme *Sheer Athleticism* for this year's *Orthopaedic Outcomes & Research* report. A commitment to individual excellence, respect for teamwork and belief in establishing ambitious goals for ourselves and our patients make for an orthopaedic program that meets the highest standards for clinical care and research.

The overarching game plan for all our patients, whether an injured athlete or someone sidelined from an active lifestyle, is to restore optimal function and a sense of well-being. We help our patients return to work pain free, pursue physical activities that give them pleasure, and remain engaged with friends and family, no matter where they are on the age spectrum.

Jefferson's Department of Orthopaedic Surgery – which includes specialists from Rothman Institute at Jefferson and The Philadelphia Hand Center at Jefferson – has a well-earned reputation for clinical excellence, earning the No. 7 spot on *U.S. News & World Report's* ranking of best orthopaedic programs in the country.

Jefferson is also a leader in the field of orthopaedic research. In 2016 our research team published 225 papers in top medical journals and made 500 presentations at leading medical and scientific conferences in the U.S. and abroad.

Clinician researchers are investigating new surgical techniques and materials and studying how to further reduce surgical complications and enhance postoperative recovery. Patients have the opportunity to participate in clinical trials, but even if they choose not to, they still benefit from the research-informed care that is part of the fabric of major academic centers such as Jefferson.

In the laboratory, Jefferson researchers are exploring the underlying mechanisms of musculoskeletal diseases and discovering ways to improve healing and reduce scarring. Our scientists work closely with clinicians so that research findings get translated into medical and surgical practice.

Jefferson researchers also make important, forward-thinking contributions to the field of healthcare economics. Their findings are adding to the national dialogue on how to deliver first-rate care at the best possible price.





Among the many research developments in orthopaedics at Jefferson over the past year:

- A team of **hip and knee** specialists developed a mobile app that surgeons can use to calculate a patient's risk for venous thromboembolism following joint replacement and identify the ideal anticoagulation therapy for that patient.
- **Spine** researchers found that the risk for revision surgery is reduced when surgeons extend a multilevel posterior cervical decompression and fusion to T1, rather than stopping a long construct at C7.
- **Foot and ankle** surgeons found that using platelet-rich plasma to aid with incision healing after total ankle replacement did not result in fewer complications for patients.
- **Shoulder and elbow** clinicians looked at the question of whether older patients with a proximal humerus fracture receive differing care depending on the training of the doctor who cares for them.
- **Hand and wrist** researchers found that X-rays may not tell the whole story when it comes to patients with thumb basilar joint osteoarthritis.

More details on those studies and others are found on the pages ahead. Read on to learn how the attributes of *Sheer Athleticism* – focus, commitment, goal-oriented – are at work every day at Jefferson.

JEFFERSON HEALTH ORTHOPAEDICS: BY THE NUMBERS

Joint Replacement Surgeries:

12,833

Foot and Ankle Surgeries:

3,016

Shoulder and Elbow Surgeries:

4,772

Sports Medicine:

8,608

Hand and Wrist Surgeries:

16,601

Trauma:

1,380

Spine Surgeries:

4,328

Musculoskeletal Oncology Cases:

377

By the numbers: September 2015 - August 2016. Source: Jefferson internal data





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

Jefferson's orthopaedic spine specialists are leaders in both the study and treatment of spinal injuries and degenerative disease, including spinal cord injuries, spinal deformity, spondylotic stenosis and myelopathy, fractures, and tumors.

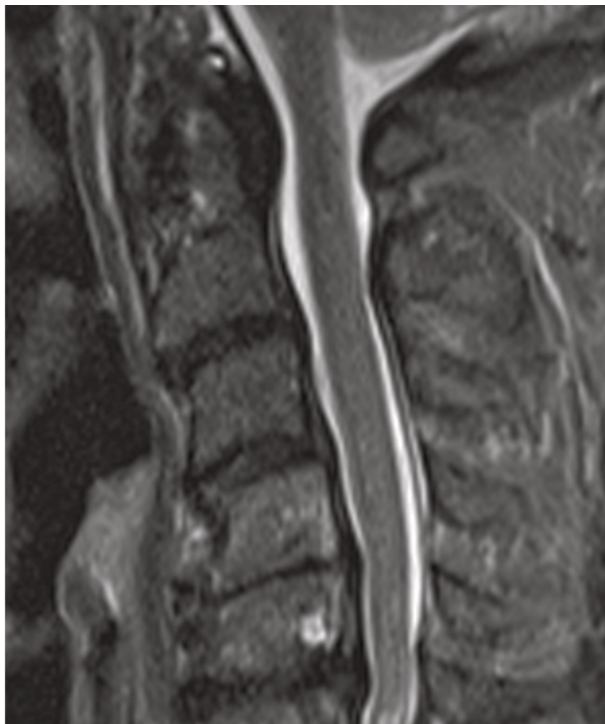
Because Jefferson is a designated Level 1 Trauma Center and a federally designated Regional Spinal Cord Injury Center, patients with spinal injuries are surrounded by multiple layers of expertise. Many spine patients in an acute situation are transferred to Jefferson because of its experience with complex cases.

All patients, whether emergency or not, benefit from the spine team's focus on providing a full continuum of care, from diagnosis to treatment planning to rehabilitation. The team's commitment to clinical and basic science research means that patients benefit from the latest findings on surgical techniques as well as nonsurgical management of pain, stiffness and other symptoms.

Here is a summary of two studies published recently by the spine team.

Comparing the Treatment Algorithm and Complications for Patients Undergoing an Anterior Cervical Discectomy and Fusion at a Physician-Owned Specialty Hospital and a University-Owned Tertiary Care Hospital

Over the past 10 years there has been a significant increase in the number of physician-owned specialty hospitals and ambulatory surgery centers in the U.S. The effects of these facilities on patient care and healthcare utilization have been the subject of significant debate in the scientific literature and federal and state legislatures.



Sagittal MRI of Spine



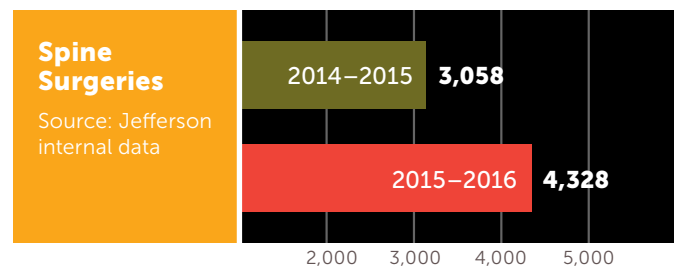
X-rays of a patient undergoing a posterior cervical fusion.

Physician-owned specialty hospitals are commonly designed to treat a narrow group of patients with similar pathology, thus allowing the entire hospitalization to be tailored to the needs of a select pool of patients. That model of care, which is sometimes used in orthopaedics, has been shown to increase patient and provider satisfaction and to decrease the rate of early complications. Physician-owned specialty hospitals may also lead to a decrease in per-patient medical expenditures because such hospitals receive substantially less reimbursement per diagnosis-related group (DRG) than large tertiary care centers.

On the other hand, the ownership stake creates a financial conflict of interest for physicians. Prior research has shown that the opening of a physician-owned specialty hospital is associated with an increase in the total number of surgeries performed in the area, though it's not clear whether the increase is due to pent-up demand or overutilization of surgery.

There is a growing demand in the U.S. to deliver healthcare services in the most cost-effective setting as possible while optimizing outcomes for patients. To help further the discussion, a Jefferson team led by Gregory Schroeder, MD, conducted a case-control study to compare the treatment algorithm and complication rate for patients who underwent an anterior cervical discectomy and fusion (ACDF) at a physician-owned specialty hospital compared to patients who underwent the same surgery at a university-owned tertiary hospital.

Each of the 77 patients who had instrumental ACDF at the specialty hospital between March 2011, and December 2014, was matched with two similar cases performed at the university hospital (154 patients in that group). Outcomes were then compared.



Among the key findings reported in the *American Journal of Medical Quality*:

- The median time between the onset of symptoms and surgery was shorter for patients who had surgery at the tertiary care center than for patients operated on at the physician-owned specialty hospital (26.7 weeks versus 32.7 weeks), but the time between when patients decided they wanted surgery and the surgery itself was shorter at the specialty hospital.
- A higher percentage of patients at the specialty hospital attempted nonoperative treatments, such as physical therapy, oral anti-inflammatory drugs and epidural steroid injections, compared to the tertiary care center.
- The complication rate and length of stay did not differ between the two settings.

"As there is an increased awareness of the scarcity of healthcare resources in the U.S., the results of the current study are paramount to future discussion about the merits of physician-owned specialty hospitals," the researchers wrote. They noted that in 2012 the Medicare reimbursement for the DRG 473 – cervical spine fusion without a complicating or comorbid condition – was \$16,486.21 for the tertiary hospital in the study, compared to \$12,021.53 paid to the specialty hospital. That is a 37% difference.

The researchers cautioned that the study did not examine long-term outcomes for patients to determine if there were differences resulting from where the surgery was performed. Jefferson investigators are conducting more research to consider the issue.

Is It Necessary to Extend a Multilevel Posterior Cervical Decompression and Fusion to the Upper Thoracic Spine?

Multilevel posterior cervical decompression and fusion is a common procedure for patients with cervical spondylotic myelopathy. While the neural elements can often be decompressed adequately with decompression and fusion extending down to C7, many surgeons elect to extend the fusion into the upper thoracic spine rather

than stopping a long construct at the cervicothoracic junction. To date there is a paucity of literature to help guide the surgeon in choosing the caudal level of a multilevel posterior cervical fusion so that the surgery works as intended and the need for revision surgery is reduced.

Surgery around the cervicothoracic junction presents a unique set of challenges to the spine surgeon. The alignment of the spine changes from cervical lordosis to thoracic kyphosis. There is also a difference in the mobility of the subaxial cervical spine and the upper thoracic spine. The abrupt change in mobility of the spine may increase the risk of traumatic or degenerative pathology at the cervicothoracic junction.

Jefferson researchers, led by Gregory Schroeder, MD, conducted a study to determine if there is a difference in the revision rate in patients who undergo a multilevel posterior cervical fusion ending at C7, T1 or T2-T4.

A total of 212 patients with an average follow-up of 49.8 months were included in the retrospective study. There were 81 patients in the C7 group; 101 in the T1 group; and 30 in the T2-T4 group. The patients had all been operated on by one of seven fellowship-trained spine surgeons at a single practice between January 2008 and September 2013.

The revision rate for the entire study group was 28.8%. Revisions were more common in the C7 group (37.7%) and the T2-T4 group (40%) than in the T1 group (18.7%). There was no difference in the reason for revision surgery among the three groups.

When additional variables were taken into consideration, patients whose fusion stopped at C7 were 2.29 times more likely to need revision surgery than patients in the T1 group, but no difference between stopping at T1 and T2-T4 was identified.

"Multilevel posterior cervical fusion should be extended to T1 because stopping a long construct at C7 increases the rate of revision," the researchers reported in *Spine*.

Based on the findings, Jefferson spine surgeons now extend almost all posterior cervical fusions to T1.





JOINT REPLACEMENT

SERVICES

Joint Revision Surgery

Hip and knee replacement

Adult joint reconstruction

Partial knee replacement

Treatment of hip and knee disorders in young adults

Rapid-recovery surgery

Computer-assisted surgery

Pelvic reconstruction

Pelvic osteotomy and hip-impingement surgery

Joint preservation procedures

Jefferson's joint replacement program is one of the busiest in the country, attracting patients through its reputation for excellent surgical outcomes and dedication to returning patients to their lives as quickly as possible. Last year the department performed more than 12,000 primary or revision hip and knee arthroplasties.

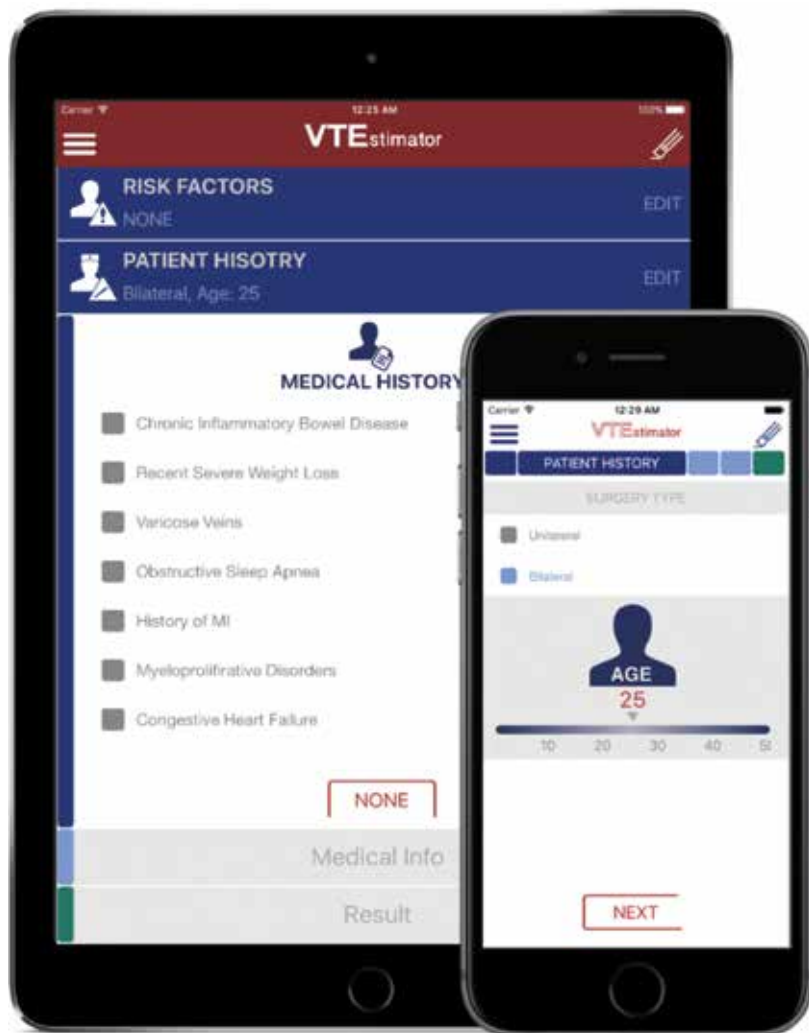
Jefferson hip and knee surgeons and researchers also presented close to 500 papers, with many of the findings considered level I or II evidence, at leading medical meetings in the U.S. and abroad. The department's extensive research agenda focuses not only on identifying new techniques and materials for surgery, but also on finding ways to reduce the risk for post-surgical complications that can extend hospital stays and make revision surgery necessary.

Jefferson's extensive electronic database of patient cases allows researchers to explore what therapies work best and what groups of patients may be at heightened risk for complications. Two particular research questions are being examined: What is the ideal approach for preventing venous thromboembolism? And what more can be done to prevent periprosthetic infection, a much-dreaded complication of joint replacement?

Here is a look at a few of those research projects:

Individualized Risk Model for Venous Thromboembolism After Total Joint Arthroplasty

Venous thromboembolism (VTE) following total joint arthroplasty (TJA) is a potentially fatal complication. The standard prevention protocol is to give all TJA patients postoperative VTE prophylaxis, but that uniform approach does not distinguish between patients with varying degrees of VTE risk. As a consequence, some TJA patients may not be getting potent enough anticoagulation therapy, while others, whose medical profile puts them at low risk for VTE, may be getting exposed unnecessarily to the potential dangers of anticoagulation therapy, including bleeding, wound complications, hematoma formation and periprosthetic joint infection.



Screen capture of the VTEstimator, a free app available on the iTunes App store, used by physicians to determine the best course of anticoagulation therapy based on a patient's risk factors.

Jefferson researchers, led by Javad Parvizi, MD, FRCS, sought to develop a simple scoring system that doctors could use to identify whether any given TJA patient is at high or low risk for VTE. The score would help determine an individualized strategy for VTE prophylaxis after surgery.

To develop the VTE risk-scoring system, the researchers drew on data from the National Inpatient Sample, which included 1,721,806 patients who underwent TJA between 2002 and 2011. Of those, 15,775 developed VTE. The researchers analyzed the dataset to determine what underlying medical factors most increased the risk for VTE in patients having TJA. Hypercoagulability turned out to be the most significant risk factor (4.8% of those patients developed VTE), followed by metastatic cancer. Other problematic risk factors were stroke, sepsis and chronic obstructive pulmonary disease, each of which put a patient at a 3% or higher risk for VTE. Additional risk factors included anemia, inflammatory bowel disease, depression, severe weight loss, varicose veins, obstructive sleep apnea and bilateral TJA.

The researchers then weighted each risk factor to develop a VTE risk-scoring system, and validated their model using an internal Jefferson database of TJA cases. The final step involved the creation of a mobile app, VTEstimator, which allows doctors to plug in a patient's age, type of surgery and risk factors to determine the ideal approach to VTE prophylaxis.

For instance, if a patient scores in the high-risk range, the doctor might be told: "You need to consider the use of strong anticoagulation drugs such as LMWH, pentasaccharide, warfarin and factor Xa inhibitors."

The researchers reported on their methodology in *The Journal of Arthroplasty*.

"There is a clear need for individualized determination of VTE risk in patients undergoing TJA," the researchers reported. "This strategy allows administration of the most effective anticoagulation while avoiding unintended complications." The App is being used throughout the Jefferson Department of Orthopaedic Surgery, and by over 3,000 surgeons, and increasing, across the globe.

Aspirin Can Be Used as Prophylaxis for Prevention of Venous Thromboembolism After Revision Hip and Knee Arthroplasty

While there is a growing body of research that provides a rationale for using less potent anticoagulation therapy such as aspirin following total joint arthroplasty, research on VTE prophylaxis after revision arthroplasty is scarce.

Revision surgery may be associated with higher risks for VTE because of prolonged operative time, increased surgical dissection, and the need for protected weight bearing and limited mobility in the weeks after surgery. The risk for bleeding complications and infection is also higher after revision surgery because of the complexity of reconstruction and extensive soft-tissue dissection.

Jefferson researchers, led by Gregory Deirmengian, MD, designed a study to determine whether aspirin, known to be effective for prevention of VTEs after primary arthroplasty, is also effective after revision TJA.

They analyzed 2,997 consecutive patients who underwent TJA between 2005 and 2013 at Jefferson. The patients had been treated with intermittent pneumatic compression devices and either aspirin (534 patients) or warfarin (2,463 patients) for VTE prophylaxis.

Among the findings:

- The incidence of symptomatic VTEs was significantly higher (1.75%) in the warfarin group compared to the aspirin group (0.56%).
- The incidence of bleeding events was higher in the warfarin group (1.58%) compared to the aspirin group (0.4%).
- The rate of surgical site infection was similar between the two groups.
- Nine patients (0.4%) in the warfarin group and one (0.2%) in the aspirin group died within one year after surgery, though the mortality rates were not significantly different.

“Although we acknowledge some limitations, this study is the first of its kind, to our knowledge, to demonstrate that the combination of mechanical prophylaxis and aspirin is a viable option for prevention of VTEs after revision joint arthroplasty,” the researchers reported in *The Journal of Arthroplasty*. Administration of aspirin to patients deemed at low risk should, in the least, “be expected to reach the same efficacy as warfarin, and may reduce the risk for bleeding events.” Joint revision patients considered to be at heightened risk for VTE based on their medical profile may require more potent thromboprophylaxis, the researchers said.

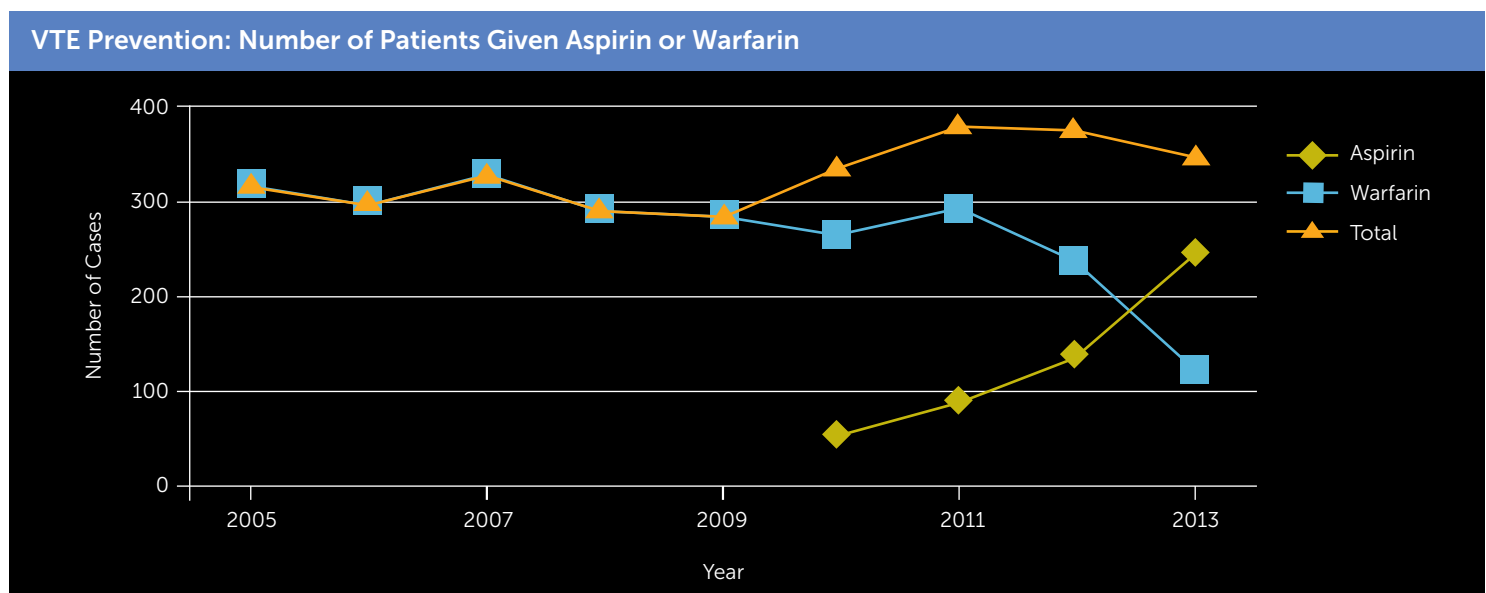
How much aspirin should be given? The researchers noted that there is not enough reliable data published to say what dose of aspirin is ideal for preventing

VTEs following revision surgery, though the current recommendation by the AAOS is 325 mg twice daily, recent research from our institution has demonstrated that lower dose aspirin, 81 mg twice daily, is a better option. The result of the dose comparison study will be published in the *Journal of Bone and Joint Surgery* shortly .

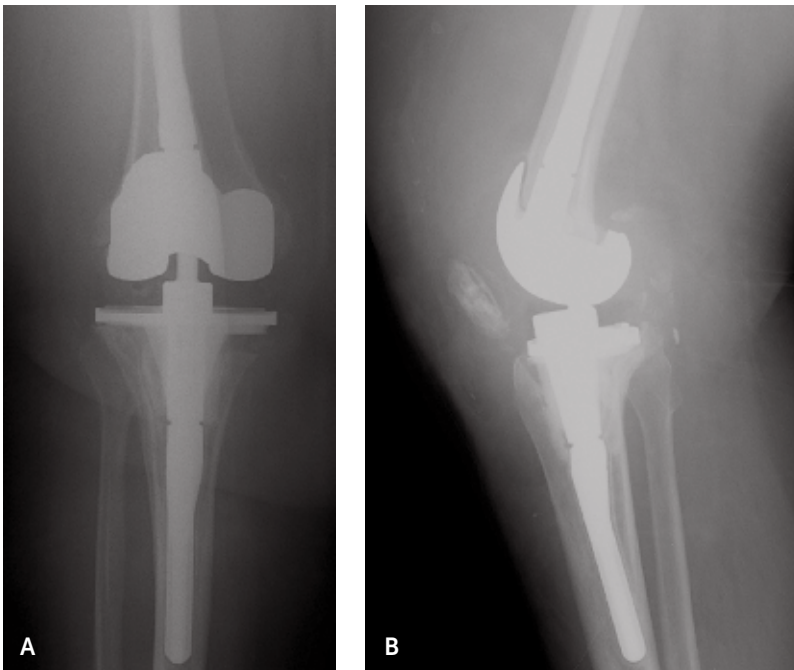
Administration of Aspirin as a Prophylaxis Agent Against Venous Thromboembolism Results in Lower Incidence of Periprosthetic Joint Infection

Periprosthetic joint infection (PJI) is a potentially devastating complication following total joint arthroplasty (TJA). Approximately 1% of patients develop the problem, which may result in long and costly hospital stays and revision surgery. As more surgeries are being performed, this complication is becoming more common and is expected to cost the healthcare system more than \$1.62 billion by 2020.

Multiple risk factors for PJI following TJA have been identified, but it is not known to what extent the method of anticoagulation therapy after surgery influences the risk. The trend in orthopaedics traditionally had been toward the use of aggressive anticoagulation therapy, including warfarin, following TJA. That approach, while providing protection against clot formation, may increase the risk of wound draining and hematoma, which in turn increases the risk of PJI. Based on still unfolding evidence, joint surgeons are starting to consider that aspirin may be an equally good, or better, choice.



Source: *The Journal of Arthroplasty*

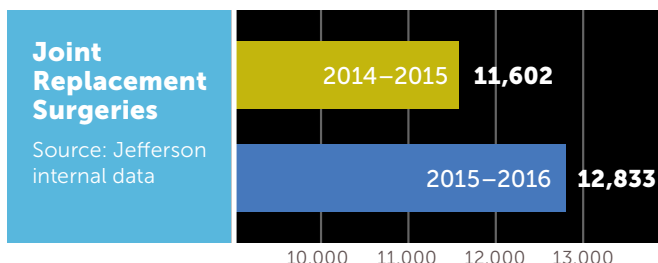


Radiographs from a patient with an elevated body mass index presenting with periprosthetic joint infection after total knee arthroplasty a) anteroposterior and b) lateral.

To get more clarity around the issue, Jefferson researchers, led by James J. Purtill, MD, analyzed a database containing information on 18,072 consecutive primary TJA cases performed at Jefferson between January 2006 and December 2012. They compared 1,456 patients who were given aspirin following surgery to 1,700 patients who received warfarin.

An analysis found that the incidence of PJI was significantly lower in patients who received aspirin (0.4%) compared to those on warfarin (1.5%). The average length of hospital stay was slightly lower in the aspirin group (2.6 days) compared to the warfarin group (2.8 days).

The researchers reported their findings in *The Journal of Arthroplasty*, noting that aspirin, as compared to warfarin, “provides adequate protection against postoperative VTE while reducing the risk of PJI following TJA.” In a related analysis published in the same journal, Jefferson researchers reported that even in TJA patients considered at high risk for VTEs, aspirin seems to be “just as safe and effective” as warfarin. In light of these findings, Jefferson surgeons have moved away from using warfarin as VTE prophylaxis, except in patients with a history of coagulable diseases or if they were taking warfarin prior to surgery.



ABINGTON: JOINT REPLACEMENT PROGRAM

Investigation of Forces and Moments During Minimally Invasive Total Hip Arthroplasty and the Likelihood of Intraoperative Fracture

Total hip arthroplasty increasingly is being performed through a minimal incision. Several studies have reported an increased rate of intraoperative fracture with this method. These fractures most often occur during femoral canal preparation. To help surgeons more safely perform total hip arthroplasty, several manufacturers have developed new broach handle designs. However, the dynamic effects of these handles on the proximal femur have not been widely investigated.

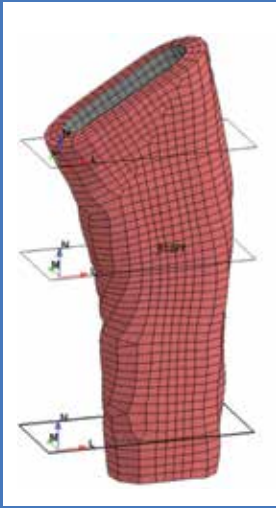
Researchers led by Andrew Star, MD, conducted a biomechanical analysis of four different broach handle design models (both curved and straight designs) to determine if there was an ideal shape for performing minimally invasive total hip arthroplasty via the direct anterior approach. The study involved a computer analysis that was confirmed by load cell mechanical testing.



Four broach handle models: H1 was relatively straight. H2 and H3 had increased curvature in a single plane. H4 was a double-offset design.



Handles were attached to a broach and digitized using a high-resolution optical system. A virtual model was constructed to include surrounding trabecular bone and a deformable cortical shell.



Researchers evaluated the off-plane reaction forces (OPRF) and reaction moments (RM) in a 3-dimensional plane around the broach while varying the location at which a hammering force was applied.

“Broach handle design is a critical determinant of resultant forces transmitted to the bone during total hip arthroplasty,” the researchers reported in a poster presentation at the American Academy of Orthopaedic Surgeons. They said curved handles generally cause more out-of-place forces than straighter handles, especially in the proximal femur. Those unanticipated forces may play a role in the increased rate of fractures seen during minimally invasive procedures.

“When surgeons use different broach handles in order to accommodate the anatomic constraints, even small changes in design can potentially lead to poor outcomes,” the researchers reported.

Intraoperative Fluoroscopy Improves Component Position During Anterior Hip Arthroplasty

Researchers led by Andrew Star, MD, conducted a retrospective study to determine whether fluoroscopic guidance improves acetabular cup abduction and anteversion alignment during anterior total hip arthroplasty.

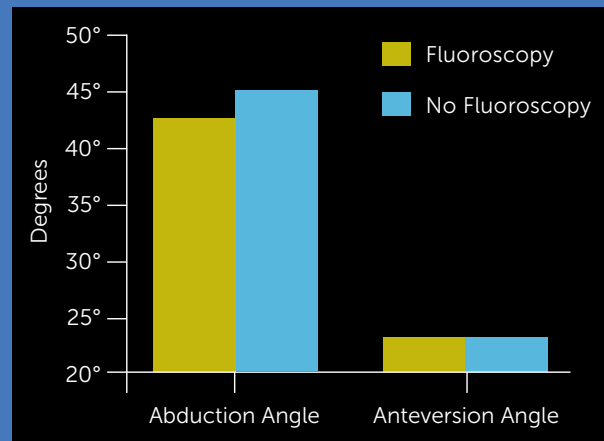
The researchers reviewed the cases of 199 patients (98 with C-arm fluoroscopy, 101 without) who were operated on by a single surgeon and had six months of postoperative anteroposterior pelvis radiographs.

Acetabular cup abduction and anteversion angles were measured and compared between groups. The average results were 43.4 degrees and 23.1 degrees respectively in the fluoroscopy group, compared to 45.9 degrees and 23.1 degrees in the non-fluoroscopy group.

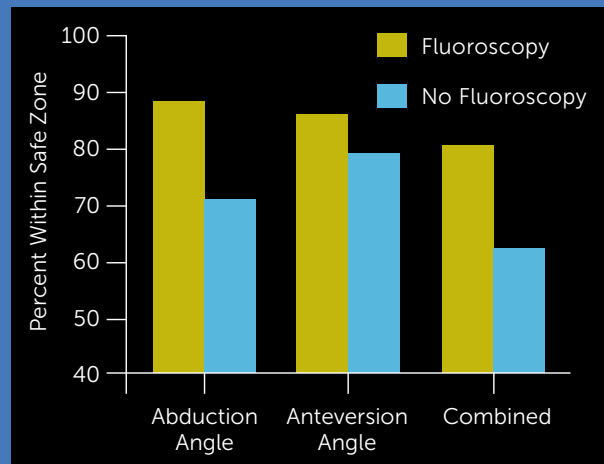
“In the fluoroscopy group, 80% of implants were within the combined safe zone compared with 63% in the non-fluoroscopy group,” the researchers reported in *Orthopedics*. “A significantly higher percentage of both acetabular cup abduction angles and combined anteversion and abduction angles were in the safe zone in the fluoroscopy group.”

The researchers concluded that “fluoroscopy is not essential for proper anteversion placement of acetabular components, but it may increase ideal safe zone placement of components.”

Acetabular cup abduction and anteversion angles with and without fluoroscopic guidance



Fluoroscopy vs. No Fluoroscopy



Source: *The Journal of Arthroplasty*





HAND AND WRIST

SERVICES

Hand and Wrist surgery

Microvascular surgery

Joint replacement
for hand arthritis

Treatment of carpal and
cubital tunnel syndrome

Brachial Plexus
reconstruction

Joint Reconstruction
for thumb arthritis

Treatment of
Dupuytren's disease

The hand is one of the body's most delicate parts, but it is also an essential tool that is used in nearly every aspect of living. Injuries to the hand, wrist or forearm can disrupt work and leisure and interfere with even the most basic tasks.

Whether a problem is due to an injury, an underlying disorder or osteoarthritis, successful treatment of the hand and wrist requires an appreciation of how all the moving parts and supporting structures work together to provide optimal function and flexibility.

Jefferson's Department of Orthopaedic Surgery is fortunate to include the expertise of hand specialists from The Philadelphia Hand Center at Jefferson and Rothman Institute at Jefferson. The surgeons excel in the treatment of hand arthritis, sports injuries and complex nerve conditions, as well as many other conditions. They utilize innovative surgical techniques and implant materials, and draw on the experience of treating over 16,000 patients a year.

Jefferson's hand and wrist surgeons are also deeply involved in research, investigating ways to improve both surgical and non surgical treatments that reduce pain and disability and restore function. Their findings are reported in leading journals and presented at major conferences such as the American Academy of Orthopaedic Surgeons and the American Society for Surgery of the Hand.

Among their most recent findings are these studies:

Osteochondral Autograft Transfer for Treatment of Metacarpophalangeal and Interphalangeal Cartilage Defects

Cartilage defects of the metacarpophalangeal (MP) and interphalangeal (IP) joints can lead to significant pain, loss of function and disability. Historically, when nonoperative treatments for these conditions fail, surgical options are limited to arthrodesis or arthroplasty, but these approaches have

disadvantages including lost motion, periprosthetic synovitis and osteolysis, implant fracture and implant loosening. The rates of complications and need for revision for most arthroplasties are major concerns that must factor into surgical decision making. The optimal treatment for the young or active patient with articular cartilage defect of the MP or IP joint remains controversial.

Jefferson hand surgeons are investigating alternative surgical approaches. In a report in *Techniques of Hand & Upper Extremity Surgery*, a team led by Randall W. Culp, MD, described a technique that utilizes a femoral osteochondral autograft to treat cartilage defects of the MP or proximal IP. They said the principles of the autografting technique are well studied in the sports medicine and arthroscopy literature for treatment of focal lesions in other joints, such as the knee and elbow, and reported outcomes have been largely favorable.

In the journal article, the surgeons describe how they have adapted the approach for MP and IP joints. They detail their surgical techniques for harvesting and implanting the autograft and managing patients following surgery.

“In our experience, the most common postoperative complication in the hand was joint stiffness, which was most common in the PIP joint,” they wrote. “In 2 of 11 cases, postoperative stiffness required tenolysis and contracture release.”

Knee discomfort was another common complaint, but it usually resolved fairly quickly.

The Jefferson researchers have done 15 of these procedures so far and have found that patients are highly satisfied, and generally able to return to high levels of activity. A professional baseball player returned to the field of play less than a year removed from surgery.

Radiographic Stage Does Not Correlate with Symptom Severity in Thumb Basilar Joint Osteoarthritis

Thumb basilar joint osteoarthritis (TBJA) is a common condition that affects nearly 7% of men and 15% of women over the age of 30. Symptoms vary in severity. Some patients have no symptoms, while others have unremitting pain and significant disability, including weakness, loss of motion and deformity.

Radiographic severity of TBJA is typically assessed using the Eaton-Littler staging system. The classification system ranges from Stage 1 to Stage 4, with the higher stages indicating more advanced osteoarthritis. It is used by clinicians to help determine the best treatment for patients, whether surgical or non-surgical.

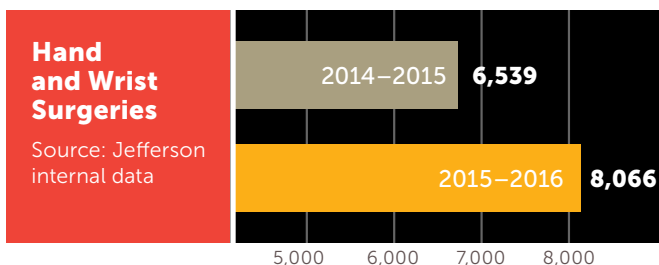
What isn't clear is whether radiographic severity correlates with patient-reported symptoms. Jefferson researchers led by C. Edward Hoffler II, MD, PhD, conducted a retrospective study to find out.

Sixty-two patients (15 men and 47 women) with TBJA were included in the study. They had all completed the *Quick Disabilities of the Arm, Shoulder, and Hand* 11-item questionnaire (*QuickDASH*), which has a 0-to-100 scoring system, with higher scores indicating more disability. The patients also completed the *Medical Outcomes Study 12-Item Short-Form Survey (SF-12)*, which has both physical and mental components that use a 0-to-100 scale, with higher scores indicating better function.

Each patient's radiograph was assigned an Eaton-Littler score, which was compared to the scores on the patient-reported surveys.

The researchers, reporting in the *Journal of the American Academy of Orthopaedic Surgeons*, said the severity of the TBJA as characterized by the Eaton-Littler scale did not correlate with the severity of symptoms as measured by the patient-reported surveys.

For instance, the average *QuickDash* score for patients with Stage 1 TBJA was 31.5; for those with stage 2 it was 37.9; for those with stage 3 it was 30.1; and with stage 4, it was 39.4. The *SF-12* Mental Component scores and the *SF-12* Physical Component scores also did not correlate with TBJA stage.



The researchers concluded that “alternate radiographic characterization of TBJA may allow us to correlate anatomic changes with symptoms severity,” and may help “improve surgical decision making and monitoring of treatment response.”

“Patients commonly want to know when looking at their radiographs how ‘bad’ their hand arthritis is,” the researchers wrote. “Based on the results of our study, the answer appears to be, ‘It’s not how it looks but how it feels.’” The results of this study have allowed the Jefferson surgeons to better counsel their patients on appropriate treatment recommendations for this common degenerative problem.

Orthogonal Plate Fixation with Corrective Osteotomy for Treatment of Distal Radius Fracture Malunion

Distal radius fractures (DRF) are among the most common fractures, and they account for a considerable burden to patients and a significant share of healthcare costs. Over recent decades the number of DRFs treated surgically has increased as implant technologies and fixation techniques have evolved. But despite those advances, the risk of developing complications following initial treatment of DRF persists, most notably including posttraumatic arthritis, median nerve compression, symptomatic hardware, tendon rupture and fracture malunion.

Malunions can occur following either nonoperative management or failed operative treatment and may cause progressive pain and disability. For patients with symptomatic DRF malunions, surgical intervention with corrective osteotomy is typically the treatment of choice, and a variety of surgical approaches and osteotomy techniques with generally favorable outcomes have been reported. However, the generalizability of such findings remains unclear because the studies tended to focus on the use of a given technique for a specific fracture pattern.

To help further the understanding of what surgical technique might be optimal, Jefferson researchers headed by Randall W. Culp, MD conducted a study to analyze the outcomes of distal radius correcting osteotomy with 90-90 (volar- and radial-sided

orthogonal) plate fixation for treatment of symptomatic fracture malunions. The retrospective study included 39 patients who underwent corrective osteotomy with 90-90 fixation (all performed by a single surgeon, Dr. Randall Culp) between January 2008 and December 2014. The researchers reviewed patient charts, clinical assessment tests and radiographs.

The researchers reported their findings in the *Journal of Hand Surgery*:

- At an average postoperative follow-up of four years, significant improvements were observed clinically in wrist flexion-extension arc, grip strength, pain levels as measured by Visual Analog Scale (VAS) and Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) functional scores.
- Radiographically significant postoperative improvements were noted in ulnar variance, radial incline, intra-articular step-off and radial tilt, with volarly- and dorsally-angulated malunions corrected to 9 and 7 degrees of volar tilt, respectively.
- Twelve patients (31%) underwent additional surgery, with the most common type being plate removal in seven patients. Three of the seven patients had removal of the radial plate.

“For patients with symptomatic malunion of the distal radius, corrective osteotomy with 90-90 plate fixation is an effective treatment option for improving pain and restoring function for both volarly- and dorsally-angulated malunions, including malunions with an intra-articular component,” the researchers said.

They said it would be useful to conduct more research to compare the 90-90 plate fixation method to other technique for DRF malunion correction to determine if it is superior and warrants wider use.

Based on the results of this study, the technique is being used with increased frequency to treat these difficult problems.

Fingertip Amputation Treatment: A Survey Study

Finger injuries are common, accounting for an estimated three million emergency department visits a year, with 44.5% of them diagnosed as lacerations. Amputations of the finger, partial or complete, can happen on the job or at home. There are an estimated 30,000 non-work-related amputations of the finger annually in the U.S.

While the fingertip may seem somewhat inconsequential, in fact it is a highly specialized structure that contributes to precision function of the hand through tactile feedback and fine motor control as well as hand aesthetics. An injury can compromise a variety of fingertip

structures, including the distal phalanx, which provides length and structural support; the fingernail, germinal matrix and sterile matrix, which protect the fingertip and function as tools; and the volar skin pad, which is important for sensation and fine motor activities.

There is considerable debate regarding the optimal management of fingertip amputations, and to date there have been no prospective, randomly controlled trials to inform treatment choices. While there are more surgical options available than ever before for treating fingertip amputations, some research has questioned whether more complex reconstructive procedures are worth the time, expense and risk. Because there is scant evidence

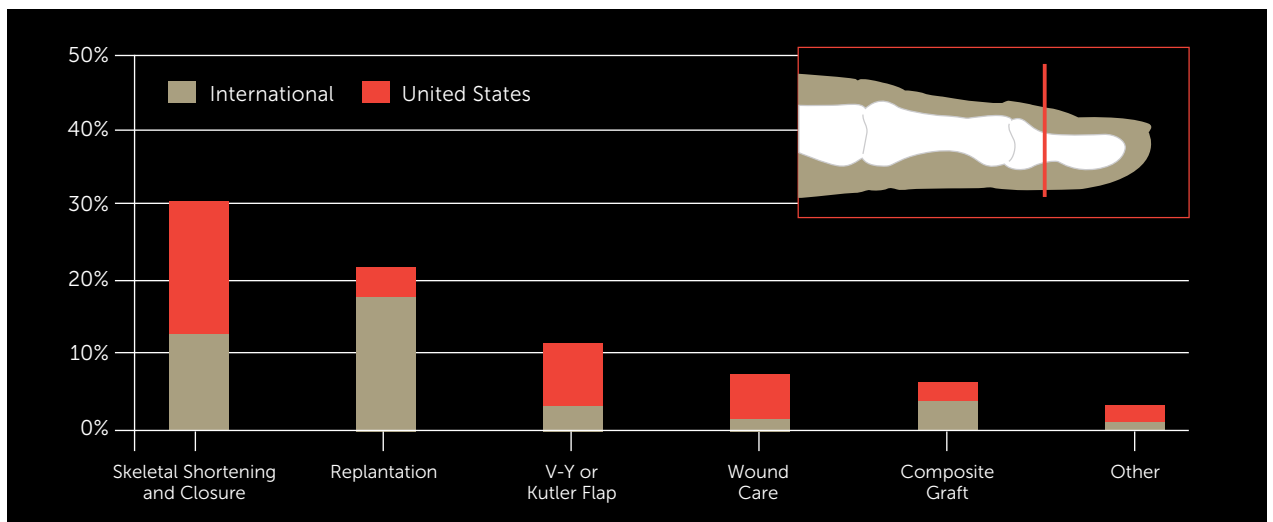


Figure 1. Allen level 4 injuries – Six most common treatment preferences in descending order of use by U.S. and international surgeons

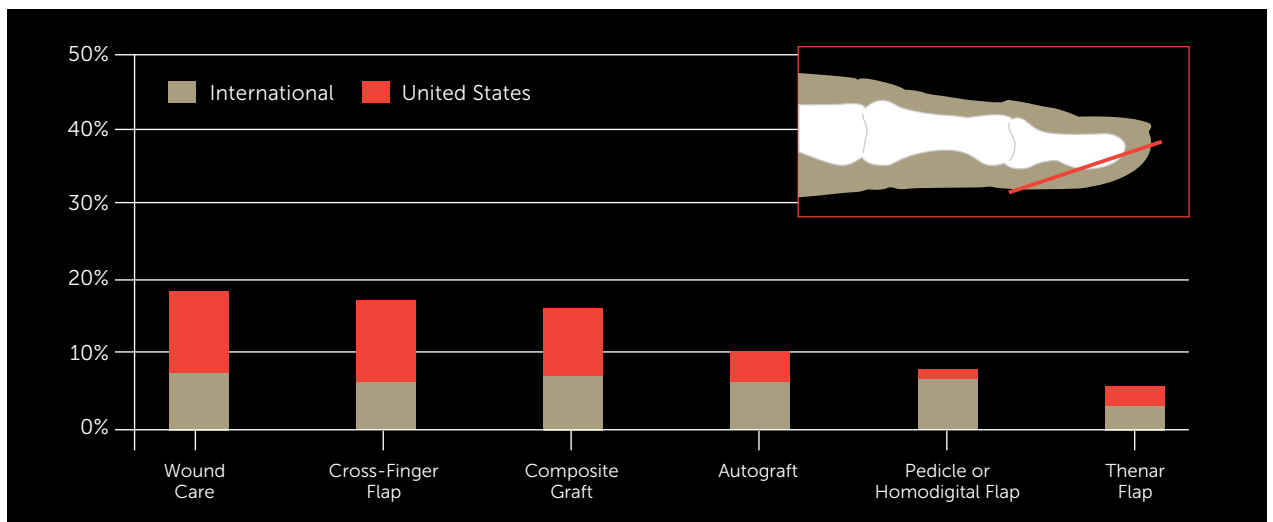


Figure 2. Volar oblique injuries – Six most common treatment preferences in descending order of use by U.S. and international surgeons

Source: *The American Journal of Orthopedics*

on whether one treatment choice results in better outcomes for patients than others, treatment preferences vary from one surgeon to another.

Jefferson researchers, led by Andrew J. Miller, MD, conducted a survey study of U.S. and international hand surgeons to better understand how surgeon and patient factors influence the decision on treatment for a distal fingertip amputation. The surgeons sent out a 16-question survey via the American Association for Hand Surgery and reciprocal international hand societies. They received 198 responses.

The survey consisted of six surgeon demographic questions; five treatment preference questions regarding patient age, sex, occupation and germinal matrix management; and five clinical scenarios based on Allen levels 2, 3 (with and without exposed distal phalanx) and 4 and volar oblique middle-finger amputations. The surgeons were presented with a variety of treatment choices and asked to pick one for each scenario. The choices included wound care, skeletal shortening, and closure, composite graft, autograft, V-Y/Kutler flap, advancement flap, thenar flap, cross-finger flap, pedicle and homodigital flap and replantation.

The researchers reported in the *The American Journal of Orthopedics* that there was great variation in how surgeons said they would treat the clinical scenarios presented in the survey. Among the key findings:

- Surgeons with less than 30 years of experience or without plastic surgery background were more likely to choose wound care.
- Replantation was more common with international surgeons than U.S. surgeons.
- Pedicle and homodigital flaps were also more common internationally.
- Surgeons in practice less than five years were more likely to perform skeletal shortening.

The researchers said the survey results “underscore the need for a well-designed comparative study to determine the most effective treatments for distal fingertip amputations.” The results of this study have allowed the Jefferson surgeons to critically evaluate their treatment recommendations for this difficult and heterogeneous group of patients.



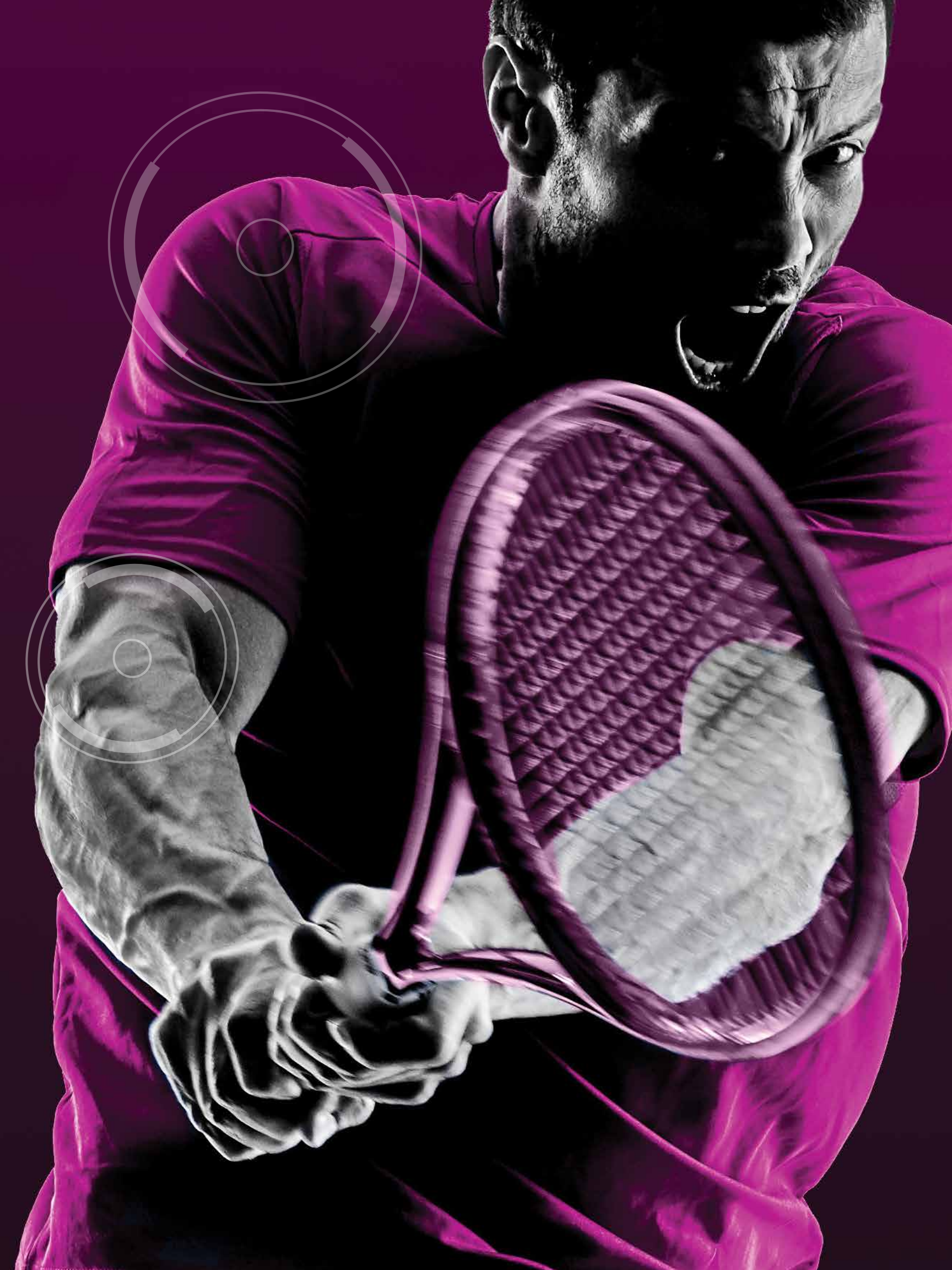
Figure 3. Fingertip amputation exam



Figure 4. Fingertip amputation exam



Figure 5. Fingertip amputation exam





SHOULDER AND ELBOW

SERVICES

Shoulder and elbow replacement surgery

Treatment of rotator cuff injuries

Treatment of shoulder and elbow instability

Tendonitis treatment

Distal biceps and triceps rupture repair

Treatment of shoulder and elbow fractures

Shoulder and elbow surgery, arthroscopy and open

It is an especially busy time for shoulder and elbow surgeons. As the population ages, there are more instances of elderly persons experiencing fractures caused by falls and fragility. At the same time, younger and middle-aged patients are enjoying active lifestyles and pursuing sports at a high intensity, which can put them at risk for acute and overuse-related orthopaedic injuries.

Jefferson's shoulder and elbow surgeons are positioned to address patient care at both ends of the age spectrum. Their clinical expertise is combined with a robust research agenda that is focused on understanding which treatments, surgical or nonsurgical, work best for which groups of patients.

The researchers are also exploring important questions around the critical issue of cost-effectiveness in health care. Not only do patients expect the very best outcomes; their insurers want proof that treatments are providing the best results at the best price.

Here is a look at some of the findings published by Jefferson's shoulder and elbow team:

Predicting Revision Following *In Situ* Ulnar Nerve Decompression for Patients with Idiopathic Cubital Tunnel Syndrome

Cubital tunnel syndrome (CTS) is second only to carpal tunnel syndrome in incidence among compression neuropathies of the upper extremities. Despite the common nature of CTS, there is no established consensus on the optimal surgical treatment. There is a wide range of surgical options, including *in situ* decompression, medial epicondylectomy, and subcutaneous, intramuscular or submuscular transposition of the ulnar nerve. Generally, *in situ* decompression offers the least-invasive surgical option, but it may increase the need for revision surgery.

Researchers led by A. Lee Osterman, MD, conducted a study to determine the incidence of needed revision after *in situ* ulnar nerve decompression for patients with idiopathic CTS and to investigate which patient risk factors may contribute to an increased need for revision.

The team conducted a retrospective review of all patients who had the procedure between January 2006 and December 2010 at The Philadelphia Hand Center. There were 216 patients included and they had an average age of 53.



GERALD R. WILLIAMS, JR., MD

Gerald R. Williams, Jr., MD, Professor of Orthopaedic Surgery and a well-regarded clinician and researcher in Jefferson's Shoulder and Elbow Division, has taken on a national role as President of the American Academy of Orthopaedic Surgeons (AAOS).

Dr. Williams said his goals as president of the 39,000-member organization include establishing an alternative accreditation pathway, together with orthopaedic specialty societies, for orthopaedic fellowship programs and to continue to push for the best interests of orthopaedic surgeons and patients in the ever-changing arena of healthcare funding.

While much of orthopaedics research is focused on refining surgical techniques and developing new implant designs and materials, Dr. Williams said another important area of research is to determine the best avenues for delivering cost-effective care. Because orthopaedic procedures such as hip, knee and shoulder arthroplasty are commonly known as "big-ticket" items, they are coming under increasing scrutiny by health insurers looking to hold down costs. One possibility is to perform such procedures at an orthopaedic specialty hospital instead of a full-service tertiary care center, or even to do select surgeries at an outpatient facility, depending on the particulars of the case, Dr. Williams said.

As part of his research at Jefferson, Dr. Williams has studied outcomes for shoulder arthroplasty at an orthopaedic specialty hospital versus a tertiary center, and found

that the average length of stay was significantly shorter at the specialty hospital.

"We need to identify the ideal setting to provide the best possible outcomes for patients," said Dr. Williams, the John M. Fenlin, MD, Professor of Shoulder and Elbow Surgery at the Sidney Kimmel Medical College at Thomas Jefferson University.

Dr. Williams, who has been at Jefferson since 2007, earned his medical degree from Temple University and trained in orthopaedic surgery at University of Texas Health Science Center in San Antonio.

Prior to assuming the AAOS presidency, Dr. Williams served two years as the group's vice president. Other previous leadership roles include serving as president of the American Shoulder and Elbow Surgeons, the Pennsylvania Orthopaedic Society and the Philadelphia Orthopaedic Society. He is also co-founder and former president of the Mid-Atlantic Shoulder and Elbow Society. He stepped down as Director of Jefferson's Division of Shoulder and Elbow Surgery to concentrate on the AAOS initiatives.

Dr. Williams said both payers and patients need to recognize that orthopaedic care, whether surgery or nonsurgical therapy, is a high-value area of medicine because it provides demonstrable results that impact every aspect of life.

"We get people back to work, back to sports, back to living their lives as fully as possible," he said.

The review found that:

- Revision surgery was required in 3.2% (7) of patients.
- Age younger than 50 at the time of the index decompression was the lone significant predictor of need for revision surgery, although why young age is a factor is not clear.
- Gender, diabetes, smoking history and workers' compensation status were not predictive of the need for revision surgery.
- Disease-specific factors, including nerve conduction velocities, McGowan grading and predominant symptom type, were also not predictive of revisions.

"For patients with idiopathic CTS, the risk of revision surgery following *in situ* ulnar nerve decompression is low," the researchers reported in the *Journal of Hand Surgery*. "The findings of this study suggest that, in the absence of underlying elbow arthritis or prior elbow trauma, *in situ* ulnar nerve decompression is an effective minimal-risk option for the initial surgical treatment of CTS."

Surgeons at Jefferson choose the optimal surgery based on patient characteristics and disease presentation. However, given the study findings, *in situ* decompression is recommended when appropriate.

Length of Stay after Shoulder Arthroplasty – The Effect of an Orthopaedic Specialty Hospital

Shoulder arthroplasty has a high per-day hospital cost of approximately \$25,000. As government and private insurers increasingly look for ways to reduce healthcare costs and improve access to care, it is likely that high-volume procedures such as shoulder arthroplasty will come under more scrutiny. One potential avenue for lowering costs for shoulder arthroplasty is to reduce hospital length of stay (LOS), which in turn might reduce hospital-acquired infections and improve patient satisfaction. What isn't clear is whether the length of stay tends to be shorter when shoulder arthroplasty is performed at an orthopaedic specialty hospital, such as Rothman Orthopaedic Specialty Hospital, compared to a tertiary referral center, such as Jefferson.

To examine the question, Jefferson researchers headed by Surena Namdari, MD, retrospectively compared 136 primary shoulder arthroplasties done at Jefferson

between January 2013 and July 2015 to 136 shoulder arthroplasties performed at Rothman Orthopaedic Specialty Hospital, which is part of the Jefferson system. The comparison cases were matched for patient characteristics, medical factors and insurance and discharge status. The same group of surgeons performed all the cases using the same techniques and protocols.

Among the findings:

- The average length of stay was shorter at the orthopaedic specialty hospital – 1.31 days compared to 1.85 days at the tertiary referral center.
- Overall, the 136 patients at the tertiary center spent 73 more nights in the hospital than the 136 patients operated on at the orthopaedic specialty hospital.
- Three of the 136 patients at the orthopaedic specialty hospital (2.2%) required transfer to a tertiary center.
- Two patients at the specialty hospital and one patient at the tertiary care center were readmitted.

The researchers reported in the *Journal of Shoulder and Elbow Surgery* that the reduced LOS at the orthopaedic specialty hospital may be a “result of fast-track rehabilitation and strict disposition protocols.”

“With rising shoulder arthroplasty demand, utilization of orthopaedic specialty hospitals may be a safe avenue to delivery of more efficient and effective orthopaedic care,” they reported.

The researchers noted that the study considered only one key factor, LOS. They noted that it would be ideal to analyze all of the factors contributing to the cost of shoulder arthroplasty, including in-patient hospitalization, outpatient therapy and rehabilitation and ambulance transfers.

“Multicenter investigations will be necessary to determine whether the trends observed in this study are generalizable to other health systems with different arrangements,” they said.

Based on the findings, the Jefferson system is now assigning complex shoulder replacements and revision surgeries to its tertiary care centers, and more routine cases to the orthopaedic specialty hospital.

Recurrent Cubital Tunnel Syndrome Treated with Revision Neurolysis and Amniotic Membrane Nerve Wrapping

Cubital tunnel syndrome (CTS) trails only carpal tunnel syndrome in incidence among entrapment neuropathies of the upper extremity. Surgery is often required to provide adequate relief for CTS symptoms. There are a range of surgical options, including *in situ* ulnar nerve decompression, medial epicondylectomy and anterior transposition of the ulnar nerve.

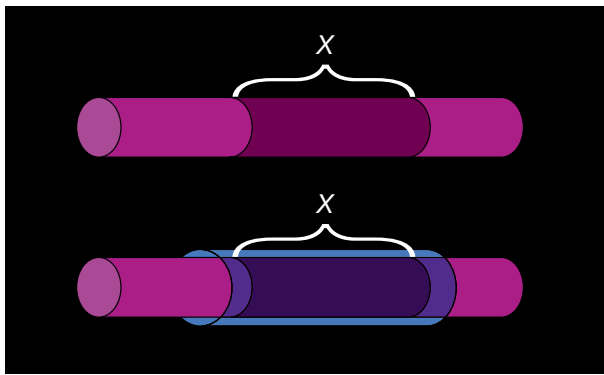
Surgical intervention for CTS is generally associated with favorable outcomes, although a notable number of patients will require additional surgery because of persistent, recurrent or new-onset neuritic symptoms. One predominant cause of symptom recurrence after primary surgery for CTS is perineural scarring of the ulnar nerve.

Identifying ways to prevent such scarring during primary or revision surgery would be extremely useful. With that goal in mind, Jefferson researchers led by Mark S. Rekant, MD, conducted a study to examine the outcomes for a group of patients with recurrent CTS who underwent revision neurolysis with amniotic membrane nerve wrapping. The technique involves wrapping the ulnar nerve with an amniotic membrane allograft to serve as an adhesion barrier against inflammation and scarring, while also providing an improved healing environment for optimal nerve regeneration.

Amniotic Membrane Nerve Wrapping: Preoperative and Postoperative Patient Outcomes							
Measured Outcome	VAS pain (0 – 10)	QuickDASH (0 – 100)	Grip Strength Affected Side (pounds)	Grip Strength Affected vs. Contralateral Side (%)	Pinch Strength Affected Side (pounds)	Pinch Strength Affected vs. Contralateral Side (%)	Elbow ROM (Flex-Ext Arc, Degrees)
Mean Change	-3.5	-30	+25	+38%	+4.2	+27%	+16

* Denotes postoperative values that do not have a preoperative comparison; these values were excluded from the mean calculations in the bottom row
VAS = Visual Analog Scale; QuickDASH = Quick Disabilities of the Arm, Shoulder and Hand Functional Outcome score; ROM = Range of Motion

Source: Mark Rekant, MD



Amnion wrapping

The researchers identified eight CTS patients who had undergone the procedure and then collected follow-up data on them for an average of 30 months. The patients, who ranged in age from 39 to 57, had undergone at least two ulnar nerve operations before the revision neurolysis with amnion placement.

The Jefferson team reported in the *Journal of Shoulder and Elbow Surgery*, that all of the patients showed improvement after the revision surgery with amniotic membrane nerve wrapping based on several objective measures, including pain levels on a visual analog scale (VAS), the 11-item version of the *Disabilities of the Arm, Shoulder and Hand (QuickDASH)* outcome scores, elbow flexion-extension arc of motion (in degrees), grip strength and pinch strength.

“This series observed significant improvements in pain, function, and strength compared with preoperatively,” the researchers reported. “In addition, no patient experienced any complications, adverse events, or signs of rejection to the allogenic tissue.” They said “all patients expressed subjective satisfaction with their results.”

The researchers noted, however, that more research is needed to compare the amniotic membrane wrapping technique to other approaches. They said a cost comparison of the various techniques would also “be of particular interest in today’s healthcare landscape.”

Thanks to the research done at Jefferson, this technique is an acceptable treatment option for these difficult cases, with many surgeons employing this approach.

Displaced Proximal Humerus Fractures in Older Patients: Shoulder Surgeons Versus Traumatologists

As the U.S. population ages, fragility fractures are becoming more common. Proximal humerus fractures represent approximately 5% of fractures and comprise 10% of fractures among elderly persons.

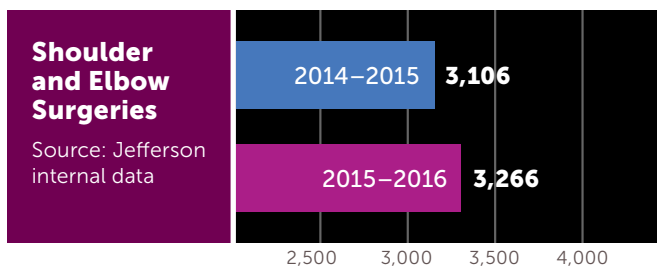
Although the majority of proximal humerus fractures are minimally displaced and may be managed nonoperatively, surgical treatment often is considered for displaced three- and four-part fractures. A number of operative interventions are used for proximal humerus fractures in elderly persons, including closed reduction and percutaneous pinning; transosseous suture repair; open reduction and internal fixation (ORIF), with locking plates or intramedullary nails with or without bone grafting; hemiarthroplasty; and reverse total shoulder arthroplasty.

There is little data, however, on what approach works best for elderly patients. Absent that information, treatment choices may be driven by a surgeon’s specialty training, number of years in practice and practice setting.

Jefferson researchers headed by shoulder surgeons Charles Getz, MD and Luke Austin, MD, conducted a survey in which they asked fellowship-trained shoulder surgeons and fellowship-trained orthopaedic traumatologists to specify how they would treat 15 different cases of displaced proximal humerus fractures. The doctors were presented with a clinical scenario and radiographic and CT images of the fractures, and were then asked to respond to a series of multiple choice questions about how they would treat the case.

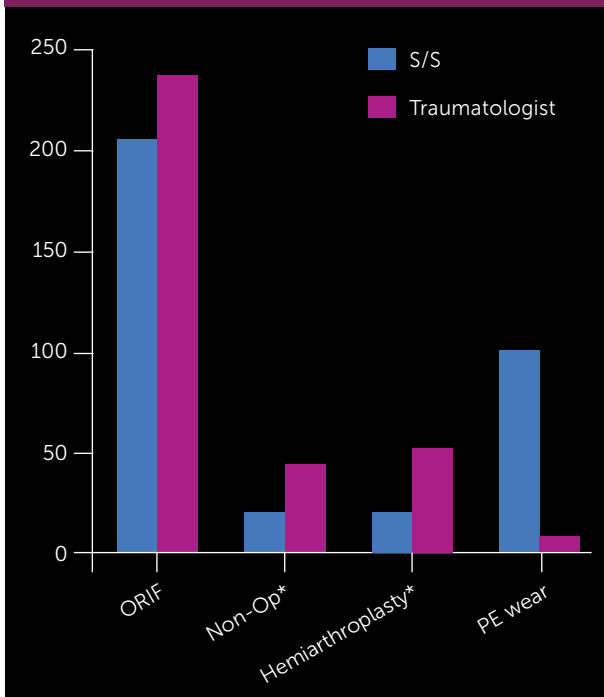
A total of 46 shoulder surgeons and 23 orthopaedic traumatologists responded to the survey. Their responses showed significant variations in treatment choice, depending on the surgeon’s specialty.

Among the shoulder surgeons, there were a total of 19 instances in which a case was indicated for nonoperative management; 204 instances in which ORIF was picked; and 122 instances when the choice was arthroplasty (21 hemiarthroplasty and 101 reverse total shoulder arthroplasty).



Source: Jefferson internal data

Management Choice for Proximal Humerus Fracture



Management selection distribution of all presented cases categorized by surgeon type. Significant differences are denoted by *. Abbreviations: Non-op, nonoperative; ORIF, open reduction and internal fixation; S/S, shoulder surgeon; PE Wear, Polyethylene wear. Source: Matthew L. Ramsey, MD

Among the traumatologists who completed the survey, there were 44 instances when a case was selected for nonoperative management; 234 instances in which ORIF was the choice; and 67 instances when the choice was arthroplasty (54 hemiarthroplasty and 13 reverse total shoulder arthroplasty).

Given identical imaging and clinical scenarios on a case, "shoulder surgeons in the current study were more likely to consider arthroplasty for treatment of displaced proximal humerus fracture, and orthopaedic traumatologists were more likely to use ORIF or to manage the same patient nonoperatively," reported the researchers in the journal *Orthopedics*.

"When hemiarthroplasty and reverse total shoulder arthroplasty were considered as distinct treatment options, these differences between the subspecialty groups became even more pronounced," they said. Surgeon specialty training, years in practice and practice setting (academic or private) all were influencing factors.

"The resulting variation in care can subsequently translate to differences in outcome and costs," the researchers concluded. They said more research is needed to examine the issue. Understanding the outcome of different surgical approaches will help refine decision-making when choosing the appropriate treatment for each patient.

Length of Stay for Shoulder Arthroplasty: Orthopaedic Specialty Hospital vs. Tertiary Care Center

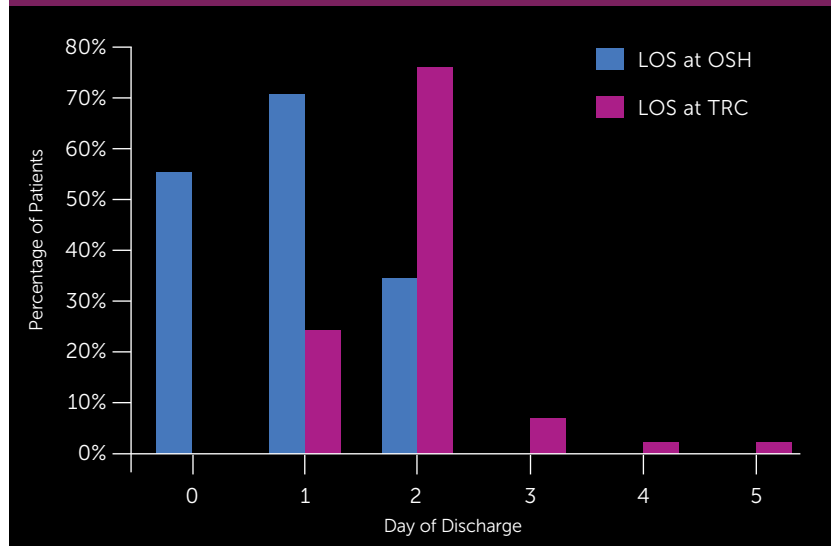


Figure 1: Length of stay (LOS) by nights in the hospital for matched cohorts from an orthopaedic specialty hospital (OSH) compared with a tertiary center (TRC) Source: Matthew L. Ramsey, MD

Patient Screening Criteria for the Orthopaedic Specialty Hospital

Hard stops (nearly automatic disqualification from OSH utilization)

AICD	<input type="checkbox"/>	History or family history of malignant hyperthermia
BMI>40	<input type="checkbox"/>	End-stage renal disease

Chronic conditions (each worth 1 point toward risk score)

CHF	<input type="checkbox"/>	Chronic steroids	<input type="checkbox"/>	Hemoglobin <9
TIA or CVA	<input type="checkbox"/>	Atrial fibrillation	<input type="checkbox"/>	Vascular disease
CKD	<input type="checkbox"/>	Cancer	<input type="checkbox"/>	BMI >35
Diabetes	<input type="checkbox"/>	HIV/AIDS	<input type="checkbox"/>	Asthma
COPD	<input type="checkbox"/>	Sleep apnea		

Life style risk factors (each worth 1 point toward risk score)

Hospitalization or emergency department visit in past 12 months	<input type="checkbox"/>	History of falls
Admission to nursing facility or rehabilitation in past six months	<input type="checkbox"/>	Lives alone
Requires assistance with activities of daily living	<input type="checkbox"/>	>5 medications
Requires assistance with home medications	<input type="checkbox"/>	Chronic pain
Noncompliance with home treatment (e.g., accuchecks)	<input type="checkbox"/>	Alcohol/drug abuse
Noncompliance with home medications	<input type="checkbox"/>	Dyspnea
Impaired ambulatory status (other than orthopedic issue)	<input type="checkbox"/>	Low economic status
Limited access to transportation	<input type="checkbox"/>	Poor health literacy
Caregiver anxiety or patient is primary caregiver	<input type="checkbox"/>	Pets in the home
Acute/chronic wound or pressure ulcer	<input type="checkbox"/>	Cognitive impairment
Depression/anxiety or history of mental illness	<input type="checkbox"/>	Weak social support
Setup of home environment (stairs, throw rugs, hand rails)	<input type="checkbox"/>	Age >76 years

AICD, automatic implantable cardioverter-defibrillator; BMI, body mass index; CHF, congestive heart failure; TIA, transient ischemic attack; CVA, cerebrovascular accident; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease.

Scoring: Sum of all boxes checked (mild risk, <2; moderate risk, 3-5; high risk, >5).

Source: Matthew L. Ramsey, MD





FOOT AND ANKLE

SERVICES

Achilles Tendon Rupture and Tendonitis

Ankle Sprains and Fractures

Arch and Heel Pain

Arthritis - Foot and Ankle

Athlete's Foot

Claw and Hammer Toe

Flat Foot

Foot Callus/Corns, Bunions, Plantar Warts

Foot Pain

Fracture of the Talus

Lisfranc Fracture/Dislocation

Posterior Cruciate Ligament Injury - (PCL Injury)

Posterior Tibial Tendonitis

Stiff Big Toe

Tarsal Tunnel Syndrome

Hallux valgus

Flat foot reconstruction

The combined foot and ankle is one of the most complex structures in the human body, with each bone, joint, muscle, tendon and ligament working in tandem to provide strength, flexibility, support, stability and cushioning. If a person's feet hurt due to injury, arthritis or overuse, the discomfort can affect nearly every aspect of daily living.

The foot and ankle specialists at Jefferson see more than 20,000 patients a year and perform more than 3,000 surgeries annually. They are leaders in total ankle replacement to treat arthritis, and have developed novel techniques for the treatment of common injuries such as Achilles tendon rupture. In many cases, nonoperative treatments, including physical therapy, can restore patients to better mobility and less pain.

The foot and ankle team is dedicated to research that improves the understanding of foot and ankle biomechanics and leads to better outcomes for patients debilitated by injuries or arthritis.

Here is some recently published research:

Motion Following Total Ankle Arthroplasty Versus Ankle Arthrodesis

For patients with end-stage ankle arthritis, the perceived disability can be devastating. Patient surveys have found that the mental and physical disability associated with the condition can be as severe as that experienced by patients with end-stage hip arthrosis.

The complex interplay of joints surrounding the ankle presents a challenge for surgically treating tibiotalar arthritis. Tibiotalar arthrodesis has traditionally been the treatment of choice for ankle arthritis, and short-term and mid-term follow-up studies indicate improvements in both pain and function. Long-term studies, however, have been less encouraging, showing the eventual deterioration in patient function associated with the development of adjacent joint arthritis. Significant reductions in sagittal plane movement and hindfoot inversion have been reported following tibiotalar arthrodesis.

Recent advancements in total ankle arthroplasty (TAA) have made it an increasingly attractive option for treating end-stage tibiotalar arthritis. Improvements in implant designs and lessons learned from the high failure rate of earlier generations of implants have contributed to TAA success. Implant survival rates approaching 70% to 95% at intermediate follow-up have been reported.

One particular reason for the enthusiasm for TAA is that it has the potential to replicate more physiological movements of the foot and ankle. There have been few studies, however, evaluating movement in patients who underwent TAA compared to patients who had arthrodesis.

Motion Analysis: Total Ankle Replacement vs. Tibiotalar Fusion

Demographic	Total Ankle Replacement	Tibiotalar Fusion	p value
Number	41	27	N/A
Overall Arc	34.2 (17 - 59.1)	24.3 (6.9 - 44.3)	0.00025
Tibiotalar Motion	23.7 (5.7 - 46.4)	N/A	N/A
Talonavicular Motion	10.5 (1.2 - 28.8)	22.8 (5.6 - 41.4)	<0.0001

A one-tailed Mann-Whitney test was used to detect statistically significant differences in sagittal plane motion. p-values <0.05 were considered statistically significant.

Demonstration of overall arc of motion following a replacement or a fusion of the ankle joint, demonstrating contribution from the tibiotalar and talonavicular components
Source: *The Bone & Joint Journal*

Patient-Centered Outcomes

Demographic	Total Ankle Replacement	Tibiotalar Fusion	p value
Number	41	27	N/A
SF-12 MCS	55.36 (26.18 - 64.5)	55.69 (39.91 - 67.55)	0.2253
SF-12 PCS	47.43 (32.11 - 56.82)	45.23 (17.26 - 57.52)	0.4349
VAS	12.05 (0 - 70)	24.89 (0 - 87)	0.0096
FAAM ADL	82.19 (33.33 - 100)	71.67 (28.57 - 100)	0.01036
FAAM Sports	57.27 (12.5 - 100)	43.39 (6.25 - 90)	0.019

A one-tailed Mann-Whitney test was used to detect statistically significant differences in patient-centered outcomes. p-values <0.05 were considered statistically significant.

Functional outcomes following ankle replacement vs. fusion demonstrating a significantly better pain improvement and Foot and Ankle Ability Measure (FAAM) functional ability in patients undergoing ankle replacement
Source: *The Bone & Joint Journal*

Jefferson researchers led by David I. Pedowitz, MD, designed a study to look further at the issues. They identified 41 patients who underwent TAA and 27 who had tibiotalar arthrodesis and had at least two years of follow-up, and asked them to participate in a series of assessments. The patients were clinically evaluated and underwent a five-view weight-bearing radiological evaluation to measure overall arc of movement and talonavicular movement in the sagittal plane. The patients also completed several questionnaires to gather measures of pain and function, including the *Short-Form 12 version 2.0*; *visual analogue for pain (VAS) score*, and the *Foot and Ankle Ability Measure (FAAM)*.

The researchers reported in *The Bone & Joint Journal* that the TAA patients had greater mean overall sagittal movement compared with patients who had tibiotalar arthrodesis (34.2 degree versus 24.3 degrees). In the arthrodesis group, as expected, the entire arc of movement came from the midfoot, while in the TAA group the arc of movement came from both the tibiotalar joint and the midfoot. In addition to the better movement, TAA patients reported less pain and better function than the tibiotalar arthrodesis group.

"We were able to detect significant differences in both overall sagittal plane movement and movement across the talonavicular joint demonstrating more normal replication of ankle biomechanics in patients undergoing TAA," the researchers reported. They said they suspected that the "abnormal biomechanics of the hindfoot following arthrodesis are responsible for the higher rates of hindfoot arthritis seen in long-term follow-up studies."



Figure 1. Range of motion (demonstrated through solid white lines) occurring through the ankle joint (yellow arrow) in a patient who had a TAA



Figure 2. Range of motion (demonstrated through solid white lines) occurring through the talonavicular joint (yellow arrow) in a patient who has an ankle fusion
Source: Steven M. Raikin, MD

The Efficacy of Platelet-Rich Plasma for Incision Healing After Total Ankle Replacement Using the Agility Total Ankle Replacement System

The use of platelet-rich plasma (PRP) to augment incision healing has been well documented in the literature. Because studies have been limited in their scope and the results mixed, there is no consensus on the value of PRP.

In the case of total ankle replacement (TAR), incision-healing complications continue to be a challenge despite dramatic improvements in implant design. But whether PRP helps improve healing outcomes is not clear.

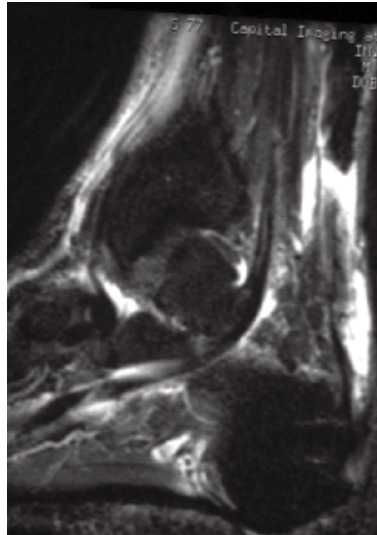
Jefferson researchers, including senior author Steven M. Raikin, MD, conducted a retrospective study to analyze the role of PRP in 133 consecutive cases of TAR, performed by a single surgeon. PRP to augment incisional closure was used in 78 of the cases, but not in the other 55.

When the cases were analyzed for wound healing complications – including a need for prolonged wound care or return to the operating room to address a major problem – no statistically significant differences emerged between the PRP group and the non-PRP group. Based on that finding, “the authors no longer routinely use PRP to augment incision healing,” the researchers reported in *Foot & Ankle International*. “TAR remains a successful operation, and further investigation is warranted to determine the optimal management of incisions in the early postoperative time period.”

Treatment of Chronic Achilles Tendon Ruptures with Large Defects

The Achilles tendon is the strongest and longest tendon in the human body. It is also the most commonly ruptured tendon in the lower extremity. When an Achilles tendon ruptures and is initially misdiagnosed, thus becoming a chronic injury, a defect or gap often forms at the rupture site.

There has been little research done on the best treatment for ruptures with defects of 6 cm or larger. Steven M. Raikin, MD, and colleagues conducted a retrospective study of 32 cases in which large rupture gaps (at least 6 cm) were treated with a surgical technique that combined a turndown of the proximal, central Achilles with a Flexor Hallucis Longus (FHL) tendon transfer. The number of days from injury to surgery ranged from 30 to 315, and the available data included an average follow-up of 62.3 months.



MRI showing Achilles tendon with large gap

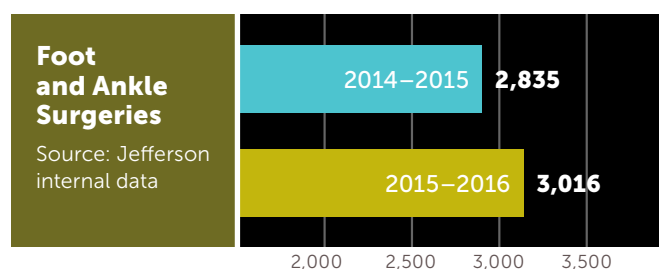


Intra-operative photograph showing the central Achilles turndown procedure

The review found overall favorable results for the surgical technique. Among the findings, reported in *Foot and Ankle Specialist* were:

- Full healing was achieved in all 32 patients within five months.
- Mean Foot and Ankle Ability Measures (FAAM) scores increased from 36.6% before repair to 90.2% at the latest follow-up.
- Mean visual analogue scales (VAS) of pain decreased from 6.6 out of 10 to 1.8 of 10 from the first and last visit.
- Postoperative complications occurred in five patients (15.6%), including three superficial wound problems, one deep wound infection and one deep vein thrombosis.
- The majority of patients reported excellent (53.1%) or good (37.5%) satisfaction.

“Our study demonstrates that combining our method of an Achilles tendon turndown with an FHL transfer to surgically treat chronic Achilles ruptures with large gaps results in a high rate of improved patient function and pain relief,” the researchers concluded. They said the method should “be strongly considered as acceptable treatment.”







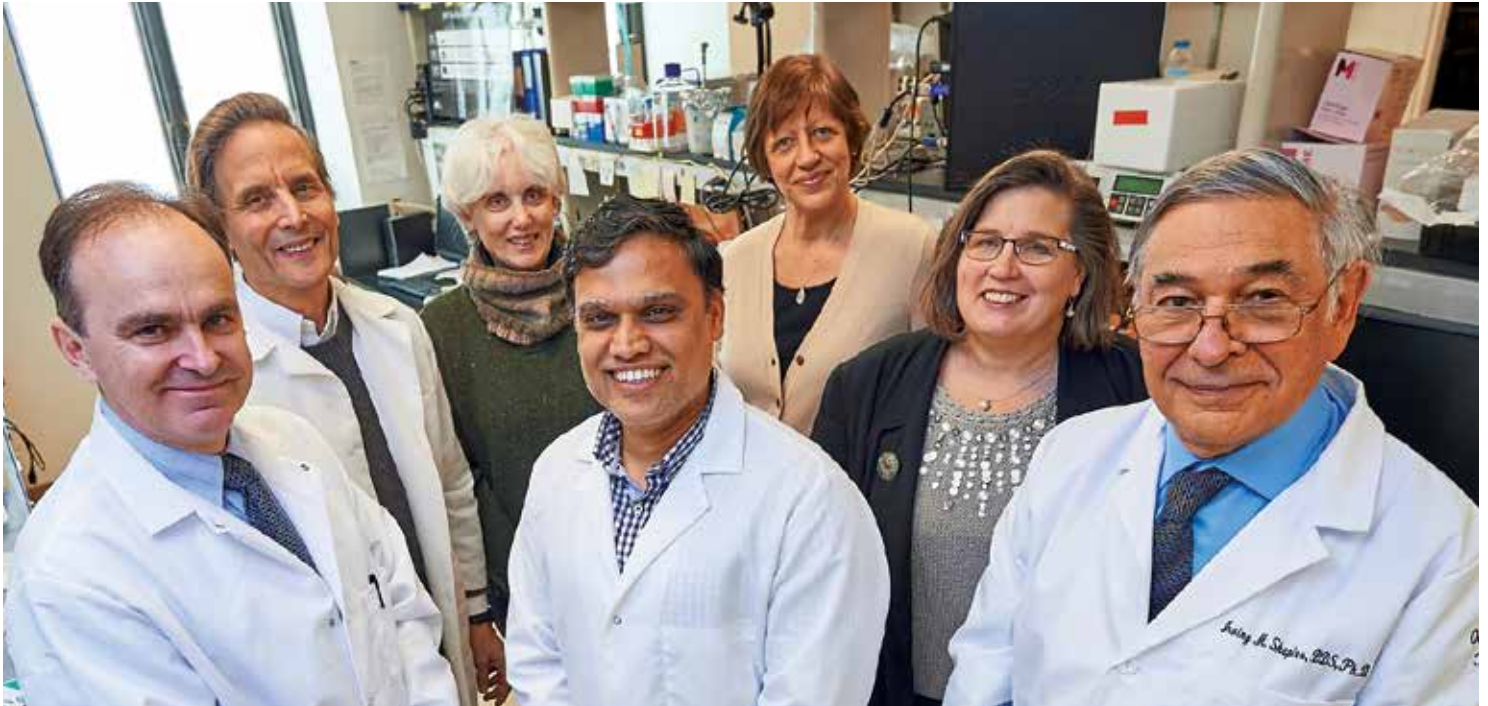
BASIC SCIENCE

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

The intervertebral disc is a complex structure that separates opposing cartilage-covered bone, permits a range of motions and accommodates high biomechanical forces. The interaction between the semifluid nucleus pulposus and the tight molecular lattice of the annulus fibrosus provides the biomechanical properties necessary for spinal stability.

Drs. Risbud and Shapiro are studying specific conditions that enhance disc cell survival as well as elucidating factors that disregulate the local microenvironment and promote degenerative disc disease. Work is focused on investigating novel transcriptional co-activators of HIF-1 in disc cells. The researchers have observed that chromatin modifying enzymes HDACs and circadian rhythm proteins BMAL1 and RORalpha control HIF-1 activity. They have found that loss of BMAL1 in mice leads to disc degeneration. Moreover, the lab recently elucidated a novel non-canonical autophagic pathway in disc cells that is hypoxia-dependent but mTOR-independent.

The researchers also are exploring the mechanisms by which inflammatory cytokines promote disc degeneration and inflammation. They found an unexpected synergism between two seemingly unrelated protein families: the heparan sulfate proteoglycans, syndecan and key catabolic molecules. They discovered that inflammatory cytokines upregulate syndecan-4 expression and influence the expression and activity of A Disintegrin and Metalloproteinase with Thrombospondin motifs (ADAMTS) as well as Matrix Metalloproteinase 3 (MMP-3), which promote the breakdown of the proteoglycan and the collagen-rich matrix of the disc. While these events probably represent an initiating factor leading to degeneration, the researchers noted that the inflammatory cytokines promote chemokine expression by disc cells and are thus instrumental in chemotaxis and macrophage infiltration. This finding led to the generation of a more comprehensive theory encompassing feed-forward events triggering back pain as well as the amplification of inflammatory events that promote disc degeneration.



From left to right: Andrzej Fertala, PhD, George Feldman, DMD, PhD, Noreen Hickok, PhD, Makarand V. Risbud, PhD, Dessislava Markova, PhD, Theresa A. Freeman, PhD, Irving Shapiro, BDS, PhD

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

Developmental Dysplasia of the Hip (DDH) is a debilitating condition characterized by incomplete formation of the acetabulum and/or femur. This can lead to dislocation of the femur, suboptimal joint function and accelerated wear of the articular cartilage, resulting in a crippling arthritis of the hip. Jefferson researchers studying the DNA of a four-generation family have found a potentially harmful mutation in the CX3CR1 receptor.

This DNA variant has been shown by researchers in China to increase a person's odds of getting DDH by a factor of 2.5. A potentially harmful mutation in the teneurin3 gene has been identified in another family. Both of these DNA changes are thought to delay the maturation of stem cells in forming the cartilage anlage of the labrum of the acetabulum.

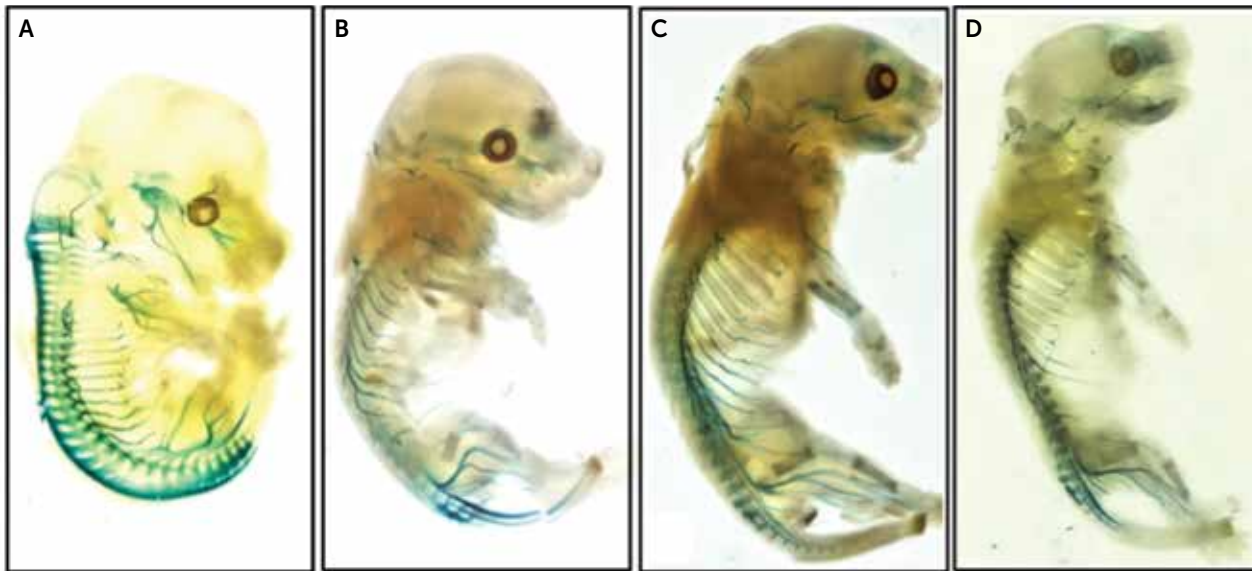
To test this hypothesis, mice with similar mutations have been made and used to examine the causative relationship between changes in the DNA and changes in the hip socket. Mice with a dysfunctional CX3CR1 receptor appear to show changes in their hip sockets similar to those seen in humans. The mice also demonstrate gait abnormalities that are consistently seen in humans and mice with osteoarthritis of the hip.

Dr. Feldman and colleagues have broadened the relevance of these findings to include unrelated individuals with DDH. In addition to mutations in both

the teneurin3 and CX3CR1 genes, they have found that these severely affected individuals have mutations in genes linked to the pathways in which both of these family-linked susceptibility inducing genes reside. The researchers have found potentially harmful changes in the DNA of these sporadic individuals that are in genes shown in dogs to be linked to the canine version of DDH. Identification of these mutations may lay the foundation for an accurate diagnostic test in newborns and prevent hip dysplasia from developing into osteoarthritis.

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

New bone is formed at sites of high strain and removed in areas of low strain. This process enables bone mass and geometry to adapt to changing functional demands by generating bone where it is needed and eliminating bone that is underutilized. Although the detection of forces in the skeleton has traditionally been attributed to osteocytes, recent work has raised the possibility that sensory nerves, which blanket the surfaces of bone, occupy a privileged location for the acquisition of mechanical signals. Nearly all of these nerves express TrkA, the high affinity receptor for nerve growth factor (NGF). Dr. Tomlinson's lab previously identified a critical role for high-affinity nerve growth factor receptor (NGF-TrkA) signaling in skeletal development, during which osteochondral progenitors express NGF to coordinate the innervation, vascularization and ossification of long bones. The researchers have demonstrated that NGF is robustly expressed by mature osteoblasts in response to



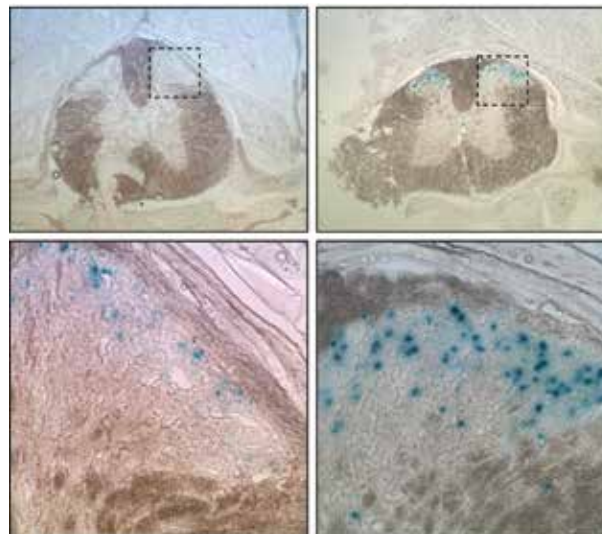
Embryo samples:
 A – Embryonic Day 14.5
 B – 16.5
 C – 18.5
 D – Post natal date zero

Reporter animals that express Track A (TrkA: neurotrophic tyrosine kinase receptor type 1) show us how Track A sensory nerves extend toward bone during development

non-damaging mechanical loads. Inhibition of NGF-TrkA signaling impairs load-induced bone formation whereas administration of exogenous NGF increases relative bone formation rates. Ongoing studies are focused on identifying the pro-osteogenic factors released by TrkA sensory nerves in response to NGF as well as developing mutated forms of NGF to minimize non-osseous effects. The research suggests that modulation of NGF-TrkA signaling may be an attractive target for improving the skeletal response to loading and reducing overall fracture risk.

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

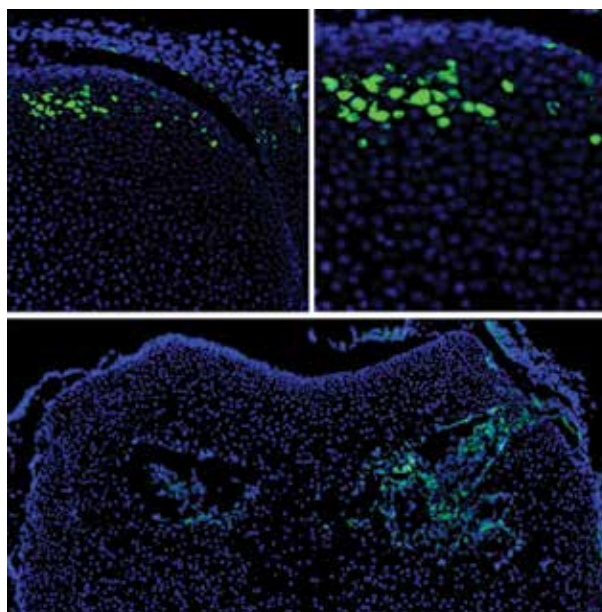
Dr. Freeman has been working in the field of plasma medicine to develop therapeutic applications of a novel non-thermal atmospheric dielectric barrier discharge plasma (cold plasma). Investigations of plasma treatment of mesenchymal cells and mouse limbs and extracellular matrix have enhanced cell differentiation and limb growth, promoted regeneration of cartilagenous tissues and increased bone formation. In addition, plasma treatment can sterilize the surface of implants and destroy biofilms, and kill cancer cells and simultaneously promote T-cell recognition to eliminate melanoma tumors. These examples show the numerous potential medical applications of this technology and ways it can further the understanding of plasma/cell and tissue interactions. Repair and regeneration of tissues after injury or wounding is an important area of study that impacts multiple diseases. The development of musculoskeletal tissue dysfunction or degeneration can often be attributed to a trauma that occurs at a younger age but over time results in the degeneration of tissue function, loss of activity and pain. If a treatment could be given at the time of the injury that reduced tissue damage



Animals that express a protein called Beta Gal (β-galactosidase)

Cross sections of spine stained using X-Gal (to reveal Wnt signaling)

Zoomed-in portion is the Dorsal Horn



NGF expressing cells at the distal end of the femur

Vascular canal is populated with NGF cells in secondary ossification

Green is NDF
 Blue is Dapi

and promoted tissue regeneration, the later development of musculoskeletal tissue degeneration could be dramatically slowed. Dr. Freeman is 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, which not only limits cartilage degeneration by reducing tissue destruction but also stimulates endogenous cells to activate repair cascades to generate a more robust healing/regenerative response.

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

Fibrosis, which results from excessive and disorganized collagen production, can affect almost all tissues. Following knee injury or knee replacement surgery, for instance, arthrofibrosis can cause a painful and debilitating condition known as stiff knee.

Dr. Fertala and a group of orthopaedic surgeons are examining novel ways to block excessive collagen production, with the goal of preventing abnormal scarring and improving recovery. Inhibition of the extracellular process of collagen fibril formation represents a new approach to limiting posttraumatic or postsurgical localized fibrosis. The group has demonstrated that a monoclonal antibody that targets the C-terminal telopeptide of the $\alpha 2$ chain of human collagen I is able to block critical collagen I-collagen I interaction, thereby reducing the amount of collagen deposits in vitro and in animal models.

The approach is being tested in a preclinical study with the use of a clinically relevant animal model. Data indicate that the anti-collagen antibody reduces the amount of newly-formed collagen fibrils in an injured joint capsule, thereby improving the range of motion of an antibody-treated knee. Ongoing studies will further define benefits and limitations of the proposed approach to limit post-traumatic stiffness of joints and test its clinical potential. The group is also engaged in work on reducing neurofibrosis in peripheral nerves.

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

Prosthetic joint infections (PJI) are difficult to diagnose and hard to treat. It is critical to find effective prevention, treatment and diagnostic strategies. Typically, surgeons give antibiotics before and immediately after surgery to minimize the chances of infection. Research from



Noreen Hickok, PhD, researching infection of bones and joints.

Dr. Hickok's lab has shown that the joint environment can mask infection, making it more difficult for antibiotics to work. This difficulty arises because of bacterial interactions with the joint fluid as well as their interactions with hardware. Researchers have used various methods to make implanted materials antibacterial, including performing surface modifications of orthopaedic hardware for joints or spine with antibiotics. They are also testing whether it would be more effective to utilize implant hardware that comes pre-loaded with antibiotics, which could be activated if necessary.

These devices could be triggered by ultrasound to release locally targeted antibiotics. Another application involves using soft materials that are loaded with antimicrobial compounds. Bacterial adhesion causes local release of the drugs, eliminating bacterial colonization of implanted materials. An additional application involves light-activated therapy that could be used during an operation to reduce the risk of infection.

From the Laboratory of Rowena McBeath, MD, PhD, Assistant Professor of Orthopaedic Surgery

Tendinosis results in painful movement of bones and joints. Current treatment involves physiotherapy, steroid injections and surgery if pain persists. However the cellular basis of tendinosis is unknown. Dr. McBeath, a hand surgeon and clinician scientist, studies human tendon cells in culture and the mechanical and intramolecular signaling mechanisms that govern their proliferation and differentiation. Recent studies on tendinosis of the wrist, named DeQuervain's tendinosis, has linked disease severity with development of chondroid metaplasia of the tendon compartment tissue. Dr. McBeath's studies on human tendon cells have revealed a capacity of these cells to transdifferentiate, or change their phenotype from tendon to fibrocartilage. These findings may explain the mechanism by which tendinosis develops in patients, and suggest further direction into development of cellular and molecular therapies for these painful conditions.

FUNDED CLINICAL TRIALS

INVESTIGATOR(S)

A Prospective, Randomized Control Trial of Post-Operative Pain Management Following Primary Single Level Open or MIS TLIF - A Multi-Center ACSR Study Protocol. Association for Collaborative Spine Research (01/2015-ongoing)	Mark F. Kurd, MD; Kristen E. Radcliff, MD; Alexander R. Vaccaro, MD, PhD; Christopher Kepler, MD
Association for Collaborative Spine Research (ACSR) Radiation Exposure Registry. Association for Collaborative Spine Research (02/2015-ongoing)	Kristen E. Radcliff, MD; Christopher Kepler, MD; Mark F. Kurd, MD; Alexander R. Vaccaro, MD, PhD; Alan S. Hilibrand, MD
The Development and Validation of Disease Specific Outcome Instruments for Spine Trauma - International Validation of AO Patient Reported Outcome Spine Trauma. AOSpine (07/2015-ongoing)	Kristen E. Radcliff, MD; Christopher Kepler, MD; Mark F. Kurd, MD; Alexander R. Vaccaro, MD; PhD; Alan S. Hilibrand, MD
Cellentra Viable Cell Bone Matrix (VCBM) Anterior Cervical Discectomy and Fusion Outcomes Study (VCBM/MaxAn®) Biomet (11/2014-ongoing)	Christopher Kepler, 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. Pfizer (01/2015-ongoing)	Christopher Kepler, MD; Alexander R. Vaccaro, MD; PhD
Post Market Clinical Follow Up Study of the Titan Reverse Shoulder System Used in Primary or Revision Total Shoulder Arthroplasty. Zimmer (06/2014-ongoing)	Surena Namdari, MD; Matthew L. Ramsey, MD; Joseph A. Abboud, MD; Charles L. Getz, MD
A Retrospective and Prospective Data Collection Study of the Titan Modular Total Shoulder System. (TSS) Zimmer (03/2015-ongoing)	Surena Namdari, MD; Matthew L. Ramsey, MD; Joseph A. Abboud, MD; Charles L. Getz, MD
Retrospective and Prospective Clinical Outcomes of the Zimmer Nexel Total Elbow. Zimmer (06/2015-ongoing)	Surena Namdari, MD; Matthew L. Ramsey, MD; Joseph A. Abboud, MD; Charles L. Getz, MD
Prospective Post Market Clinical Follow-Up Study of the Zimmer Trabecular Metal Humeral Stem. Zimmer (04/05/2012-ongoing)	Joseph A. Abboud, MD
Retrospective, Post-Market, Clinical and Radiographic Follow-Up Study of the DePuy Delta Xtend Reverse Shoulder System. DePuy Synthes (9/24/2013-ongoing)	Joseph A. Abboud, MD; Gerald R. Williams, Jr., MD
A Phase II Randomized, Double-Blind, Placebo Controlled Study to Assess Safety, Tolerability and Effect on Tumor Size of MCS110 in Patients with Pigmented Villonodular Synovitis (PVNS). Novartis (10/1/2013-ongoing)	John A. Abraham, MD
Post-Market Clinical Follow-Up Study of the Zimmer Vivacit-E Highly Crosslinked Polyethylene William V. Arnold, MD; PhD; Liner Used with the Continuum Acetabular Shell. Zimmer (10/1/2013-ongoing)	Javad Parvizi, MD
Prospective Post-Market Clinical Follow-Up of the Zimmer Trabecular Metal Reverse Luke S. Austin, MD; Matthew D. Pepe, MD; Shoulder System. Zimmer (08/2011-ongoing)	Bradford S. Tucker, MD
Prospective Clinical Evaluation Treating Subchondral Bone Marrow Lesions with Subchondroplasty for Pain Relief. Knee Creations LLC (3/15/2012-ongoing)	Steven B. Cohen, MD
Trabecular Metal Femoral Hip Stem Used within the Zimmer Hip Registry. Zimmer (02/09/2012-ongoing)	Carl Deirmengian, MD
Prospective Post-Market Clinical Follow-Up of the Zimmer Trabecular Metal Reverse Charles L. Getz, MD; Shoulder System. Zimmer (08/23/2011-ongoing)	Matthew L. Ramsey, MD
Ascension Radial Head. Integra Life Sciences (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. Zimmer (7/18/2013-ongoing)	Charles L. Getz, MD; Matthew L. Ramsey, MD; Joseph A. Abboud, MD
Post-Market Study of the Stryker Orthopaedics Triathlon TS Total Knee System. Stryker Orthopaedics (4/1/2012-ongoing)	Fabio R. Orozco, MD; Alvin C. Ong, MD
Persona Outcomes Knee Study (POLAR). Zimmer (3/1/2013-ongoing).	Matthew S. Austin, MD
Retrieval of Discarded Surgical Tissue. National Disease Registry Institute (1/12/2004-6/30/2013)	Javad Parvizi, MD; Peter F. Sharkey, MD; James J. Purtill, MD; William J. Hozack, MD; Richard H. Rothman, MD, PhD
Multi-Center Trial of the Continuum Ceramic Bearing System in Total Hip Arthroplasty. Zimmer (08/05/2010-ongoing)	Javad Parvizi, MD; William J. Hozack, MD; Matthew S. Austin, MD
Evaluation of In-Vivo Wear of Ceramic Femoral Head Against Highly Cross-Linked Polyethylene: A Comparative Study. Ceramtec (11/2011-ongoing)	Javad Parvizi, MD
Retrospective and Prospective Data Collection Study of the Titan Modular Total Shoulder System (TSS) Integra (8/2014-present)	Surena Namdari, MD; Matthew Ramsey, MD; Joseph Abboud, MD; Mark Lazarus, MD; Gerald Williams, MD; Charles Getz, MD

FUNDED CLINICAL TRIALS

INVESTIGATOR(S)

Prospective Post Market Clinical Follow-Up Study of the Zimmer® Trabecular Metal™ Total Ankle System. Zimmer (8/2014-present)	Steven Raikin, MD; David Pedowitz, MD
A Multi-Center 2x2 Factorial Randomized Trial Comparing Sliding Hip Screws Versus Cancellous Screws and Vitamin D versus Placebo on Patient Important Outcomes and Quality of Life in the Treatment of Young Adult (18-60) Femoral Neck Fractures. McMaster University (8/2014-present).	James Krieg, MD; Asif Ilyas, MD; Gregory Deirmengian, MD; Sommer Hammoud, MD; John Abraham, MD; Jamal Ahmad, MD
Prophylactic Antibiotic Regimens in Tumor Surgery (PARITY): A Multi-Center Randomized Controlled Study Comparing Alternative Antibiotic Regimens in Patients Undergoing Tumor Resections with Endoprosthetic Replacements. McMaster University (2/2014-present)	John Abraham, MD; Barry Kenneally, MD
Triathlon Titanium Knee Outcomes Study. Stryker (4/2014-present)	Fabio Orozco, MD; Alvin Ong, MD; Zachary Post, MD
Post Market Study of the Stryker Orthopaedics Triathlon PKR Knee System. Stryker (11/2013-Present)	Fabio Orozco, MD; Alvin Ong, MD; Zachary Post, MD
Clinical study protocol for the Investigation of the Simplify Cervical Artificial Disc. Simplify Medical (04/2016-present).	Kristen Radcliff, MD; Barrett Woods, MD
A Prospective, Multicenter Study of Instrumented Posterolateral Lumbar Fusion (PLF) with OsteoAMP® to Evaluate Long-Term Safety and Efficacy in Patients Requiring 1-2 Level Instrumented PLF. Bioventus, LLC (01/2016-present).	Barrett Woods, MD; Kristen Radcliff, MD
A Prospective, Randomized, Comparative Study to Assess the Prevention of Surgical Site Infection (SSIs) in Revision Total Joint Arthroplasty Patients treated with Single-Use Negative Pressure Wound Therapy (PICO) or standard care dressing (AQUACEL Ag Surgical Dressing). Smith and Nephew (12/2015-present).	Antonia Chen, MD; Javad Parvizi, MD; Matthew Austin, MD; William Hozack, MD; James Purtill, MD
A Phase 2a Randomized, Single-Blind, Placebo-Controlled, 24-week Escalating Dose Study to Assess the Safety, Tolerability and Clinical Activity of 3 Concentrations of Locally Applied MBN-101 to Infected Osteosynthesis Sites. Microbion Corporation (3/2016-current).	James Krieg, MD
Use of Autologous Adipose-derived Stromal Vascular Fraction to treat osteoarthritis of the knee; a controlled, randomized, double blinded trial. GID Group (04/2016-present).	Bradford Tucker, MD
A Phase 2b/3, Double-blind, Randomized, Placebo-Controlled, Multicenter Study to Assess the Efficacy and Safety of VX-210 in Subjects With Acute Traumatic Cervical Spinal Cord Injury. Vertex Pharmaceuticals, Incorporated (04/2016-present).	Alexander Vaccaro, MD, PhD; Chris Kepler, MD; Greg Schroeder, MD; Alan Hilibrand, MD
One Stage versus Two Stage For Periprosthetic Hip And Knee Infection. Orthopaedic Research and Education Foundation (05/2016-present).	Javad Parvizi, MD; Antonia Chen, MD; Matthew Austin, MD; Greg Deirmengian, MD
Evaluation of Post-Operative Pain Following Primary Total Knee Arthroplasty with Intraoperative Subanesthetic Ketamine Administration and Spinal Anesthesia. Sharpe-Strumia Research Foundation (06/2016-current).	Eric Levicoff, MD; Robert Good, MD
An open-label, multi-center, randomized study to evaluate the safety and efficacy of oral fusidic acid (CEM-102) in combination with oral rifampin for prosthetic joint infection, in comparison with standard of care intravenous antibiotic treatment regimens, during two-stage prosthesis exchange. CEM-102 Pharmaceuticals, Inc. (01/2014-present).	Javad Parvizi, MD; William Hozack, MD; Richard Rothman, MD; Matthew Austin, MD; Gregory Deirmengian, 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 Multicenter Randomized Clinical Trial. The Knee Society (09/2016-present).	Matthew Austin, MD; Javad Parvizi, MD; Antonia Chen, MD; Gregory Deirmengian, MD; James Purtill, MD; William Hozack, MD; Richard Rothman, MD
Understanding the Presence of Bacteria in the Glenohumeral Joint by Polymerase Chain Reaction (PCR)-Based Electron Spray Ionization of Time-of-Flight Mass Spectrometry (ESI-TOF-MS): An Evaluation of Non-Arthritic, Arthritic, and Revision Arthroplasty. Orthopaedic Research and Education Foundation (07/2016-present).	Surena Namdari, MD
Novel Antibiotic Prophylaxis in Orthopedic Arthrodesis Surgeries. Orthopaedic Research and Education Foundation (07/2016-present).	Antonia Chen, MD
The Effect of Cytokine Levels on the Clinical Outcomes in Patients Undergoing Anterior Cervical Discectomy and Fusion. Orthopaedic Research and Education Foundation (07/2016-present).	Gregory Schroeder, MD
The Investigational Plan for the Evaluation of the ACADIA Facet Replacement System. Globus Medical (8/2013-present).	Victor Hsu, MD

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FUNDED CLINICAL TRIALS

INVESTIGATOR(S)

Short, Medium, and Long Term Survivorship of the Attune Primary Total Knee Prostheses. DePuy Synthes (9/2013-present).	Andrew Star, MD
Dynesys Post Market Clinical Outcome Study. ZimmerBiomet (6/2014-present).	Michael Gratch, MD
Joint Registry - General Outcomes DePuy Tracking System (DOTS). DePuy Synthes (8/2010-current).	Andrew Star, MD
A Prospective, Multi-Center, Randomized Study Comparing the VertiFlex Superior Interspinous Spacer (ISS) to the X-STOP Interspinous Process Decompression (IPD) System in Patients with Moderate Lumbar Spinal Stenosis. VertiFlex, Inc. (10/2009-present).	Guy Lee, MD
MIS-ReFRESH- Multi-center, partially randomized, controlled trial of MIS Robotic vs. Freehand in Short Adult Degenerative Spinal Fusion Surgeries. Mazor Robotics, Ltd. (9/2016-present).	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. Orthospace, Ltd. (1/2016-present).	Joseph Abboud, MD
Influence of lateralization on outcomes after reverse arthroplasty? A randomized controlled trial. DJO Surgical (10/2016-present).	Joseph Abboud, MD; Surena Namdari, MD; Gerald Williams, MD
Investigator Driven: FlexiGraft Rotator Cuff Study. Arthrex, Inc. (9/2016-present).	Joseph Abboud, MD; Surena Namdari, MD; Charles Getz, MD
Arthrex Shoulder Arthroplasty Registry Protocol. Arthrex, Inc. (9/2016-present).	Joseph Abboud, MD; Surena Namdari, MD; Charles Getz, MD
A Prospective, Randomized, Multicenter Study to Evaluate the Safety and Efficacy of Arthrex Eclipse Shoulder Arthroplasty System. Arthrex, Inc. (4/2016-present).	Joseph Abboud, MD; Surena Namdari, MD; Charles Getz, MD
Tornier Shoulder Outcomes Study. Tornier, Inc. (10/2014-present).	Joseph Abboud, MD; Mark Lazarus, MD; Gerald Williams, MD
Pyrocarbon IDE study. Tornier, Inc. (03/2016-present).	Joseph Abboud, MD; Surena Namdari, MD; Charles Getz, MD
Post-Market Study of Robotic-Arm Assisted Total Knee Arthroplasty. Stryker, Corp. (7/2016-present).	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. Integra (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. AO Foundation (10/2016-present).	Alexander Vaccaro, MD, PhD; Gregory Schroeder, MD; Christopher Kepler, MD
Prospective, Single-Blinded Randomized-Control Comparison of Platelet Rich Plasma versus Corticosteroid Injection for Treatment of Trigger Finger (Sponsored by Arthrex)	A. Lee Osterman, MD; Randall W. Culp, MD; Sidney M. Jacoby, MD; Patrick M. Kane, MD
Interosseous Membrane Reconstruction with Bone-Patellar Tendon-Bone Graft for the Chronic Essex-Lopresti Injury: Outcomes at Over Ten-Year Mean Follow-Up.	A. Lee Osterman, MD; Randall W. Culp, MD; Sidney M. Jacoby, MD; Patrick M. Kane, MD
Capitate Implant Resurfacing with Proximal Row Carpectomy for Treatment of Wrist Arthritis	Randall W. Culp, MD
Prospective Comparison of Robert's- and Bett's-view Radiographs for Evaluation of Basal Thumb Arthritis: Analysis of Interobserver Reliability and Patient Preference	Sidney M. Jacoby, MD; Eon K. Shin, MD; Patrick M. Kane, MD
Platelet Rich Plasma Injection and Needling for Treatment of Lateral Epicondylitis: Comparative Outcomes of Needle Tenotomy Versus "Peppering"	A. Lee Osterman, MD; Randall W. Culp, MD; Sidney M. Jacoby, MD; Patrick M. Kane, MD
Prospective Randomized Control Trial Investigating the Effect of Patient Education on Post-Operative Opioid Consumption Following Common Hand and Wrist Surgeries	Patrick M. Kane, MD; Eon K. Shin, MD; Sidney M. Jacoby, MD
Prospective Single-Blinded Randomized Controlled Trial Comparing Outcomes and Revision Rates Following Tenolysis with and without AlloWrap® Amnion Membrane Barrier	Randall W. Culp, MD
Multicenter Randomized, Controlled Trial Comparing Combination Therapy of Ibuprofen + Acetaminophen versus Hydrocodone + Acetaminophen for the Treatment of Pain after Carpal Tunnel Surgery	Patrick M. Kane, MD; Blane A. Sessions; A. Lee Osterman, MD; Sidney M. Jacoby, MD
A Multicenter Prospective Evaluation of Clinical and Radiographic Outcomes Following Stablyx® CMC Implant Arthroplasty for Treatment of Basal Thumb Arthritis	A. Lee Osterman, MD



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