ORTHOPAEDIC CARE IS HELD TO THE HIGHEST STANDARD IN THE DEPARTMENT AS WE REMAIN DEDICATED TO GIVING BACK TO THE COMMUNITY BY TESTING AND DEVELOPING NEW TECHNOLOGIES, AND COMMITTED TO IMPROVING SAFETY AND COST-EFFECTIVENESS.

The Department of Orthopaedic Surgery and Rehabilitation strives to provide exceptional service to all of our patients, educate the best and the brightest residents so they can become outstanding orthopaedic surgeons, and perform advanced research that impacts patients suffering from musculoskeletal disorders. I know these are lofty and ambitious goals, but we are enthusiastic about doing our best for you. Our success and professional fulfillment is measured in the futures of our patients and residents, and innovations that contribute to the advancement of our international community. We publish a biennial report to share updates of these successes with the peers and friends of our department.

New this year, we have included five patient stories that demonstrate our tripartite mission in action. We have joined many of our colleagues in contributing to the American Academy of Orthopaedic Surgeons’ (AAOS) recent A Nation in Motion: One Patient at a Time campaign, which comprises 500 stories about patients whose lives have been restored through access to high-quality orthopaedic care. We are pleased to parallel that powerful theme in our report, knowing the root of our mission is and always will be the well-being of patients. I am also proud to share that orthopaedics is one of five specialties nationally ranked at The Nebraska Medical Center, our hospital partner and the top hospital in the state, by U.S. News & World Report for 2012-13. The program is ranked No. 36 of 50 from more than 1,600 listed nationwide, which is an exceptional and hard-earned honor.

Orthopaedic care is held to the highest standard in the department as we remain dedicated to giving back to the community by testing and developing new technologies, and committed to improving safety and cost-effectiveness. I hope you’ll enjoy reading about some of the department’s groundbreaking laboratory and clinical studies throughout the report, as well as in the scientific abstracts at the conclusion. Residents are inspired by the faculty’s passion for orthopaedic surgery and ongoing developments in the field, and our ultimate goal is that they carry that passion wherever their practices take them.

We are excited to announce that Dr. Chris A. Cornett (adult spine) and Dr. M. Layne Jensen (pediatric orthopaedic and spine) joined our full-time faculty in the fall of 2011. I invite you to learn more about each of them in the “Team in Motion” section of the report.

On behalf of the faculty, residents, and staff of the Department of Orthopaedic Surgery and Rehabilitation, as well as our many patients - past, future and present – I would like to extend our gratitude for the generous financial support you have provided for us during the 2010 and 2011 calendar years. Please review our “Honor Roll of Contributors” and “Grants, Funds and Endowments” sections, which acknowledge gifts that have been vital to the success of our department’s residency program, ongoing research and much more.

I hope that you get a sense of “Lives in Motion”: the vitality of people who make up our department, and those thriving because of the work we do – as you pursue this report. We will continue to share newsworthy updates from the department with the friends and alumni who help us fulfill our mission of excellence in patient care, resident education and groundbreaking research.

Thank you for your support.

KEVIN GARVIN, M.D.
Professor & Chair

MESSAGE FROM THE CHAIR

Kevin L. Garvin, M.D., with his patient Susan Beckman
OUR MISSION IS TO IMPROVE THE QUALITY OF ORTHOPAEDIC MEDICINE THROUGH THE FUSION OF STATE-OF-THE-ART PATIENT CARE, SUPERIOR EDUCATION AND INNOVATIVE RESEARCH. OUR WORK IS NOT ONLY ABOUT PURSUING THE HIGHEST STANDARD IN EACH OF THESE AREAS, BUT MAKING CONNECTIONS BETWEEN THEM TO GIVE OUR ADVANCEMENTS THE ULTIMATE RANGE OF MOTION—IMPROVING QUALITY OF LIFE FOR OUR OWN PATIENTS AND THE GREATER COMMUNITY.


PATIENT CARE

Our department is invested in ensuring that those in need of orthopaedic medicine receive the most personalized and innovative care possible. We take an interdisciplinary approach to the prevention, diagnosis and treatment of musculoskeletal disorders in children, adolescents and adults.

Our orthopaedic surgeons are leaders in the field—many recognized as “Best Doctors in America” and serving in local, state, national and international scientific organizations. Working with experienced nurses and physicians in other specialties, we treat patients in the following areas:

ADULT RECONSTRUCTIVE AND GENERAL ORTHOPAEDICS: inflammatory and degenerative joint problems, bone and soft tissue reconstruction and prosthetic joint replacement

FOOT AND ANKLE SURGERY: common and complex foot and ankle disorders, ranging from bunions to fractures

HAND SURGERY: hand and wrist conditions such as arthritis, nerve compression and congenital hand deformities and injuries

ORTHOPAEDIC ONCOLOGY: benign and malignant bone and soft tissue tumors, bone grafts and custom prosthetic implants

SHOULDER AND ELBOW: evaluation and management of shoulder and elbow arthritis, dislocations, fractures and tendon tears

TRAUMA: emergency evaluation, treatment and long-term follow-up of fractures, dislocations and other musculoskeletal injuries

PEDIATRIC ORTHOPAEDICS: limb and spine deformities, bone and joint infections and fractures and dislocations of the arms, legs and spine in infants, children and teenagers

SPORTS MEDICINE: treatment of sports injuries or illnesses such as sprains, ligament or cartilage injuries, or joint ailments in athletes of all ages

SPINE: evaluation and management of spine conditions, such as deformities, injuries and deterioration

Each year, our team of dedicated healthcare professionals treats more than 35,000 patients from Nebraska, the Midwest and around the world.

U.S. NEWS & WORLD REPORT RANKED THE NEBRASKA MEDICAL CENTER AS NEBRASKA’S TOP HOSPITAL FOR ORTHOPAEDICS

The Nebraska Medical Center, UNMC’s hospital partner, was ranked No. 1 in Nebraska in 2012-13, and named one of America’s Best Hospitals. Of the nation’s roughly 5,000 hospitals, fewer than 150 are nationally ranked. The Nebraska Medical Center was ranked in five specialties, including orthopaedics.

The orthopaedic program was ranked No. 36 in the nation—the only one in the state—from more than 1,600 listed nationwide. The medical center also received national ranking in Cancer, Gastroenterology, Nephrology and Neurology & Neurosurgery, and “high-performing” rating in Cardiology & Heart Surgery, Diabetes & Endocrinology, Ear, Nose & Throat, Gastroenterology, Pulmonology and Urology.

“These rankings are proof of the tremendous amount of work our physicians and staff have done to care for our patients,” said Glenn A. Fosdick, president and CEO of The Nebraska Medical Center. “It’s an honor to be recognized as a leader in so many different areas.”

The Nebraska Medical Center also has 43 physicians included on the 2012-13 list of U.S. News Top Doctors, which spans 27 specialties. From the Department of Orthopaedic Surgery and Rehabilitation, Dr. Kevin Garvin has been named one of America’s Top Doctors (among the top 1 percent of orthopaedic surgeons in the nation, according to Castle Connolly’s estimation) and Dr. Matthew Mormino has been named a Regional Top Doctor (among the top 10 percent of orthopaedic surgeons).

UNMC’s pediatric hospital partner Children’s Hospital & Medical Center was nationally ranked among the top 50 for pediatric orthopaedics in U.S. News & World Report’s 2011-12 Best Children’s Hospital rankings. Also in 2011-12, U.S. News & World Report listed The Nebraska Medical Center as “high-performing” in nine specialties, including orthopaedics.
RESEARCH

ADVANCEMENTS IN PREVENTION, DIAGNOSIS AND TREATMENT ARE ACHIEVED THROUGH YEARS OF DILIGENT SCIENTIFIC RESEARCH. OUR WORLD-CLASS RESEARCH PROGRAM IS FOCUSED ON MUSCULOSKELETAL DISEASES, MOLECULAR BIOLOGY AND GENETICS, AND THE DEVELOPMENT OF LESS INVASIVE SURGICAL TECHNIQUES AND BIOMEDICAL ENGINEERING. THIS INCLUDES KNEE IMPLANT SIMULATION AND TESTING, AND COMPUTER-AIDED AND ROBOTIC SURGERY. BY REMAINING AT THE FOREFRONT OF ORTHOPAEDIC MEDICINE, WE ARE ABLE TO OFFER OUR PATIENTS THE MOST INNOVATIVE CARE AND PROVIDE OUR RESIDENTS WITH A COMPREHENSIVE, RESEARCH-LED EDUCATION TO FUEL LIFELONG LEARNING.

Our Biomechanics and Nano-Biotechnology Laboratories are located in the Scott Technology Center on the University’s Aksarben campus. Research faculty and engineers at the Biomechanics and Advanced Surgical Technologies Laboratory perform cutting-edge experimental testing of orthopaedic implants, and contribute to the development of multi-axial implant simulators. Under the direction of Hani Haider, Ph.D., the department is working to create implants that last longer and perform better for nimble, active patients. Meanwhile, our team of researchers and surgeons is working to develop a freehand, “GPS-style” surgical navigation system for knee-replacement, allowing for enhanced accuracy, better implant alignment, less trauma to soft tissue and bone and, therefore, faster recovery.

Researchers in our Nano-Biotechnology Laboratory are working with super-small nanostructures that, though undetectable to the human eye, will make a tremendous impact on orthopaedic surgery by creating hard, wear-resistant coatings to prolong the life of orthopaedic implants. Led by Fereydoon Namavar, Sc.D., the team is in close collaboration with researchers from UNMC’s departments of Genetics, Cell Biology & Anatomy, and Pathology & Microbiology. Because these coatings are extremely versatile, they have many other scientific and biomedical applications.

OUTCOMES RESEARCH: PATIENTS HELPING PATIENTS

Our patients supplement the laboratories’ ongoing orthopaedic research as we continually expand our surgical outcomes database. More than 4,000 subjects who have undergone joint replacement, revision joint surgery, shoulder surgery or treatment for Whiplash Associated Disorders (WAD) contribute to the ever-evolving treatment for future orthopaedic patients.

By allowing us to collect pre- and post-op data about surgical cases, and responding to questionnaires about their health, function, and quality of life, our patients help clinicians understand what is working well and what could be enhanced. These collections of data, or outcomes studies, serve as valuable tools for surgeons to evaluate the effectiveness of various treatments and ensure that patient care is continually improving.

As a result of the diverse range of research studies happening within the department, several posters, abstracts and presentations were accepted at the annual meetings of various orthopaedic organizations and have provided us the opportunity to share and compare findings with other institutions.

A collection of scientific abstracts at the conclusion of this report provide an in-depth look at our department’s recent research.

EDUCATION

Our department is investing in the future of Nebraska and our field by educating the best and brightest future orthopaedic surgeons, and cultivating promising educators who will teach generations of orthopaedic surgeons and cultivating promising educators who will teach generations of orthopaedic surgeons and cultivating promising educators who will teach generations of orthopaedic surgeons and cultivating promising educators who will teach generations of orthopaedic surgeons and cultivating promising educators who will teach generations of orthopaedic surgeons and cultivating promising educators who will teach generations of orthopaedic surgeons and cultivating promising educators who will teach generations of orthopaedic surgeons and cultivating promising educators who will teach generations of orthopaedic surgeons and cultivating promising educators who will teach generations of orthopaedic surgeons and cultivating promising educators who will teach generations of orthopaedic surgeons and cultivating promising educators who will teach generations of orthopaedic surgeons and cultivating promising educators who will teach generations of orthopaedic surgeons and cultivating promising educators who will teach generations of orthopaedic surgeons and cultivating promising educators who will teach generations of orthopaedic surgeons.

Our residency program provides an outstanding educational experience and enriched social environment in the safe, affordable metropolitan Omaha area.

The Nebraska Orthopaedic Residency Training Program is affiliated with The Nebraska Medical Center, Children’s Hospital & Medical Center, Omaha Veterans Affairs Medical Center, Creighton University Medical Center and Bergan Mercy Medical Center.

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RESEARCH-LED EDUCATION TO FUEL LIFELONG LEARNING.
This biennial report is not simply about the work we do, but why we do it and the ways in which faculty, staff, resident, physician and patient lives intersect with one another and the community at large.

The strength of our mission will be communicated through the stories of five of our patients, who are the most sincere testament to effective integration of the education, research and patient care that give their bodies motion and make our work personal.
PATIENTS IN MOTION

GINGER LOSTROH ALWAYS DEFINED HERSELF AS AN ATHLETE. AT AGE 30, HER WORLD TURNED UPSIDE DOWN WHEN HER RIGHT LEG APPEARED TO BE COMPLETELY SEVERED BY AN AUTO ACCIDENT. EIGHT YEARS LATER – AND A BETTER TENNIS PLAYER THAN EVER – SHE WOULDN’T TAKE BACK HER TRAUMA, EVEN IF SHE HAD THE OPTION.

“WITH AN IMPOSSIBLE CRYSTAL BALL SITUATION FACING US ON DAY ONE, WE MADE THE RIGHT CHOICE FOR GINGER,” DR. MORMINO SAID.
Ginger suffered a complex tibia-fibula fracture with substantial soft tissue loss. Dr. Michael Clare (a foot and ankle surgeon with the department at the time) took Ginger on as a patient, consulting with his partner Dr. Matthew Mormino. The physicians faced a tough decision: attempt to save the leg, or amputate it and immediately move Ginger toward rehabilitation with a prosthesis. "You don't have the opportunity to know the patient very well; they show up one day and you have to make a choice," Dr. Mormino said. "A lot of things go into determining whether or not to amputate, including the severity of the injury itself, but also their ability to tolerate undergoing multiple surgeries and the mental aspects of 'living for your leg' for a long period of time."

After the initial inspection, Dr. Clare and Dr. Mormino made the choice most medical centers wouldn't have. Ginger underwent a series of surgeries during a monthlong hospitalization to clean up the wound and stabilize the bone with a metal rod from the knee to the ankle. Dr. Perry Johnson performed plastic surgery to help cover the bone defect by rotating muscle over it, and the soft tissue envelope healed without infection or consequential systemic illness.

Prior to this trauma, Ginger was at peak fitness—playing tennis, running marathons and competing in triathlons. With the bone stabilized, Ginger set out to regain strength with two years of arduous daily physical therapy.

INSPIRING RESOLVE

Although stabilized, Ginger’s bone took quite a bit of work to heal. Based on x-rays after the initial surgery, Dr. Clare and Dr. Mormino collaboratively decided to perform an exchange rodding of her tibia (replacing the existing rod with a larger one). "The doctors would meet as a group, to discuss case studies and the best way to proceed. You feel like you’re getting the best overall care when you know they’re discussing options," Ginger remembered.

In the meantime, Ginger returned to life as usual, largely due to her own resolve.

Roughly 18 months into intensive physical therapy, she was able to put weight on her leg again and began to play tennis. Before long, she improved from a 3.0 to a 4.5 amateur ranking—quite unlikely for a player who hasn’t been trained since childhood, much less one without a healed bone. (Professional tennis players start ranking at a 5.0.)

“Ginger was determined to live her life and accept that her leg was going to slow her down a bit, but not much,” said Dr. Mormino.

Dr. Mormino had officially inherited Ginger’s care when Dr. Clare left Omaha in 2005. He was exploring the possibility of enrolling her in a phase III stem cell clinical trial because cases like hers inspired his interest in capturing stem cells and using them to stimulate bone healing. Unfortunately, Ginger’s workman’s compensation carrier wouldn’t cover the procedure. Instead, Dr. Mormino treated her with a surgery to expose the fracture site and graft with bone morphogenetic proteins (BMP)—a product naturally found in bones that helps stimulate healing.

“I was exploring the possibility of enrolling her in a phase III stem cell clinical trial because cases like hers inspired my interest in harvesting stem cells and using them to stimulate bone healing. Unfortunately, Ginger’s worker’s compensation carrier wouldn’t cover the procedure. Instead, it was decided to treat her with a surgery to expose the fracture site and graft the area with bone morphogenetic proteins (BMP)—a product naturally found in bones that helps stimulate healing.”

"For years, people have been looking for the magic bullet to stimulate bone healing. I don’t think BMP is that magic bullet, but it’s close," Dr. Mormino said. "In all of our clinical studies, it looks like BMP is equivalent to using a patient’s own bone.”

“THIS ACCIDENT WAS KIND OF LIKE TAKING AWAY THE ONE THING THAT DISTINGUISHED ME AND MADE ME FEEL GOOD ABOUT MYSELF. LOSING MY LEG WOULD CHANGE EVERYTHING," SHE SAID. “BUT WHEN I WOKE UP AND THE LOWER PART OF MY LEG WAS STILL THERE, EVEN THOUGH I WAS TOLD I STILL MIGHT, I NEVER THOUGHT THAT I WOULD LOSE IT. I KNEW I HAD A LONG ROAD AHEAD OF ME, BUT THEY WERE GIVING ME A CHANCE.”
The BMP procedure was very successful, but still didn’t result in a union. Over the course of six years, Ginger had radiograph appointments with Dr. Mormino and department residents every three months.

“My goal was to provide her with a healed tibia. I was never in doubt that she was going to have a good result out of this, but I also knew it was going to take a while,” Dr. Mormino said. “She saw several generations of orthopaedic surgery residents come and go.”

A LEAP OF FAITH
Although much of Ginger’s bone regenerated over the years, her leg still wasn’t fully healed. In 2008, her workman’s compensation provider requested that she get a second opinion before moving forward. Ginger visited with a recommended orthopaedic limb specialist in Denver, CO, who proposed excising 6-7 centimeters of assumedly dead bone, and conducting bone transport (pulling the live bone apart to form new bone) by placing an external fixator on her leg for up to two years.

“A SUCCESSFUL TIBIAL UNION
In 2010, Dr. Mormino took Ginger to the operating room for a final time to perform an open reduction internal fixation (ORIF) surgery, using plates and screws supplemented with iliac crest (pelvis) bone autograft to heal the tibial nonunion. ORIF in itself is a common surgical procedure, but Dr. Mormino took an atypical approach by placing the plate, screws and graft around the metal rod she already had in place, rather than performing an exchange nailing or removing it. This is a procedure Dr. Mormino has performed 15 to 20 times during his career with great success. He shares this technique with the orthopaedic residents and has presented research outcomes nationally.

Matthew A. Mormino, M.D.
Orthopaedic Traumatology and Lower Extremity

“I FORGET THAT I EVEN HAVE A DAMAGED LEG. IF I HAD A CHOICE TO TAKE BACK THE ACCIDENT, I WOULDN’T DO IT. I HAVE MET SOME OF MY GREATEST FRIENDS AND IT HASN’T REALLY IMPEDED ME. AND IF I CAN GET OVER THIS, WHAT OTHER CHALLENGES ARE THERE THAT I CAN’T OVERCOME?”

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Despite that Ginger had been fully functional for years, this procedure would set her back tremendously in terms of movement and rehabilitation.

Now Ginger faced her own tough “crystal ball” choice between two drastically different opinions: one doctor telling her that, although not fully healed, she had made progress and should stay on course; and another telling her that the treatment to date had been a failure.

“Ultimately, Ginger took that leap of faith in me – with me – and we were right,” Dr. Mormino said, believing that it came down to a trusting relationship.

Ginger still plays tennis and finished the Bicycle Ride Across Nebraska (BRAN) in 2010. “I forget that I even have a damaged leg,” Ginger said. “If I had a choice to take back the accident, I wouldn’t do it. I have met some of my greatest friends and it hasn’t really impeded me. And if I can get over this, what other challenges are there that I can’t overcome?”
“DR. GARVIN IS A BRILLIANT SURGEON. HE BOUGHT ME 10 SOLID YEARS AND HE SAVED ME. I DO MEAN THAT WITH ALL MY HEART AND SOUL.”

PATIENTS IN MOTION

SUSAN MILLER-HARSin WAS TWO WEEKS OUT FROM DELIVERING HER THIRD SON WHEN SHE BROKE HER HIP. IT WAS FIRST SUGGESTED SHE HAVE IT REPLACED AT AGE 35, BUT UNDER THE THOUGHTFUL CARE OF DR. KEVIN GARVIN, SHE WAS ABLE TO HOLD OFF UNTIL A SUPERIOR MATERIAL CAME TO BEAR. NOW SHE THRIVES—HORSEBACK RIDING AND BIKE RIDING LIKE HER BODY WAS BUILT TO DO.
Throughout her pregnancy, Susan had endured terrible hip pain that was dismissed by her prenatal care providers. Whether an impending stress fracture coincidentally caused her fall, or the trip caused the break upon impact is unknown; but Susan was rendered motionless at the foot of the stairs. Her son Zach, age 4, called 9-1-1 and was able to guide rescuers to the house.

Susan was taken to Memorial Community Hospital in Blair, and later a hospital in Omaha, because the now distressed baby was in a hurry to send her into labor. Doctors calmed the baby in utero and an orthopaedic surgeon pinned her femoral neck fracture - placing several screws across the bone. She delivered Drew by caesarian section two weeks later, and spent a time caring for her three young boys from a wheelchair.

Six trying months passed and Susan returned to her orthopaedic surgeon complaining of pain. Her discomfort and concern were again rebuffed, and it was suggested that she return in a year to have her hip replaced.

GETTING A SECOND OPINION
Susan was frustrated, hurting and in need of another opinion. A friend referred her to Dr. Kevin Garvin at UNMC in December 1994.

Dr. Garvin reviewed her x-rays and identified a nonunion where the femoral neck had failed to heal. Susan was also suffering from avascular necrosis in the ball of her hip (a lack of blood supply to the bone tissue that ultimately causes collapse and arthritis). Knowing that she would ultimately need a total hip replacement and that many doctors would choose to perform one immediately, Dr. Garvin also knew that available prosthetic materials weren’t ideal, and believed he could optimize her functionality by helping her keep her own parts as long as possible.

On January 11, 1995, he performed a femoral osteotomy to help the nonunion heal and a revascularization procedure for her avascular hip bone with intent to postpone total hip replacement and improve her current function.

The surgery was successful and Susan maintained an active lifestyle for nearly 10 years, but when walking up a flight of stairs felt daunting, she knew it was time to return to Dr. Garvin.

On February 6, 2004, Dr. Garvin replaced her hip using a newly developed highly crosslinked polyethylene implant. At the time, Dr. Garvin had three material options for the hip replacement, including metal-on-metal, ceramic-on-ceramic and highly crosslinked polyethylene - a biomaterial introduced in 1999. He felt that the latter was the best fit for Susan’s youth and activity.

“TAKING A FALL”

SUSAN MILLER-HARSIN WAS EIGHT AND A HALF MONTHS PREGNANT IN MARCH 1994. SHE, HER HUSBAND AND THEIR TWO SONS HAD RECENTLY MOVED FROM OMAHA TO A RELATIVELY SECLUDED, COUNTRY HOME IN BLAIR, NE. TWO-YEAR-OLD JOSH TUMBLED DOWN THE STAIRS TO THE UNFINISHED BASEMENT ONE MORNING. IN A HURRY TO CONSOLE HIM, SUSAN FELL AFTER HIM.
Eight years later, she has no pain and is as busy as ever—horseback riding, managing her equine therapy business, bike riding and swimming. Due to her trust in Dr. Garvin, Susan brought her son Josh, now a student and cross-country runner at Kansas University, in for an evaluation of his femoral stress fractures, to ensure that her family receives the best care possible.

"My husband is an athlete. My kids are athletes. That’s our world," Susan said. "I wouldn’t have been able to participate in their world the way I do now if it weren’t for Dr. Kevin Garvin."

At the time, many physicians were opting for metal-on-metal articulation, which looked phenomenally durable in the labs, yet, years later has raised concerns associated with accumulating high levels of metal ions and toxicity in the body. Now, most agree with Dr. Garvin that highly crosslinked polyethylene is a preferable material. He has led clinical outcomes studies by following patients with highly crosslinked polyethylene bearings, including Susan Miller-Harsin, one, two and five years after surgery, and every five years thereafter. In 13 years, he has seen very positive results. To further support these findings, experts in the UNMC Orthopaedics Biomechanics and Advanced Surgical Technologies Laboratory are testing the ongoing wear on metal-on-plastic implants and exploring the impregnation of highly crosslinked polyethylene with Vitamin E, which binds to free radicals in the plastic to further enhance its strength.

Kevin L. Garvin, M.D.
Adult Reconstructive Surgery

See the abstracts "With All the Metal-Metal-Fuss, What About Femoral Head Wear in Metal-on-Plastic Total Hip Replacements—A Study of Several Designs" (Page 112) and "More Than One Type of Vitamin E Stabilized Highly Crosslinked UHMWPE Greatly Reduces Wear in TKA" (Page 114) to learn more about this research.
PATIENTS IN MOTION

FRANK HIFFERNAN SUFFERED A HUMERUS FRACTURE DURING A BASKETBALL GAME IN 2010 THAT LED DR. SEAN MCGARRY TO DISCOVER A FAST-GROWING OSTEOSARCOMA.

DR. MCGARRY TEARS UP AS HE WATCHES FRANK STRUM THE GUITAR WITH THE ARM HE ALMOST HAD TO LOSE.
X-rays indicated that the fracture was well aligned, and that they should let healing run its course without surgery. But follow-up x-rays six weeks later appeared abnormal. Concerned that the extent of Frank’s injury didn’t match its result, Frank’s physician referred him to Dr. Sean McGarry who specializes in cancers of the extremities. Dr. McGarry conducted a biopsy to discover an osteosarcoma of the proximal humerus. The rare and aggressive bone cancer appears in roughly 1,000 children and adolescents each year. Osteosarcoma usually emerges as a painful mass, the ache of which won’t subside with medication. Due to the fracture, UNMC was fortunate to catch Frank’s tumor early—speculatively, halfway through its four- to six-month growth period. “It was about as quickly as we can typically get to a patient,” Dr. McGarry said.

SALVAGING A LIMB AND A LIFE
As recently as 40 years ago, radiation and amputation were the immediate responses to osteosarcoma. Still, four in five patients died within the first five years. Around 1970, chemotherapy became the standard treatment—increasing five-year survival rates to roughly 70 percent—and, within the last 20 years, the standardized surgical procedure has evolved to limb-salvage. About 90 percent of the time limb-salvage is feasible, and, although the tumor was large, Dr. McGarry wanted to save Frank’s arm. Frank would undergo three months of chemotherapy with a medical oncologist prior to surgery. Originally, in the 1980s, 12 weeks of chemotherapy before surgery allowed time to have a custom prosthesis made. Incidentally, the protocol has enabled doctors to gauge how well the tumor is responding to chemotherapy and determine a prognosis.

Once Frank finished his initial chemotherapy, Dr. McGarry spent hours studying his new scans (x-ray, MRI and CT scans) before removing the tumor and replacing most of the humerus bone with a metal implant. Due to the amount of bone and muscle that had to be extracted, Frank does not have much shoulder function, but he can move normally from his elbow to his hand.

“All of the nerves to the hand were next to the tumorous bone, so, in surgery, I was peeling back all of the layers to save as much as possible. Now, watching him play guitar, I get tears in my eyes—knowing how close he was to not being able to do that,” Dr. McGarry said. Dr. McGarry determined that the cancer was gone and Frank was doing very well after eight additional months of chemotherapy. “We were all so relieved and thankful that it was finally over,” Frank said of himself and his parents, Cristen and John Hiffernan, III. “I learned that life is precious and every day counts.”

A LUCKY BREAK
Frank Hiffernan was playing basketball like any other 15-year-old, when he went up for a rebound and was shoved by another player. “It wasn’t particularly aggressive, but my arm broke,” Frank said.

Frank Hiffernan was playing basketball like any other 15-year-old, when he went up for a rebound and was shoved by another player. “It wasn’t particularly aggressive, but my arm broke,” Frank said.
Frank will visit UNMC for x-rays and scans every three months for two years, and slightly less frequently thereafter. “Five years is a big milestone. When you make it to five years, there’s a good chance you have the cancer beat,” Dr. McGarry said.

During the long months after diagnosis, Frank wasn’t able to go to school, but he is now back to life as a junior at Westside High School—playing on the soccer team and mastering the guitar. Although Frank first picked up the guitar at age 7, his journey through treatment allowed him to meet new people that have taught him to play and sing “like never before.”

“Dr. McGarry is a very kind-hearted man and an amazing surgeon,” said Frank. “He is obviously passionate about his work and the people he is helping.” When Frank finishes high school, he will go to college and possibly medical school to become a doctor himself.

LOOKING FORWARD

During their five years with the department, each general orthopaedic resident spends three months with Dr. McGarry. Knowing that most will not go on to practice oncology or limb-salvage, his goal is to give them the tools to recognize when an x-ray like Frank’s does not look quite right and it would be best to send him to UNMC for evaluation—giving him his best chance at life.

Osteosarcoma treatment has improved tremendously over the past half-century. Dr. McGarry devotedly acquires and shares knowledge about where the field has been, where it stands now, and where it is going. He frequently authors tumor lectures and tutorials for the Orthopedics® Hyperguide, an online resource for residents studying for board exams and practicing physicians preparing for recertification. Dr. McGarry also actively pursues clinical outcomes studies and serves on multiple panels of the National Comprehensive Cancer Network (NCCN), an alliance of experts from 21 of the world’s leading cancer centers. The NCCN allows specialists like Dr. McGarry and his peers to compare findings from patient care, clinical outcomes and clinical trials—to help set national guidelines that reflect the newest data available in cancer treatment. Doctors in academic centers and community practices around the world use these guidelines to help inform their decisions when diagnosing and treating cancer patients.

Sean V. McGarry, M.D.
Musculoskeletal Oncology

“In an upper extremity, amputation is a pretty horrible thing, especially for a teenager. We would do everything we could to save the limb,” Dr. McGarry said.
PATIENTS IN MOTION

DONNA FOREMAN ENDURED SEVERE JOINT PAIN AND WAS ESSENTIALLY CONFINED TO CRUTCHES FOR NEARLY 20 YEARS. SHE WAS DENIED KNEE REPLACEMENTS BY SIX DOCTORS IN NEBRASKA BEFORE SHE FOUND DR. BEAU KONIGSBERG.

"NOBODY BELIEVED IN ME.
I HAD NO WHERE ELSE TO TURN.
DR. KONIGSBERG GAVE ME MY LIFE BACK."

SHE WALKS...
Immediately following her misstep, Donna, age 30, and her doctors in Loveland, CO, began a series of joint surgeries. Her first procedure was a patellar shaving to help realign the kneecap. That was soon followed by a tibia tubercle transfer (TTT) to correct the alignment of and pressure on the patellar tendon, and an anterior cruciate ligament (ACL) reconstruction. Neither remedied the pain.

Meanwhile, Donna had anterior/posterior lumbar fusion surgery (L3 to S1) in 1993 to address spinal complications also caused by the accident.

Donna began suffering from fibromyalgia, a chronic disorder characterized by widespread muscle and tissue pain, and correlative depression that speculative precipitated from stress. She returned to Lincoln, NE, to be near family and caregivers.

Still unable to walk without aid, Donna remained unemployed. In 2004, as luck would have it, she fell and fractured her left proximal tibia. Again, surgery provided little relief and with inactivity her body weight nearly doubled over time.

“I couldn’t exercise because if I moved my toes, the pain was so severe that I would break down in tears,” Donna said.

Nonetheless, six orthopaedic surgeons in the area denied her knee replacements because she was so heavy. Donna was facing a catch-22: She needed to lose weight in order to justify a knee replacement, but needed new knees in order to exercise.

Though elective gastric bypass procedure (GBP) is not often recommended for fibromyalgia patients, Donna was being forced to consider it. She and her cousin Susan retreated to Colorado to soul-search before making a final decision. As they sat for lunch one day, her original surgeon’s physician assistant (PA) happened to walk in to the restaurant. The PA was appalled by Donna’s condition and encouraged them to solicit another opinion in Omaha.

Donna returned home with fresh resolve; she would not undergo GBP. Her general practitioner suggested an orthopaedic specialist at UNMC who might help, and in September 2010 (19 years after her accident) Donna saw Dr. Beau Konigsberg for the first time.
After Dr. Konigsberg examined her x-rays, Donna said something like, “I know what you’re going to say: I need to lose 100 pounds before you can help me.” Instead, he expressed sympathy for and concern with the poor shape of her knees. She cried in his office as she realized someone would finally take care of her.

“Donna was probably not the ideal candidate for knee replacements because of her age, weight and complicated problems,” Dr. Konigsberg said. “But because she was so debilitated, in so much pain and with such limited function – because her quality of life was so low – I felt it was reasonable. We were her last port in the storm.”

Two weeks later, Dr. Konigsberg removed all of the hardware in Donna’s right leg and performed a knee arthroplasty. Her surgical history and post-traumatic arthritis made for a complex procedure, which consequently made it an excellent teaching case for residents. For example, ACL reconstruction had caused extensive bone loss, requiring a thicker polyethylene tibial plate and longer metal stem than typically needed for non-revision procedures.

In December of 2011, Dr. Konigsberg performed surgery on Donna’s left knee to remove the existing metal plate and screws, and replaced her joint the following March. Donna and her caregivers were continually impressed and reassured by Dr. Konigsberg’s team of residents and nurses. “They took care of me as an individual,” explained things in a simplified way. “Dr. Konigsberg talked to me – helped me – and he’s still there.”

A HOPEFUL OUTLOOK

Within five months of her final surgery – the 23rd in 20 years – Donna reported an exceptional 135 degrees of motion with both knees, as well as a loss of 25 inches, 15 pounds and counting. She is not only able to walk, but also dance for upwards of 30 minutes of daily exercise. She is less dependent on narcotic pain medication, professionally pursuing her love of photography and living her life again.

“Nothing stops me now,” she said.

Donna’s case does not represent a feat of innovation; rather, a feat of humanity. By all of today’s standards, Donna’s case was a great success. But in the Department of Orthopaedic Surgery and Rehabilitation, we know that to continue to be the “best of the best,” we can’t simply conform to current standards; we must set new ones. Department surgeons and researchers are working together to conduct groundbreaking research in the department’s Orthopaedics Biomechanics and Advanced Surgical Technologies Laboratory that will benefit TKR patients like Donna in the future. Through the development of a novel computer-aided surgical navigation system that could one day revolutionize orthopaedic surgery, this research aims to improve bone-cutting accuracy, implant alignment and procedure duration, and reduce costs. Currently, Navigated Freehand Cutting (NFC) is transitioning from an experimental pilot to a clinically viable prototype. See the abstracts “Innovative Navigated Ink-jet Bone Marker to Improve Surgical Plan Transfer and Cutting Speed” (Page 94), “Innovative Laser Bone Marking Technology On-board Smart Instruments for Navigated Freehand Bone Cutting” (Page 96) and “Complete TKR Surgery Experiments on Cadavers Confirm Feasibility of Navigated Freehand Cutting (NFC)” (Page 98) to learn more about this research.

Beau S. Konigsberg, M.D.
Adult Reconstructive Surgery

“DONNA WAS PROBABLY NOT THE IDEAL CANDIDATE FOR KNEE REPLACEMENTS BECAUSE OF HER AGE, WEIGHT AND COMPLICATED PROBLEMS,” DR. KONIGSBERG SAID. “BUT BECAUSE SHE WAS SO DEBILITATED, IN SO MUCH PAIN AND WITH SUCH LIMITED FUNCTION – BECAUSE HER QUALITY OF LIFE WAS SO LOW – I FELT IT WAS REASONABLE. WE WERE HER LAST PORT IN THE STORM.”
PATIENTS IN MOTION

STEFANIE AND STEPHEN GUIN OF LEES SUMMIT, MISSOURI, WERE TOLD THAT THEIR DAUGHTER SHOWED SIGNS OF ONE OF THE WORST CASES OF BRITTLE BONE DISEASE EVER SEEN IN UTERO, AND LIKELY WOULDN’T MAKE IT INTO THE WORLD.

HARPER IS BEAUTIFUL LIVING PROOF THAT THINGS AREN’T ALWAYS AS THEY SEEM.

SHE LIVES...
LIVES IN MOTION

HARPER’S DIAGNOSIS

STEPHANIE AND STEPHEN GUIN, WHO WELcomed their son JUDE ALMOST THREE YEARS PRIOR AND HAD RECENTLY OVERCOME A TUMULTUOUS ECTOPIC PREGNANCY, WERE EXPECTING A HEALTHY BABY. THE EARLY SONOGRAM AND BLOOD-WORK CAME BACK FREE OF CHROMOSOMAL ABNORMALITIES AND THEY WERE EAGER TO LEARN THE GENDER.

On April 21, 2010, the ultrasound technician showed the Guins a fetus that was moving around just as they expected. But an eerie silence befell the room as she measured its limbs and reluctantly shared that it was a girl. The baby’s arms and legs were bowed—possible sign “dwarfism” or “brittle bone disease.” The OB/GYN elaborated that it looked like her leg was broken, but that they should go to another hospital for a more detailed sonogram and expert opinion.

Osteogenesis imperfecta (OI), also known as “brittle bone disease,” is a heterogeneous disorder caused by gene mutations that affect the body’s production of collagen. At present, there are eight types of OI, estimated to be prevalent in one in 25,000–50,000 infants. Type I is the most mild and common form, Type II is considered “lethal,” Type III is the most severe among children who survive neonatally and Type IV is, relatively, moderate. (Types V–VIII are similar in appearance to Types II–IV.)

The couple was immediately launched into a state of confusion and fear. A genetics counselor, ultrasound technician and perinatologist confirmed a fractured femur, speculated OI Type II (i.e. “lethal pregnancy”) and conducted an amniotic fluid test. It would take five weeks to get the amniocentesis results back to confirm Harper’s condition, but the Guins were told they had three options that would “all end the same way.” Their choices included terminating the pregnancy (in the next couple of weeks to avoid having to do so out-of-state); delivering Harper early to say their goodbyes, knowing she wouldn’t survive, or continuing the pregnancy and putting Harper on life support indefinitely.

“The whole time, I’m feeling her kick and move inside of me,” Stephanie said. “It was like what I was hearing and feeling, with my heart and body, weren’t panning up.”

FINDING HOPE AT CHILDREN’S HOSPITAL & MEDICAL CENTER

Stephanie was not ready to make any decisions without confirmed results, so she spent the next month learning about the disease and connecting with families through the Osteogenesis Imperfecta Foundation and a Yahoo group. She met several mothers in her area who recommended Children’s Hospital & Medical Center in Omaha. Stephanie felt dismissed by most centers she called about treatment, but immediately got a different vibe from Children’s. Rosa Kreiksmeier, APRN, spoke of the patients in their OI Clinic having races in the hallways—living hope, not doom and gloom.

In May 2010, just after receiving the call that Harper had OI Type IV (less severe than previously estimated), the Guins drove to Omaha and sat down with Rose, Dr. Richard Lutz, medical director and specialist in pediatric genetics, endocrinology and metabolism, and Dr. Paul Esposito to ask questions and get a full understanding of their options. Whether or not Harper would be a patient at Children’s, the doctors wanted Stephanie and Stephen to be able to make informed decisions. “After those two hours with them, we had a spring in our step,” she said. “The sun was shining. We had hope.”

DETERMINING MEDICAL TREATMENT

Dr. Esposito and the Children’s OI Clinic strongly believe in treating infants early to decrease bone fractures. This involves administering intravenous bisphosphonate medication like pamidronate every two months, to safely improve bone density, reduce incidence of breaks, improve mobility and prevent some secondary deformities. Bisphosphonate treatment was developed in the late 1990s primarily by Dr. Francis Glorieux and his pediatric musculoskeletal research colleagues at Shriners Hospital for Children in Montreal, Canada. Dr. Horacio Plotkin, a pediatric endocrinologist who was one of the pioneers of OI treatment and helped establish the Children’s OI Clinic, first administered it in Omaha in 2003.

“Many kids with more severe OI can have 30 to 50 fractures in their first year and be wheelchair-bound for life without treatment,” Dr. Esposito said. “Parents choose our treatment program because they know that the quality of kids’ lives is improved. Our combined medical and surgical management is key. Almost all of the kids we treat are walking, which rarely happened in the past.”

Harper received her first pamidronate infusion at Children’s one week after she was born on September 1, 2011. (She was safely delivered by cesarean section. She had seven healed/healing fractures at birth, and spent nearly a week in the NICU before the Guins insisted on taking her to Omaha.) At that first appointment, Dr. Esposito forewarned the Guins that although they had made it a week without any fractures, Harper’s bones would break soon.

Indeed, one leg fractured four days later and the other soon followed suit. Harper continued to get infusions every eight weeks—so she could respond to them quickly— without fracture. Harper continued to respond very well— and Dr. Esposito deemed it time to consider surgery.
"The medical makes the surgical possible," Dr. Esposito said.

For children with moderate to severe OI, bisphosphonate infusions are followed by surgical insertion of rods that straighten the severely bowed bones and grow with them. Fassier-Duval Telescopic Rods, the most common type used, are inserted through small incisions under fluoroscopic control, in conjunction with percutaneous osteotomies (cutting of the bone). Multiple bones can be operated on at once without the need for casting, therefore, minimally limiting postoperative function.

Dr. Esposito performed surgery on both of Harper’s femurs on December 8, 2011, because of her severe bowing and fracture risk. Her legs were splinted for less than three weeks, and within eight weeks she was back on track. In April 2012, exactly two years after doctors told her parents that she wouldn’t survive birth, Harper took her first steps.

At 22 months, she is dancing, learning to run and playing with her brother Jude. She will soon decrease her frequency of pamidronate infusions to every 12 weeks, and in September 2013, she’ll start preschool. "She doesn’t know she’s fragile," Stephanie said. "Sure, she has taken some tumbles, but nothing that some chocolate milk doesn’t cure."

"Your view on having children changes and you just want them to have a happy life," Stephen said. "All of our worries there have gone away. Harper doesn’t know a limit."

Dr. Esposito was one of the first to embrace this method and was trained by Dr. Francois Fassier of Montreal, co-inventor of the telescopic rods. He has since developed one of the most active programs in the country – directly caring for children from more than 40 states and several other countries, and providing consultancy to surgeons nationwide.

The original protocol was to give bisphosphonate infusions for five years and then cease medical treatment, realizing that excessively dense bone may become brittle and predisposed to fracture. But because all bone generated after that time would be soft and likely to break at the "transition zone," a new course of treatment was needed. Dr. Horacio Plotkin piloted a half-strength pamidronate protocol that could be administered until a child is finished growing. The "Omaha dose" has since been adopted at centers worldwide.

ON THE FOREFRONT OF OI RESEARCH, EDUCATION AND CARE

Dr. Esposito teaches his methods to residents of the UNMC Department of Orthopaedic Surgery and Rehabilitation, as well as to pediatric orthopaedists around the country through tutorials. Because he and his team are anxious for more centers to share this approach to OI, many patients like Harper get their first dose of bisphosphonate medicine at Children’s and subsequent infusions at their local centers - returning to Omaha only for annual clinic visits and surgical procedures.

Dr. Esposito and Dr. Lutz have made multiple national presentations and published a variety of articles related to OI treatment. They will publish and present clinical outcomes from their first 50 surgically treated patients with average four-year follow-up to the American Academy of Orthopaedic Surgeons (AAOS) in 2013. Meanwhile, biomedical research is in progress at Shriners Hospital for Children in Montreal, the Kennedy Krieger Institute in Baltimore, MD, and other centers that will likely result in new genetic treatments and medicines. Dr. Esposito anticipates that Children’s will be involved in their clinical trials. "We’re so lucky that we have connected with Omaha and Dr. Esposito," Stephanie said. "I hope he’s figuring out a way to make a lot more of him."

"SHE DOESN’T KNOW SHE’S FRAGILE," STEPHANIE SAID. "SURE, SHE HAS TAKEN SOME TUMBLES, BUT NOTHING THAT SOME CHOCOLATE MILK DOESN’T CURE."
THE DEPARTMENT OF ORTHOPAEDIC SURGERY AND REHABILITATION TEAM INCLUDES DEDICATED FACULTY, RESIDENTS AND STAFF IN WHOM OUR PATIENTS, STUDENTS, PEER PROVIDERS AND THE GREATER COMMUNITY TRUST TO—NOT SIMPLY “GO THROUGH THE MOTIONS,” BUT—BE GENUINE LEADERS IN THE FIELD.
KEVIN L. GARVIN, M.D., CHAIRMAN

Adult Reconstructive Surgery

Kevin L. Garvin, M.D., is professor and chair of the University of Nebraska College of Medicine’s Department of Orthopaedic Surgery and Rehabilitation, as well as the L. Thomas Hood, M.D., Professor of Orthopaedic Surgery and Rehabilitation. He received his medical degree at the Medical College of Wisconsin in 1982. He completed an orthopaedic surgery residency program at the University of Arkansas for Medical Sciences in Little Rock (1987) and a fellowship in hip surgery at the Hospital for Special Surgery in New York City (1988). Dr. Garvin has served as associate editor for the Journal of Bone and Joint Surgery, as well as deputy editor for Clinical Orthopaedics and Related Research, and continues to serve as a consultant reviewer for both publications. Dr. Garvin is a member of the American Orthopaedic Association (ABC Traveling Fellow, 1995; chair, Resident Leadership Forum, 2008), Council of Orthopaedic Residency Directors Board, 2009-2012), the Hip Society (member-at-large, Board of Directors, 2008), Board of Specialty Societies Executive Committee, 2009-2012), the Knee Society (member, Nominating Committee, 2010-2012, chair, Research Committee, 2012-2015), the Association of Bone and Joint Surgeons and the Mid-America Orthopaedic Association (president, 2004-2005). Dr. Garvin has been selected as one of the Best Doctors in America from 1996-2012. He is a board certified orthopaedic surgeon with special interests in hip and knee reconstruction, as well as prevention and treatment of musculoskeletal infections.

CHRIS A. CORNETT, M.D.

Adult Spine Surgery

Chris A. Cornett, M.D., is an assistant professor in the Department of Orthopaedic Surgery and Rehabilitation. Dr. Cornett received his master’s degree in physical therapy (2001) and medical degree (2005) from the University of Nebraska Medical Center. He completed both an orthopaedic surgery internship and orthopaedic surgery residency at the University of Wisconsin Hospital and Clinics in Madison, WI, in 2006 and 2010, respectively. Following residency, Dr. Cornett completed a spine surgery fellowship at the University of Pittsburgh Medical Center in 2011. Dr. Cornett’s clinical expertise is in all aspects of adult spine surgery (cervical, thoracic, and lumbar). In his spine-only practice, Dr. Cornett treats a variety of conditions including degenerative conditions/arthritis, spinal stenosis, myelopathy, spondylolisthesis, disc herniations, instability, scoliosis, tumors, and trauma.

MIGUEL S. DACCARETT, M.D.

Sports Medicine and Orthopaedic Traumatology

Miguel S. Daccarett, M.D., is an assistant professor in the Department of Orthopaedic Surgery and Rehabilitation. He received his medical degree from Pontificia Universitas Xaveriana, IHS in Bogota, Colombia in 1992. In conjunction with his last year of medical school, Dr. Daccarett completed a general rotating internship at St. Ignatius University Hospital, and in 2000 completed his orthopaedic residency program at El Bosque University Orthopaedic Surgery Program in Bogota, Colombia. Dr. Daccarett has completed three orthopaedic fellowships, including an orthopaedic trauma fellowship (University of Louisville, KY, 2004), an orthopaedic oncology fellowship (University of Florida in Gainesville, FL, 2005), and an orthopaedic sports medicine fellowship (Harvard University/Children’s Hospital in Boston, MA, 2006). Dr. Daccarett is a candidate member of the Musculoskeletal Tumor Society, as well as a member of the American Orthopaedic Society for Sports Medicine (AOSSM), the Orthopaedic Trauma Association (OTA), and faculty member of AO North America (AONA). He is also a member of the International Cartilage Repair Society (ICRS), the Colombian Society of Orthopedics, and the International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine (ISAKOS). Dr. Daccarett’s special interests include the treatment of pelvic and periarticular fractures, sports-related injuries and multi-ligament injuries of the knee including ACL and PCL reconstruction and cartilage repair procedures, including osteoarticular cartilage and mesenchymal transplantation, meniscal repair and autologous chondrocyte transplantation (ACI).

MARK E. DIETRICH, M.D.

Sports Medicine and General Orthopaedics

Mark E. Dietrich, M.D., is an assistant professor in the Department of Orthopaedic Surgery and Rehabilitation. He received his law degree from the University of Nebraska College of Law in 1994 and his medical degree from the University of Nebraska College of Medicine in 2001. Dr. Dietrich completed a five-year residency program at the University of Nebraska/Creighton University Health Foundation in 2006, followed by an orthopaedic sports medicine fellowship at Minnesota Sports Medicine in Minneapolis in 2007. He is board certified in orthopaedic surgery. He is a member of the American Academy of Orthopaedic Surgeons, American Orthopaedic Society for Sports Medicine, Nebraska Orthopaedic Society, and Nebraska State Bar Association. Dr. Dietrich’s specialty interests include sports-related injuries, hip arthroscopy, and arthroscopic knee and shoulder reconstruction.
Paul W. Esposito, M.D., is a professor of Orthopaedic Surgery and Pediatrics at the University of Nebraska College of Medicine. He received his medical degree from Hahnemann Medical College and Hospital in 1977. He completed his internship and residency in orthopaedic surgery at the U.S. Naval Hospital in Oakland, California (1978 and 1983, respectively), and a pediatric orthopaedic fellowship at Children's Hospital Medical Center in Cincinnati in 1984. He is board certified and is a member of the Pediatric Orthopaedic Society of North America, a member of the American Orthopaedic Association, a fellow of the American Academy of Orthopaedic Surgeons, and a fellow of the American Academy of Pediatrics (AAP). He is active in the AAP, a member of the Section on Orthopaedics (and past member of the executive committee of this section), and is currently active in the Section on Sports Medicine, as well as the Council on Children with Disabilities. Dr. Esposito is the AAP representative to the U.S. Bone and Joint Initiative (USBJI), a national organization dedicated to increasing awareness of bone and joint conditions and disease, and is the head of the pediatric specialty section of this organization. He is a reviewer for PEDIATRICS and the Journal of Pediatric Orthopaedics. He is the chair of the Board of Directors of One World Health Center. Dr. Esposito is on the advisory board of directors at Children's Hospital and Medical Center, served as president of the Medical Staff (2008-2010). He is a member of the medical advisory board of the Osteogenesis Imperfecta Foundation. He has published a book chapter and made numerous presentations in the last two years regarding the treatment of osteogenesis imperfecta. Dr. Esposito was once again selected as one of Best Doctors in America in 2011-2012, on honor he has received since 1999. Dr. Esposito's special interests are in children's extremity deformities, osteogenesis imperfecta, congenital and developmental disorders, cerebral palsy, and musculoskeletal effects of pediatric obesity.

Hani Haider, Ph.D.

Director, Orthopaedics Biomechanics and Advanced Surgical Technologies Laboratory

Hani Haider, Ph.D., is a professor in the Department of Orthopaedic Surgery and Rehabilitation, and director of Biomedical Engineering Research. Dr. Haider studied in England for his first degree and Ph.D. in Mechanical Engineering. From a fluid dynamics and mechatronics faculty teaching background at the University of Sheffield, he joined the faculty of University College London Medical School at the well-known Centre of Biomedical Engineering in Stanmore in 1997. He was the principal mechanical and software engineer who produced the Instron-Stanmore Kneew Simulator and the International Standards Organization (ISO) method for simulation and wear testing of knee replacement systems. He was invited to join the faculty of the University of Nebraska Medical Center in March 2000. Dr. Haider had won three different University prizes in his university student career, and two as faculty from the University of Nebraska Medical Center for Special and Outstanding Professional Achievement. He also received the "The KLININGER International Research Prize"/Austria, the HAP Paul Award by the International Society for Technology in Arthroplasty for innovation in joint replacement technology, as well as the Robert Fifer Award and the Mannly Hormetz Award from the ASTM for his contributions to international standards development.

In Nebraska, Dr. Haider has received over 50 research contracts, mostly from orthopaedic companies in the USA, and from Europe and Japan, and federal research funding, all together totaling over $10 million. He has presented over 200 papers in peer-reviewed journals and international conferences in orthopaedics biomechanics. Professor Haider is a member of the Biomedical Engineering Committee of the American Academy of Orthopaedic Surgeons (AAOS), and representative of the Orthopaedic Research Society (ORS) to the AAOS, and a member of the ORS Basic Science Committee. He co-chairs the committee for Knee Implant Wear Testing of ASTM International, and chairs the ASTM patella testing, and Total Ankle Replacement Specification/Testing standard committees. He is the Scientific Review Director of the International Society of Technology in Arthroplasty (ISTA) and is a member of its Board of Directors. Dr. Haider is the Reviews Editor for the Journal of Engineering in Medicine, and is on the editorial boards of two international scholarly journals, and a reviewer for various others.

Paul W. Esposito, M.D.

Pediatric Orthopaedic Surgery

Curtis W. Hartman, M.D.

Adult Reconstructive Surgery

Curtis W. Hartman, M.D., is an assistant professor in the Department of Orthopaedic Surgery and Rehabilitation. He received his medical degree at the University of Missouri in 2001, and completed his orthopaedic surgery residency at the University of Nebraska/Creighton University Medical Center Health Foundation in 2008. Following residency, Dr. Hartman completed a fellowship in adult reconstruction at the Rush University Medical Center and Central DuPage Hospital, in Chicago, Illinois, in 2009. He is board certified in orthopaedic surgery. He is a member of the American Academy of Orthopaedic Surgeons, the Mid-America Orthopaedic Association, the American Association of Hip and Knee Surgeons, and the American Orthopaedic Association’s Emerging Leaders Program. Dr. Hartman specializes in comprehensive care for adult patients with hip and knee arthritis. His other interests include revision of failed hip and knee replacements, as well as management of infected hip and knee replacements.

Brian P. Hasley, M.D.

Pediatric Orthopaedic and Spine Surgery

Brian P. Hasley, M.D., is an associate professor of Orthopaedic Surgery at the University of Nebraska College of Medicine, Department of Orthopaedic Surgery and Rehabilitation. He earned his medical degree from the University of Nebraska College of Medicine in 1999 and completed his residency in orthopaedic surgery at the University of Nebraska Medical Center in 2004. Following residency, Dr. Hasley completed the Dorothy and Bryant Edwards Fellowship in pediatric orthopaedic surgery and scoliosis at the Texas Scottish Rite Hospital for Children, University of Texas at Southwestern Medical Center in Dallas (2005). Dr. Hasley completed post fellowship spine research at the same facility. Dr. Hasley is board certified by the American Board of Orthopaedic Surgery. He is a fellow of the American Academy of Orthopaedic Surgeons, and a member of the Scoliosis Research Society and the Pediatric Orthopaedic Society of North America (POSNA). Dr. Hasley has been selected as one of the Best Doctors in America from 2007-2012. His areas of focus are pediatric orthopaedic and pediatric spine surgery.

M. Layne Jenson, M.D.

Pediatric Orthopaedic and Spine Surgery

M. Layne Jenson, M.D., is an assistant professor in the Department of Orthopaedic Surgery and Rehabilitation. He received a master’s degree in Business Administration with a concentration in Health Organization Management from Texas Tech University in Lubbock in 2005. He completed his medical degree at Texas Tech University SOM in Lubbock, also in 2005. Dr. Jenson completed his residency in orthopaedic surgery at the Texas Tech University Health Science Center in 2010. Following residency, he completed the Ryerson Fellowship in Pediatric Orthopaedic Surgery at the Northwestern School of Medicine at Children’s Memorial Hospital in Chicago in 2011. Dr. Jenson’s areas of focus include scoliosis, hip dysplasia, pediatric and adolescent sports injuries, limb deformity, and trauma.
Beau S. Konigsberg, M.D., is an assistant professor in the Department of Orthopaedic Surgery and Rehabilitation. Dr. Konigsberg received his medical degree from the University of Nebraska Medical Center in 2001, and completed his orthopaedic surgery residency at the University of Nebraska/Creighton University Health Foundation in 2007. Following residency, Dr. Konigsberg completed an adult reconstruction and arthroplasty fellowship at Midwest Orthopaedics at Rush/Rush University Medical Center in Chicago, Illinois (2008). He is board certified in orthopaedic surgery. He is a member of the Orthopaedic Research and Education Foundation, the American Academy of Orthopaedic Surgeons, the Mid-America Orthopaedic Association, the American Association of Hip and Knee Surgeons, the Nebraska Orthopaedic Society, the Metro Omaha Medical Society, and the American Orthopaedic Association Emerging Leaders Program. Dr. Konigsberg specializes in comprehensive care for adult patients with hip and knee arthritis.

Seana V. McGarry, M.D., is an assistant professor in the Department of Orthopaedic Surgery and Rehabilitation. Dr. McGarry received her medical degree from the Creighton University School of Medicine in 1998. He completed a surgery internship at the University of Colorado Health Sciences Center in 1999. Dr. McGarry continued on at the University of Colorado Health Sciences Center to complete his orthopaedic residency in 2004. Following residency, he completed an orthopaedic oncology fellowship at the University of Florida – Shands Hospital in 2005. He researched the role of stem cells in bone and soft tissue cancer. Dr. McGarry is board certified by the American Board of Orthopaedic Surgery. He is a member of both the American Academy of Orthopaedic Surgeons and the Musculoskeletal Tumor Society. He specializes in orthopaedic oncology with a focus on limb salvage.

Matthew A. Mormino, M.D., is professor and residency program director, as well as the Herman A. and Lee A. Lefkowitz Professor of Orthopaedic Surgery, at the University of Nebraska Medical Center. Dr. Mormino is a graduate of Northwestern University Medical School in 1991 and completed his orthopaedic surgery residency at the University of Nebraska Medical Center in 2001, and completed his orthopaedic surgery residency at the University of Nebraska/Creighton University Health Foundation in 2007. Following residency, Dr. Mormino completed an adult reconstruction and arthroplasty fellowship at Midwest Orthopaedics at Rush/Rush University Medical Center in Chicago, Illinois (2008). He is board certified in orthopaedic surgery. He is a member of the Orthopaedic Research and Education Foundation, the American Academy of Orthopaedic Surgeons, the Mid-America Orthopaedic Association, the American Association of Hip and Knee Surgeons, the Nebraska Orthopaedic Society, the Metro Omaha Medical Society, and the American Orthopaedic Association Emerging Leaders Program. Dr. Mormino specializes in comprehensive care for adult patients with hip and knee arthritis.

Fereydoon Namavar, Sc.D., is a professor in the Department of Orthopaedic Surgery and Rehabilitation, and director of the Nano-Biotechnology Laboratory. He is an active member of the Nebraska Center for Materials and Nanoscience and a courtesy professor at the Department of Electrical Engineering at the University of Nebraska – Lincoln. Dr. Namavar earned a Doctor of Science, summa cum laude, degree in nuclear physics, from the Institute for Nuclear and Radiation Physics at the Katholieke Universiteit Leuven in Belgium. One of his primary research interests is to understand how cells attach to a nanostructured surface. By mimicking the cell behavior he is designing and fabricating nanostructured surfaces that exhibit or simulate the effects of cell-cell interactions. Presently, he is also involved with the development of novel concepts and technologies to maximize the lifetime of orthopaedic implants and minimize the possibility of wear and revision surgery through the development of novel nanostructure materials for (i) friction and wear reduction, (ii) substrates for tissue engineering and enhancement of bone growth, and (iii) novel anti-bacterial coatings for short- and long-term applications of prosthetic devices. In a collaborative research project with other UNMC faculty, Dr. Namavar is using stem cell nano-technology to regulate cellular growth in order to enhance or prevent cell proliferation, to either improve health or prevent disease with an emphasis on orthopaedic applications. Dr. Namavar has received grants and contracts from a variety of corporations and government agencies, including DOE, DOD, NIH, NASA and NSF. He collaborates with scientists around the world and holds several patents, including US patent 7,048,767, entitled “Nano-crystalline, homo-metallic, protective coatings” for reducing the wear of artificial orthopaedics implants.

Lori K. Reed, M.D., is an assistant professor in the Department of Orthopaedic Surgery and Rehabilitation. Dr. Reed received her medical degree from the University of Iowa College of Medicine in 1999. She completed her orthopaedic surgery residency at the Creighton University/University of Nebraska Medical Center Health Foundation in 2004. She then went on to complete her Foot and Ankle/Lower Extremity Reconstruction Fellowship at the Florida Orthopaedic Institute in Tampa (2005). Dr. Reed is board certified in orthopaedic surgery. She is a member of the American Academy of Orthopaedic Surgeons, American Orthopaedic Foot and Ankle Society, Orthopaedic Trauma Association, AO Trauma, Mid America Orthopaedic Society, Nebraska Orthopaedic Society, Nebraska Chapter of the American College of Surgeons, and the Emerging Leader Program of the American Orthopaedic Association. Dr. Reed specializes in foot and ankle disorders, lower extremity post-traumatic reconstruction, and general orthopaedics.

Susan A. Scherl, M.D., is a professor in the Department of Orthopaedic Surgery and Rehabilitation. She earned her medical degree from the Boston University School of Medicine in 1987. Dr. Scherl completed two years of general surgery residency at St. Luke’s/Roosevelt Hospital Center in New York (1989) and a five-year orthopaedic residency at State University of New York Health Science Center in Brooklyn (1994). She completed a pediatric orthopaedic fellowship at Case Western Reserve University in Cleveland in 1995. She is board certified in orthopaedic surgery. Dr. Scherl recently served as chair of the Pediatric Orthopaedic Society of North America (POSNA) Education Committee. She is also a member of the AAOS Leadership Development Committee and the American Orthopaedic Association Traveling Fellowship Committee. Dr. Scherl was selected as one of the Best Doctors in America for 2003-2005, and 2007-2012. Her areas of focus are pediatric orthopaedic trauma and management of orthopaedic aspects of cerebral palsy. She has edited two textbooks on musculoskeletal medicine and authored numerous book chapters and article reviews.
GLEN M. GINSBURG, M.D.

Glen Ginsburg, M.D. is a volunteer associate professor of Orthopaedic Surgery at the University of Nebraska Medical Center. He received his M.D. from the School of Medicine and Biological Sciences at the State University of New York at Buffalo, where he also completed a general surgery residency, as well as his orthopaedic residency training. Dr. Ginsburg completed a pediatric orthopaedic fellowship at the Children’s Hospital Los Angeles at the University of Southern California Department of Orthopaedic Surgery. He is board certified by the American Board of Orthopaedic Surgery. Dr. Ginsburg is the clinical director of the Motion Analysis Laboratory at UNMC’s Munroe-Meyer Institute, and serves as an academic advisor to orthopaedic residents in the Department of Orthopaedic Surgery and Rehabilitation. Dr. Ginsburg retired to volunteer associate professor status on March 15, 2011.

WALTER W. HUURMAN, M.D.

Walter W. Huurman, M.D., is a professor emeritus of Orthopaedic Surgery and Pediatrics at the University of Nebraska Medical Center. He received his M.D. degree from Northwestern University and completed his orthopaedic residency at the U.S. Naval Medical Center in Oakland, California. He completed training in pediatric orthopaedic surgery at the A.I. duPont Institute. A board certified orthopaedic surgeon, Dr. Huurman has served on the editorial boards of the American Academy of Pediatrics Journal, Pediatrics in Review, and the Journal of Pediatric Orthopaedics. He has served as associate editor of the Journal of Bone and Joint Surgery, and on the editorial review boards of the Journal of the American Academy of Orthopaedic Surgeons and Clinical Orthopaedics and Related Research. Dr. Huurman served as an oral examiner for the American Board of Orthopaedic Surgery (1982, 1986-87, 1990-92, & 1994-2003). He is a member of the Pediatric Orthopaedic Society of North America, the American Academy of Orthopaedic Surgeons, the American Academy of Pediatrics, the North American Spine Society, and the American Orthopaedic Association. His areas of concentration include the juvenile spine, clubfoot, and juvenile hip disease, as well as editing pediatric publications. Dr. Huurman retired to professor emeritus status on July 31, 2006.

KEVIN L. GARVIN, M.D., CHAIRMAN

Research Interests:

- Adult reconstruction
- Prevention and management of musculoskeletal infections

Current Research Grants:


Refereed Articles:

Book Chapters & Reviews:


Honors, Awards & Offices Held:


American Academy of Orthopaedic Surgeons:

Member, Orthopaedic Patient Safety and Quality Summit, 2012.


Adult Reconstruction Knee Program Subcommittee, 2009-2012.

Board of Specialty Societies (BOS) Executive Committee representative from the Hip Society, 2009-2012.


Member: Board of Directors (2nd term), Omaha Sports Commission, 2011-2014.


Member, Nominating Committee, The Knee Society, 2010-2011.

America’s Top Doctors, Castle Connolly Medical Ltd., 2010-2011, 2011-2012.


Operative Walk:

Surgeon, Operation Walk USA, Omaha, NE, December 2, 2011.

Leader, Operation Walk - Antigua, Antigua, Guatemala, November 5-11, 2011.

Leader, Operation Walk - Antigua, Antigua, Guatemala, October 30-November 6, 2010.


American Orthopaedic Association:

Member, Membership Committee, 2010-2012.

Board Member (elected), Council of Orthopaedic Residency Directors (CORD), 2009-2012. ABOS certified through 2020.

Research Interests:

Spiral stenosis

Fusions

Spine infections

Spondylolisthesis

Refereed Articles:


Honors, Awards & Offices Held:

Member, Omaha Medical Society, December 2011.
MARK E. DIETRICH, M.D.

Research Interests:
- Sports-related injuries
- Hip arthroscopy
- Arthroscopic knee and shoulder reconstruction

Honors, Awards & Offices Held:
- Active Member, American Orthopaedic Society for Sports Medicine, July 2010 – present
- Active Fellow, American Academy of Orthopaedic Surgeons, October 2010 – present
- Associate Master Instructor for Hip Arthroscopy, Arthroscopy Association of North America, 2010 – 2012

PAUL W. ESPOSITO, M.D.

Research Interests:
- Osteogenesis imperfecta and metabolic bone disease

Current Research Grants:
- Support for Research Assistant, Awarded by James Roberts, December 2010
- Tiny Bones Program, Wm Patrick Foundation, December 2010

Refereed Articles:

Book Chapters & Reviews:

Honors, Awards & Offices Held:
- 25 Years of Service Award, University of Nebraska Medical Center, July 2012
- Special Achievement, Alpha Omega Alpha (AOA) & Faculty Honors Convocation, UNMC, Omaha, NE, March 22, 2012:
  - Member, Medical Advisory Council, Osteogenesis Imperfecta Foundation, 2010 – present
  - Member, Board of Directors, Metro Omaha Medical Society Foundation, 2010 – present
  - One World Health Center, Omaha, NE
  - Board Chairperson and Executive Committee Chair, March 2011 – present
  - Board of Directors, March 2008 – present
  - Board of Directors, Children’s Hospital and Medical Center, Omaha, NE:
    - Executive Committee, January 1, 2009 - 2010
    - Advisory Board 2010 – present
    - Quality and Patient Safety Committee, 2008 – present
  - Medical Staff Committees, Children’s Hospital and Medical Center, Omaha, NE:
    - Ethics Committee, Omaha, NE, Children’s Hospital, 2010- present
    - Clinical Service Chief, Orthopaedic Surgery 2009- present
    - Information Technology Oversight Committee, 2009 - present
    - Allied Health Committee, 2008 – present
    - Bylaws Committee, 2008 - present
    - Credentials Committee, 2008 – present (Chair, 2011-present)
  - Surgical Services Committee, 2008 – present
  - Quality Safety Leadership Team, 2006 – present
  - Reviewer, Clinical Orthopaedics and Clinical Research, 2010 - present.

Appointed to the Board of the US Bone and Joint Decade. Served as the liaison representative of the American Academy of Pediatrics and co-chairman of the Pediatric Strategic Planning Group, 2009 - present.
- Consultant Reviewer, PEDATRICS, 2005 - present.

HANI HAIDER, PH.D.

Research Interests:
- Research and development of methods for in-vitro testing of orthopaedic implants
- Development of innovative computer-aided surgical technologies

Current Research Grants:
- Pin-on-Disk Screening Wear Test of Four Types of UHMWPE. Ortho Development. Principal Investigator, January 2012 - May 2012.
- A Simulator Study of the Wear of Large Size Vanguard SSK Constrained Tibial Bearings, Collaborative research, Biomet, Inc. Principal Investigator, August 2011 - June 2012.
- Strength and Longevity of Vitamin E Highly Cross-Linked Polyethylene of a Revision TKR System (E1 vs PS), Collaborative research, Biomet, Inc. Principal Investigator, July 2011 - July 2012.
- Simplified Orthopaedic Surgery. A four-year federally funded study sponsored by the United States Naval Health Research Center. Principal Investigator, October 2010 - 2014.
- A study of the effect of high abrasion artifacts on CoCr metallic femoral heads on the wear of conventional and Vitamin E blended UHMWPE hip replacement bearings, A collaborative study - contract with Exponent Inc, Philadelphia, PA. Principal Investigator, July 2010 – April 2011.
- Knee Simulator Test to Determine Wear Properties of Formcon Knee, Biomet Inc., Warsaw, Indiana.
- Principal Investigator, April 2010 - January 2011.
Characterization of Vitamin E Blended UHMWPE as a Bearing with CoCr and Bioactive D-Tox Femoral Hip Components. Collaborative research with Exponent Inc. and Stellakt (PA), Principal Investigator, August 2009 – May 2010.


**Referred Articles:**


Honors, Awards & Offices Held:


American Academy of Orthopaedic Surgeons (AAOS)


- Biomedical Engineering Committee, The American Academy of Orthopaedic Surgeons (AAOS), Member, and Official Representative of the Orthopaedic Research Society, February 2012.

- Associate Member Basic Science, February 2012

International Society of Technology in Arthroplasty (ISTA)

- Member, 2000 – present

- Member, Board of Directors, 2005 – present

- Program Director (Re-elected for a renewed term), March 2010 – September 2011

- Director, Scientific Review and Information Technology, September 2011

Orthopaedic Research Society (ORS)

- Member, 2000 – present

- Reviewer of abstracts (Re-appointment), August 2009 – present

- Basic Science Education Committee (BSEC), 2011

New Invention Notification award for “a noncrystalline coating of polyethylene,” The University of Nebraska Medical Center and UnMed Corporation. October 7, 2010.

International Standards Organization (ISO)

- Chair, Expert Group revising knee wear testing standards, 2002 – present

- Member, United States Delegation to Committee SC 150 (Medical Devices), 2002 – present

- Invited member, United States Delegation, Meeting of the ISO - Medical Devices, September 2010

Appointed to the Editorial Board for the Journal: Advances in Orthopaedics, June 2010 – present.

ASTM International Manny Horowitz Award, which “recognizes the most honored committee member in the general interest category who has contributed to the standards development and/or related activities.” ASTM Committee F04 on Medical and Surgical Materials and Devices, May 2010.

American Academy of Surgery and Materials (ASTM):

- Member, 2000 – present

- Chair, Ankle Replacement Testing Standards Committee, ASTM International, 2000 – present

- Co-Chair, Knee Wear Testing Standards Committee, ASTM International, 2001 – present

- Co-Chair, Symposium on Mobile Bearing Total Knee Replacement Devices, Sponsored by ASTM Committee F04 Medical and Surgical Materials and Devices, St. Louis, MO, May 2010


Session Chair: Longevity & Wear, Symposium on Mobile Bearing Total Knee Replacement Devices, St. Louis, MO, May 2010.


Editorial Board Member, Journal of Engineering in Medicine, IMechE Part H, 2009 – present.


Member, Organizing Committee, Nebraska Biomedical Engineering Workshop, 2000 – present.

Chartered Engineer - Member of the Engineering Council (UK), 1994 – present.

Member, Institution of Mechanical Engineers (I.Mech.E) (UK), 1994 – present.

CURTIS W. HARTMAN, M.D.

Research Interests:

Prevention, diagnosis, and management of prosthetic joint infections

Prevention, diagnosis, and management of osteoarthritis

Clinical outcomes of arthroplasty

Current Research Grants:


**Referred Articles:**


**Book Chapters & Reviews:**


**Honors, Awards & Offices Held:**

- Orthopaedic Basic Science Subcommittee, American Academy of Orthopaedic Surgeons, 2012

- Operation Walk:
  - Surgeon, Operation Walk USA, Omaha, NE, December 22, 2011.
  - Surgeon, Operation Walk – Antigua, Antigua, Guatemala, November 5-11, 2011.

Board Certified, American Board of Orthopaedic Surgery, July 2011.
BRIAN P. HASLEY, M.D.

Research Interests:
Spine deformity

Current Research Grants:

Referred Articles:

Honors, Awards & Offices Held:
Promoted to Associate Professor of Orthopaedic Surgery, Department of Orthopaedic Surgery and Rehabilitation, July 1, 2012.
Fellow, American Academy of Orthopaedic Surgeons, February 2010.
Member, Pediatric Orthopaedic Society of North America (POSNA), 2012 - present; Candidate Member 2008 - 2012.

M. LAYNE JENSON, M.D.

Research Interests:
Scoliosis
Hip dysplasia
Pediatric and adolescent sports injuries
Limb deformity

Honors, Awards & Offices Held:
Member, Scoliosis Research Society, 2011 - present; Candidate Member 2005 - 2011.
Member, Pediatric Orthopaedic Society of North America (POSNA), 2012 - present; Candidate Member 2008 - 2012.

BEAU S. KONIGSBERG, M.D.

Research Interests:
Adult hip and knee reconstruction

Referred Articles:

Book Chapters & Reviews:

Honors, Awards & Offices Held:
Fellow, American Academy of Orthopaedic Surgeons, February 2012.
Fellow, American Association of Hip and Knee Surgeons, November 2011.
Member, Mid-America Orthopaedic Association, 2011.
Surgeon, Operation Walk USA, Omaha, NE, December 2, 2011.
Member, Medical Student Admissions Committee, University of Nebraska Medical Center, College of Medicine, May 2011.
Board Certified, American Board of Orthopaedic Surgery, September 2010.

SEAN V. MCGARRY, M.D.

Research Interests:
Clinical outcomes in orthopaedic oncology

Referred Articles:

Book Chapters / Reviews:
Orthopedics, 2012.
Musculoskeletal Tumor Society (MSTS):
■ Member, April 2011 - present.
■ Candidate member, 2005 - 2011.

Consultant Reviewer, Clinical Orthopaedics and Related Research, March 2011 - present.
Consultant Reviewer, Orthopedia, February 2011 - present.
Tumor Module Editor, Orthopaedics® Hyperguide, February 2011 - present.
Member, Mid-America Orthopaedic Association, September 2010 - present.
Fellow, American Academy of Orthopaedic Surgeons (AAOS), September 2009 - present.

Hyperguide, CME Tumor Tutorial, February 2012.
McGarry, S.: Lipoma in Orthopedics® Hyperguide, CME Tumor Tutorial, February 2012.
McGarry, S.: Myxoma in Orthopedics® Hyperguide, CME Tumor Tutorial, February 2012.
McGarry, S.: Surgical Management of Cancer Metastatic to Bone in Orthopedics® Hyperguide, CME Tumor Lecture, February 2012.

Honors, Awards & Offices Held:
Musculoskeletal Tumor Society Foundation (MSTF):
■ Member, April 2006 - present.
■ Medical Board of Trustees, April 2006 - present.
■ Ethics Committee Member, October 2009 - 2011
■ Membership/Nominations Committee Member, February 2012 - present
National Comprehensive Cancer Network (NCCN):
■ Member, May 2006 - present
■ Bone Cancer Panel, May 2006 - present
■ Soft Tissue Sarcoma Panel, July 2007 - present
■ Metastatic Osteosarcoma of Bone Sub-committee, February 2012 - present
Musculoskeletal Tumor Society (MSTS):
■ Member, October 2011 - present
■ Candidate member, 2005 - 2011

FACULTY ACTIVITIES
Controlling the bone growth
Reducing the wear of orthopaedic implants and revision surgery

LIVES

MATTHEW A. MORMINO, M.D.

Research Interests:
- Infected nonunions
- Osteomyelitis
- Pelvis fractures

Refereed Articles:
- Bormann, K.; Carlson, M.; Daccarett, M.; Mormino, M.; and Fehringer, E.: Proximal to Middle One-third Humerus Shaft Fractures May Lead to Poorer Shoulder Function Compared to Middle to Distal One-third Humerus Shaft Fractures Following Internal Fixation. Shoulder and Elbow, (5): 12-27, January 2011

Honors, Awards & Offices Held:
- Promoted to Professor of Orthopaedic Surgery, Department of Orthopaedic Surgery and Rehabilitation, July 1, 2012
- Castle Connally Regional Top Doctors, 2011 - 2012
- Award for Faculty Excellence in Teaching, Nebraska Orthopaedic Surgery Residency Program, June 2012

FACULTY ACTIVITIES

FEREYDOON NAMAVAR, S.C.D.

Research Interests:
- How cells attach to a nanostructured surface
- Designing nano-structures that simulate the effects of cell-in-cell interactions
- Interaction of adhesive proteins with nanostructured surfaces
- Application of nanotechnology in total joint arthroplasty:
  - Reducing the wear of orthopaedic implants and revision surgery
  - Controlling the bone growth
- Interaction of stem cells and organisms with micro and nanostructured engineered materials (tissue engineering)

Effect of electrical stimulation on growth and differentiation of stem cells on nano-engineered surfaces
Development of smart infection-resistant coatings for orthopaedics and dental implants

Current Research Grants:
- Namavar, F.: Material Science Smart Coatings, Department of Energy, Principal Investigator, July 2010

Refereed Articles:
LORI K. REED, M.D.

Research Interests:
- Post-traumatic hindfoot reconstruction

Honors, Awards & Offices Held:
- Member, Public Relations Committee for the Orthopaedic Trauma Association, 2009 - current.

SUSAN A. SCHERL, M.D.

Research Interests:
- Pediatric orthopaedic trauma, especially femur fractures
- Non-accidental pediatric orthopaedic trauma
- Neuromuscular disorders
- Medical student and resident education

Refereed Articles:

Book Chapters & Reviews:

Honors, Awards & Offices Held:
- Member, American Orthopaedic Association Traveling Fellowship Committee, June 2012 - Present.
- Chair, American Orthopaedic Association ASEAN Traveling Fellowship Subcommittee, June 2012 - Present.
- Promoted to Professor of Orthopaedic Surgery, Department of Orthopaedic Surgery and Rehabilitation, July 1, 2010.
- American Academy of Orthopaedic Surgeons/Austrian-Swiss-German Traveling Fellowship, April 2010.

Orthopaedic Trauma Association:
- Member, Services Project Team, 2009 & 2010 (2 years)
- Membership Committee, 2009 & 2010 (2 years)
- Specialty Day Planning Committee, 2009 & 2010 (2 years)

The department’s 19 orthopaedic residents are involved in daily patient care and important research activities during their five years of intensive training. Directed by Matthew Mormino, M.D. (left), professor of orthopaedic surgery at UNMC, the current curriculum addresses the six core competencies outlined by the ACGME:

- Patient care
- Interpersonal and communication skills
- Professionalism
- Medical knowledge
- Systems-based practice
- Practice-based learning and improvement

Thirteen full-time clinical faculty and numerous staff members instruct, evaluate and mentor our residents at various locations on the UNMC campus. Many more Omaha-area orthopaedic surgeons serve as volunteer faculty members, supervising our residents as they rotate through different subspecialty private practice situations. Two full-time research faculty, lab technicians and a full-time research coordinator assist residents with their research projects. Additionally, the University Hospital, part of The Nebraska Medical Center, is a Level I Trauma Center where our orthopaedic surgery residents play integral roles.

While education is the primary focus, Omaha is a wonderful community, offering residents many great experiences beyond their lives in the classroom, labs, exam and operating rooms. Residents enjoy an outstanding, well-rounded educational experience and fulfilling social environment in a safe and affordable city. Although nearly 900,000 people live in the greater metropolitan area, friendly faces and small-town charm distinguish it from the hectic, fast-paced atmosphere of most major cities.

Located on the west bank of the Missouri River, the Omaha “heartland” welcomes visitors from all over the world. It has a reputation for excellent healthcare, agriculture and high-tech business. The city is home to five Fortune 500 companies and four Fortune 1000 companies. Superb restaurants, a world-renowned zoo, a thriving arts community and high quality of life are some of the things for which Omaha is recognized. Residents appreciate a variety of cultural amenities including the historic Old Market, CenturyLink Center Omaha, parks, lakes and recreation areas, championship golf courses and many other opportunities for family entertainment. We proudly claim the Nebraska Cornhuskers, the NCAA College World Series, Creighton University and University of Nebraska athletics and the Omaha Storm Chasers baseball team.

Each year, residents get together for our Welcome BBQ, infamous Crawfish Boil, Oktoberfest, Halloween, Christmas and New Year’s festivities; and flag football and intramural basketball.

More than half of those who have done their orthopaedic surgical training at UNMC now practice here in the Midwest. Physicians throughout the region continue their education with UNMC to learn the latest techniques for diagnosis, treatment and prevention of bone and joint diseases.
UNMC DEPARTMENT OF ORTHOPAEDIC SURGERY AND REHABILITATION’S ORTHOPAEDIC RESIDENCY TRAINING PROGRAM ALUMNI 1971–2012

OF ALL THE MEN AND WOMEN THAT HAVE COMPLETED THEIR ORTHOPAEDIC RESIDENCY TRAINING THROUGH THE NEBRASKA PROGRAM, MORE THAN HALF ARE NOW PRACTICING IN THE STATE OR THE MIDWEST. THE FOLLOWING IS A LIST OF ALL DEPARTMENT ALUMNI SINCE THE ORTHOPAEDIC RESIDENCY PROGRAM WAS ESTABLISHED IN 1971. THE ACCOMPANYING MAP SHOWS THE LOCATIONS OF OUR RESIDENTS IN THE UNITED STATES, ACCORDING TO THE DEPARTMENT’S MOST RECENT RECORDS.

NAME STATE YEAR
Lowell Nebbom, M.D. NV 1971
Oscar Jordan, M.D. TX 1972
Dale Phelps, M.D. CA 1972
Carl Schwartz, M.D. AK 1973
William Smith, M.D. NE 1973
Richard Bergerstrom, M.D. NE 1974
Ronald Boulware, M.D. TX 1974
John Knauff, M.D. CA 1974
Robert Stowe, M.D. OR 1974
Robert Cochran, M.D. NE 1975
James Kulbom, M.D. SD 1975
Richard Wecker, M.D. WY 1975
Floyd Pohlman, M.D. HI 1976
Jack Bridling, M.D. IA 1977
William Boulden, M.D. IA 1978
Eric Bunga, M.D. CA 1978
Neil Habridge, M.D. CA 1979
Ronald Scherb, M.D. NE 1979
Jasper Williams, M.D. WI 1979
John Yeakley, M.D. NE 1979
Alois Proett, M.D. WI 1980
Jeffrey Davick, M.D. IA 1980
Joel Adams, M.D. ME 1981
Edward Simodynes, M.D. * 1981
Ram Pankaj, M.D. IL 1982
Jan Davis, M.D. CO 1989
John Staats, M.D. NE 1988
Gary Porubsky, M.D. LA 1983
Gurpal Bhuller, M.D. VA 1982
Robert Milaski, M.D. AZ 1995
Craig Mahoney, M.D. IA 2001
Armodios Hatzidakis, M.D. CO 2001
Aaron Askew, M.D. OR 2001
NAME STATE YEAR
Jon Davis, M.D. CD 1989
Robert Dehne, M.D. TX 1989
Douglas Mullins, M.D. ID 2002
Bryan Brethauer, M.D. NE 1990
Roy Guse, M.D. TX 1990
Kevin O’Malley, M.D. NE 1990
Michael Sicuranza, M.D. PA 1991
Tari Fornows, M.D. IA 1991
Mark Goebel, M.D. NE 1991
BretMiller, M.D. IL 1991
Jeffrey Moore, M.D. AK 1992
David Thull, M.D. AZ 1992
Jeffrey Tiedeman, M.D. NE 1992
Thomas Walsh, M.D. MN 1992
James Hill, M.D. IL 1992
Todd Yoe, M.D. CA 1992
Deepee Chevda, M.D. TX 1995
Clay Frank, M.D. WI 1995
Robert Milaski, M.D. AZ 1995
Vern Prochaska, M.D. ND 1995
Julian Arrona, M.D. WA 1996
John Miyano, M.D. WA 1996
Matthew Mormino, M.D. NE 1996
Jeffrey Rodgers, M.D. IA 1996
David Castron, M.D. CA 1997
Klaus Doss, M.D. CA 1997
Keith Hughes, M.D. NE 1997
Stephen Karnagys, M.D. NE 1997
Charles Burt, M.D. NE 1998
Brett Fischer, M.D. NE 1998
Stanley Bowling, M.D. KS 2000
John McClellan, III, M.D. NE 2000
John Veitch, M.D. NE 2000
Daniel Bowell, M.D. NE 2000
Elvin Roach, M.D. NE 2000
James Ballard, M.D. OR 2002
J. Lee Lin, M.D. CA 2000
NAME STATE YEAR
James Ballard, M.D. OR 2000
David Inda, M.D. NE 2002
Michael Thompson, M.D. NE 2002
Kristoffer Brane, M.D. MN 2003
Jason Brawdy, M.D. MO 2003
John Sojka, M.D. PA 2003
Joshua Urban, M.D. NE 2004
Stephen Hansen, M.D. UT 2004
Anthony Lauter, M.D. WA 2005
Edward Prince, M.D. UT 2005
Ivan Tarkin, M.D. PA 2005
Brian Kiefer, M.D. MO 2009
Brian Mclaren, M.D. ID 2010
Bryan Herzen, M.D. FL 2010
Mark Davis, M.D. NE 2011
Randal Peterson, M.D. NE 2011
Daniel Hoeffel, M.D. MN 2011
Jeffrey Elzinga, M.D. MN 2011
David Farbman, M.D. MD 2011
Daniel Bowell, M.D. NE 2011
Armed Forces, M.D. 2011
Christian Stenmark, M.D. NE 2012
IX. LIVES IN MOTION
MEET THE RESIDENTS

CLASS OF 2013
Left to right: Drs. Eric Samuelson, Jeremy Toomey, Annie Knierim, and Nolan May

CLASS OF 2014
Left to right: Drs. Kevin Lindgren, David Minges, and Khalid Azzam

CLASS OF 2015
Left to right: Drs. Andrew Taiber, John Frank, Todd Goddie, and Brent Hood

CLASS OF 2016
Left to right: Drs. Paul Hong, Kaitlin Neary, Paul Nielsen, and Scott Vincent

CLASS OF 2017
Left to right: Drs. Paul Johansen, Courtney Grimsrud, Andy Kirkpatrick, and Eric Bonness

CLASS OF 2013
Annie Knierim, M.D.
Hometown: Glasgow, MT
College: Concordia College, Moorhead, MN
Medical School: Creighton University School of Medicine
Area of clinical/research interest: Trauma
Activities/hobbies: Hockey, basketball, skiing, hiking, biking

Nolan May, M.D.
Hometown: Hayes Center, NE
College: Nebraska Wesleyan University
Medical School: University of Nebraska – Lincoln
Area of clinical/research interest: Shoulder arthroplasty
Activities/hobbies: Sports, hunting/fishing, spending time with family

Kevin Lindgren, M.D.
Hometown: Jackson, WI
College: University of Wisconsin Medical School: Medical College of Wisconsin
Area of clinical/research interest: Sports, adult reconstruction, trauma
Activities/hobbies: Homebrewing, golf, softball

David Minges, M.D.
Hometown: St. Louis, MO
College: Creighton University Medical School: Creighton University School of Medicine
Area of clinical/research interest: Sports medicine
Activities/hobbies: Sports, running, music, hanging out with friends

CLASS OF 2014
Khalid Azzam, M.D.
Hometown: Cairo, Egypt
College: University of Cairo, Egypt
Medical School: University of Cairo, Egypt
Area of clinical/research interest: Adult reconstruction
Activities/hobbies: Swimming, horseback riding

CLASS OF 2015
John Frank, M.D.
Hometown: Monticello, AR
College: University of Arkansas (Undergraduate); University of Central Arkansas (Graduate)
Medical School: University of Arkansas for Medical Sciences College of Medicine
Area of clinical/research interest: Hand, sports, adult reconstruction
Activities/hobbies: Golf, tennis, college sports, grilling, snow skiing, live music

Todd Goddie, M.D.
Hometown: East Grand Forks, MN
College: University of Minnesota (Undergraduate & Graduate)
Medical School: University of North Dakota School of Medicine and Health Sciences
Activities/hobbies: Fly fishing and fly tying, conventional fishing, lifting weights, running, camping, riding mountain bikes, reading and cooking

Brent Hood, D.O.
Hometown: Fort Collins, CO
College: Union College (Undergraduate); University of Nebraska – Lincoln (Undergraduate)
Medical School: Des Moines University – Osteopathic Medical Center
Activities/hobbies: Golfing, cooking, Husker football and spending time with his 5 children and wife; Sound engineer/technician for various local bands and churches

Andrew Taiber, M.D.
Hometown: Cedar Rapids, IA
College: University of Iowa Medical School: University of Iowa
Area of clinical/research interest: Hand, sports, adult reconstruction
Activities/hobbies: Golf, tennis, college sports, grilling, snow skiing, live music
Recent Post-Graduate Fellowships

After completing their training at Nebraska, residents move on to the next stage of their training. Many opt to continue their education by choosing one of many fellowship opportunities around the country. Our most recent graduates and the fellowships they have chosen are listed below.

**2012 GRADUATES:**

- **Ryan W. Hess, M.D.**
  - Andrews Institute Sports Medicine Fellowship, Gulf Breeze, FL

- **Nicholas S. Aberle II, M.D.**
  - Colorado University Sports Medicine Fellowship, Denver, CO

- **Brian A. Vernon, M.D.**
  - Mayo Foundation Spine Surgery Fellowship, Rochester, MN

- **Lucas J. Burton, M.D.**
  - University of Louisville Adult Reconstruction Fellowship, Louisville, KY

**2011 GRADUATES:**

- **Jason M. Erpelding, M.D.**
  - Medical College of Wisconsin Hand Surgery Fellowship, Milwaukee, WI

- **Daniel E. Firestone, M.D.**
  - Indiana Hand to Shoulder Center Fellowship, Indianapolis, IN

- **Michael S. Dee, M.D.**
  - Southern California Orthopaedic Institute (SCOI) Fellowship, Van Noy, CA

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**CLASS OF 2016**

- **Paul Hong, M.D.**
  - Hometown: Naperville, IL
  - College: Northwestern University (Undergraduate); Indiana University (Graduate)
  - Medical School: University of Illinois - Peoria
  - Activities/hobbies: Classical and contemporary piano, hiking, backpacking, cooking ethnic foods, and technology blogs

- **Kaitlin Neary, M.D.**
  - Hometown: Tacoma, WA
  - College: University of Minnesota
  - Medical School: Croanht University School of Medicine
  - Activities/hobbies: Running, soccer, golf, cycling, climbing, hiking, marathons/triathlons, attending sporting events, playing the guitar and violin, and cooking

- **Paul Nielsen, M.D.**
  - Hometown: Columbia, MO
  - College: University of Missouri-Columbia
  - Medical School: University of Missouri - Columbia
  - Activities/hobbies: Outdoor activities (camping, fishing, boating, hiking, bicycling), recreational sports (golf, football, basketball, tennis), and military history

- **Scott Vincent, M.D.**
  - Hometown: York, NE
  - College: University of Nebraska at Kearney
  - Medical School: University of Nebraska College of Medicine
  - Activities/hobbies: Attending, watching and playing sports, working out and running, listening to and playing music (previously played trumpet in some jazz/rock ensembles in college), cooking, spending time outdoors, and traveling with his wife

**CLASS OF 2017**

- **Eric Bonness, M.D.**
  - Hometown: Omaha, NE
  - College: University of Nebraska at Lincoln Medical School: University of Nebraska College of Medicine
  - Activities/hobbies: Basketball, lifting weights, running, crossword puzzles, snowboarding, hiking, watching NBA/NFL/NCAA football, spending time with family and friends

- **Courtney Grimsrud, M.D.**
  - Hometown: Sisseton, SD
  - College: South Dakota State University Medical School: Sanford School of Medicine of the University of South Dakota
  - Activities/hobbies: Sports (especially basketball and running in half-marathons), spending time outdoors, watching movies, reading, and being with family and friends

- **Paul Johnson, M.D.**
  - Hometown: Brookfield, WI
  - College: Creighton University Medical School: Medical College of Wisconsin
  - Area of clinical/research interest: Spine, joint, pediatrics
  - Activities/hobbies: Cycling, lifting, shooting, waterskiing

- **Andy Kirkpatrick, M.D.**
  - Hometown: Appleton, WI
  - College: University of Wisconsin - Stevens Point Medical School: Medical College of Wisconsin
  - Activities/hobbies: Basketball, golf, fishing, hunting, watching football, traveling

RESEARCH

STRETCHING THE “CUTTING EDGE” OF ORTHOPAEDIC SURGERY

Orthopaedics Biomechanics and Advanced Surgical Technologies Laboratory Director Hani Haider, Ph.D., and his team are world renowned for testing prosthetic joints and leading technological advancements. In collaboration with department surgeons, the team currently comprises eight full-time professional engineering scientists and technicians, plus several continental and international consultants. Since Dr. Haider joined the Department of Orthopaedic Surgery and Rehabilitation faculty in 2000, the Biomechanics lab has earned more than $55 research and testing contracts from international companies, including a record number in 2012.

“UNMC is the leading clinical, educational, and orthopaedic research center in Nebraska, and we have a duty to contribute to the field,” Dr. Haider said. “Because we are a relatively small institution compared with other centers nationwide, the lab’s growing industrial acclaim on an international plane is remarkable."

“We could merely be an early consumer of innovations, and that is usually good, or we can strive to be creators of new technology, and that would bring excellence,” Dr. Haider continued. "A lab like ours that successfully does the latter to set an international standard is rare. I’m very proud of the pocket of excellence we have established, and hope that our alumni and Nebraskans share that pride in what they helped build.”

Dr. Haider’s team is in the process of perfecting a Nebraska-born computer-aided surgical navigation system for total knee arthroplasty (TKA) in the Advanced Surgical Technologies area of the lab. This international award-winning “GPS-style” technology is now being refined for FDA approval, clinical trials, and commercialization through a new Nebraska startup company called Track Surgical, Inc., led by a business team from Silicon Valley, CA.

The navigated freehand bone cutting technology allows precise performance of complex orthopaedic procedures without mechanical, implant-specific alignment instruments (jigs). A revolutionary software program developed in house uses data from a patient’s CT scans to create a 3-D model that interacts with “smart” surgical instruments and the bone in real time. From the computer, surgeons are able to plan procedures by programing their own preferences and the smart instruments that will then provide meaningful feedback during the surgery. An adjustable wireless microcomputer screen on the hand-held saw/drill ensures that the surgeon’s field of vision is unobstructed, and the guided tracking system immediately (optionally) slows and potentially stops the instrument if the surgeon deviates from the designated error threshold.

We have earned national attention for this research, including a multi-million dollar contract from the U.S. Navy (currently in its third year) to carry navigated freehand bone cutting from synthetic and cadaveric testing toward readiness for clinical use. Dr. Haider and his colleagues have presented work at international scientific conferences and published articles in prestigious publications, including The Journal of Arthroplasty and Clinical Orthopaedics and Related Research (CORR).

Navigated freehand bone cutting enables more accurate bone cutting at a 15 percent faster rate, and much better implant alignment. Because navigated freehand bone cutting facilitates TKA without the use of cumbersome jigs, it is radically simpler and less costly than other navigation systems, and less traumatic to bone and soft tissue – significantly reducing the risk of infection and improving recovery time.

But creating simpler surgical methods for more accurate implant placement can only improve TKA so much; we also need implants that withstand wear to meet the needs of the modern patient. The team’s innovative in vitro simulation and testing of knee and hip implants in the Biomechanics area of the lab is helping to set international standards for joint replacement systems.

Working with a suite of state-of-the-art knee and hip simulators and other innovative testing machines, many of which were engineered by Dr. Haider, researchers mimic prolonged wear and tear on joints through life-like forces, torques, motions and rotations. The in vitro simulations enable the study of particles released into the body by a given implant design and material, as well as the projected longevity, range of motion and overall efficacy in function it can provide patients of varying needs.

By pioneering new testing methods, characterizing implants, and actively helping international governing bodies (e.g., ASTM International and the International Organization for Standardization) to write implant testing standards, we are contributing to the development of better, longer-lasting joint replacements and reducing the need for revision procedures. Many of the joints tested in the UNMC Biomechanics lab are commissioned by industrial companies for FDA-clearance purposes, and ultimately receive FDA approval to move into widespread clinical use in the U.S. and other countries.

This research has garnered eight industrial contracts—an unprecedented number—from a range of companies within the past year alone.

Total knee replacement specimens in two stations of one of the lab’s knee simulators. The lab houses a suite of hip and knee testing machines that simulate the wear of hip and knee implants through life-like forces and motions. This cutting-edge research has helped set international standards for the testing of joint replacement implants.

Dr. Hani Haider
Director, Orthopaedics Biomechanics and Advanced Surgical Technologies Laboratory
Cell attachment and spreading is mediated by adhesive proteins such as Fibronectin (FN). FN is a large extracellular matrix protein consisting of globular domains, one of which contains the cell receptor-binding amino acid sequence motif Arg-Gly-Asp (RGD), which are bound by cell integrin receptors. This protein is known to play a crucial role in adhesion-dependent cellular activities including attachment, proliferation and differentiation. FN is secreted by cells or is present in blood. It has a compact structure stabilized by “electrostatic lock” (interaction between negatively and positively charged FN domains). These domains participate in inter-molecular FN-FN binding when the FN dimer is converted into the extended (activated) form.

In cell-cell interactions (e.g., when a wound is healing), mechanical force through cell motility activates (compact) FN. To simulate that natural self-healing process, Dr. Namavar and his collaborators designed and fabricated a nanoengineered cubic zirconia coating that can provide electrostatic interactions to activate and partially unfold (compact) FN. This exposes its cryptic site to initiate FN matrix assembly, which is a prerequisite of cell adhesion. “Cells aren’t interested (or surviving) on the surface of metal in the absence of adhesive protein; but when we use nanoengineering to make the implant surface ‘available,’ we can create an anchor where they can (and like to) grow,” Dr. Namavar said. (See Figure 1.) “Many people have been studying what makes one surface better than another, but we are the first to combine theory, modelling and experimentation to explain why. It is very exciting.”

Results of comparative animal studies using an intramedullary implant model indicated that maturation of newly formed bone in undernourished older rats (age 1 year) with the nanocrystalline cubic zirconia coating is comparable to the maturation in healthier, younger rats (age 3 months) with only titanium implants. Furthermore, bone growth in older rats with nanomechanically coated implants compared to older rats with only titanium implants, was enhanced twofold. This nanocrystalline coating will revolutionize the future design of prosthetic orthopaedic implants and set a “smart” standard—enhancing the life of joint replacements by reducing both wear and infection risk, and promoting osseointegration. We have successfully demonstrated the superior performance of nanoengineered surfaces to commonly used orthopaedic materials, and are confident that results illustrate a new paradigm for combining IBAD technology with nanostructured design to synthesize metastable materials with novel properties.

This nano-biotechnology research has tremendous implications beyond the department and the field of orthopaedics, as well. For example, it may be applicable for dental implants, as well as for safe storage of nuclear waste. Dr. Namavar and his colleagues at Oak Ridge National Laboratory, University of Tennessee and University of Oxford, have shared findings with many international audiences through scientific papers and presentations, and are conducting ongoing studies of the properties of nanocrystalline cubic zirconia.

For further information about the researchers’ work, contact Dr. Fereydoon Namavar in the Nano-Biotechnology Laboratory at UNMC, 505 N. 30th Street, Lincoln, NE 68588, 402-559-6102, fax 402-559-2317, namavar@unmc.edu, or visit their website at http://www.unmc.edu/nanobiotechnology/

Figure 1. Schematic representation of cell adhesion through FN matrix assembly on smooth and nanostructured surfaces. (a) Smooth surface: FN adheres to the implant surface by van der Waals interaction, but remains compact (non-active). (b) Nanostructured surface: FN is adhered to the implant surface and activated (by partial unfolding) from the compact to extended form. FN activation is due to electrostatic interactions between negatively charged implant surface patches and positively charged FN domains. Due to its partial unfolding, FN exposes its cryptic sites to initiate FN matrix assembly, which is a prerequisite of cell adhesion.

The state-of-the-art IBAD machine in the department’s Nano-Biotechnology Laboratory is one of few in the country. It combines ion-beam-assisted deposition (IBAD) technology, Dr. Namavar and his team use a large number of energetic ions with superior mechanical properties – resulting in improved hardness, adhesion, morphology, and chemical composition of a surface.

We wear orthopaedic implants in a common concern in joint replacement surgery due to correlated health risks and the need for revision procedures. Fereydoon Namavar, Sc.D., professor and director of the Nano-Biotechnology Laboratory, joined the Department of Orthopaedic Surgery and Rehabilitation faculty in 2002. Dr. Namavar’s research focuses on developing a coating that will improve orthopaedic implant surfaces and optimize wear. Through his research, he and his team discovered a nanocrystalline cubic zirconia coating with properties greater than even he could have imagined.

When joint surfaces rub together, friction can release small polyethylene particles into a patient’s joint fluid. There are several main orthopaedic implant materials: ceramic, ceramic, which wears very little, but is brittle, metal-metal, which is unbreakable, but causes metal ions to leach into the joint fluid, and metal-highly crosslinked polyethylene, which is the foremost material used by surgeons, yet still wears more than is optimal. In order to reduce friction and minimize wear particles, Dr. Namavar hypothesized that implant surfaces should have opposite hydrophilic (water-attracting) and hydrophobic (water-repelling) properties; so he set out to develop a wettable coating that would prolong the life of joint implants. Inspiration hit when Dr. Namavar’s mother-in-law pointed out that her cubic zirconia ring always fogged up when wet. By applying principles of nanoscience to the already hydrophilic surface, Dr. Namavar knew he could mimic the attributes of the lotus leaf (a unique plant that grows in muddy water, yet stays clean because of its hydrophilic properties) to achieve total wettability and hardness.

With special ion-beam-assisted deposition (IBAD) technology, Dr. Namavar and his team use a large number of energetic ions (atoms that have gained an electrical charge by losing an electron) to forge pyramidal nanostructures that are hard and super-hydrophilic. What Dr. Namavar and his collaborators soon discovered was that cells find pyramidal nanostructures hospitable. Thus, the nanocrystalline cubic zirconia coating has “smart” properties: It optimizes resistance to wear, and promotes and maintains bone growth (osseointegration).

Dr. Namavar and his colleagues soon discovered was that cells find pyramidal nanostructures hospitable. Thus, the nanocrystalline cubic zirconia coating has “smart” properties: It optimizes resistance to wear, and promotes and maintains bone growth (osseointegration). By studying how cells communicate and attach to one another, we learned that we can design a nano-grain that simulates or produces the effect of a living cell to activate fibronectin (FN) adhesive protein.
The Orthopaedic Registry to Monitor Treatment Outcomes is now active at UNMC. The Nebraska Medical Center, Children’s Hospital & Medical Center, the Veteran’s Administration Hospital, and Creighton University Medical Center with over 4000 surgery subjects enrolled who have undergone total joint replacement, revision joint surgery, shoulder surgery, or treatment for Whiplash Associated Disorders (WAD).

Any pre- or post-surgical patient who is seeing a UNMC orthopaedic surgeon may be included in the database. Patients fill out routine questionnaires regarding their health, quality of life, and functional status, preoperatively and at regular postoperative intervals. If the patients are unable to return, they are contacted by phone and questionnaires are mailed to their home.

Evaluation of current practice through the collection, interpretation and analysis of outcomes data including patient questionnaires, clinically-obtained assessment and measurements, and retrospective medical record reviews (including radiographs), ultimately leads to advancements in patient care through the establishment of improvement objectives and an increase in generalized knowledge that can be presented or published to share findings with the orthopaedic community. In addition to studies being utilized in the outcomes database, there are a variety of clinical studies being performed in the department. Currently, there are 25 active IRB approved research studies. In addition, 15 studies were completed in 2010-2011.

**The Orthopaedic Registry to Monitor Treatment Outcomes**

**Utilizing Outcomes Studies to Improve Patient Outcomes**

*Each year, the department continues to expand our surgery outcomes database, using patient outcomes to evaluate and compare the effectiveness of various treatments in an effort to ensure that diagnosis and treatment are continually evolving and improving.*

**Active Studies:**
- Does Surgical Decompression of Spinal Stenosis Improve Gait Dynamics during Ambulation and Trium Position?
- Functional Outcomes after Posterospectoral Plate Fixation of Humerus Shaft Fractures
- Periprosthetic Fractures of the Tibia: an Overview and Description of a Surgical Technique using Locking Plates, Cables and Augmentation with an Anterior 1/3 Tubular Plate
- Initial Results and Experience with Intramedullary Rodding (Fassier-Duval) in Children with Osteogenesis Imperfecta
- Outcomes of Total Hip Replacement Utilizing Oxidized Zirconium Femoral Heads on Cross-Linked Polyethylene
- Clinical Results of Uncemented Tapered Stems with Total Hip Arthroplasty: Impacts Aged 50 Years or Younger
- Orthopaedic Registry to Monitor Treatment Outcomes
- Stem Cells (Medical Record Review)
- Can Stem Cells Predict Orthopaedic Surgical Outcomes?
- Hip TKA Revision with Impact Grafting
- The Coefficient of Friction of Human Osteoarthritic Cartilage on Joint Repair Materials Lubricated by Human Osteoarthritic Synovial Fluid
- A Multi-center, Randomized, Clinical Outcome of Visionsaire Patient Matched Technology vs. Standard Surgical Instrumentation in Total Knee Arthroplasty
- Sonication for Enhanced Diagnosis of Prosthetic Joint Infection
- An Analysis of the Accuracy of Radiographic Reference Markers for Digital Templating in Total Hip Arthroplasty
- Clinical Outcomes Comparison between a Single Injection of Hylan GF20 and a Series of 5 Injections of Sodium Hyaluronate in Patients for Treatment of Osteoarthritis of the Knee. A Randomized Prospective Study
- Vertical Expandable Prosthetic Titan Rib
- CISS Multi-Center Retrospective and Prospective Observational Data Registry for Clinical and Radiographic Outcomes of Spinal Surgery Comparing Instrumentation and Procedures
- Own the Bone Registry
- Results of Total Knee Arthroplasty Revision for Rotational Malalignment
- Horseback Riding and/or Motorcycle Riding After a Total Hip Arthroplasty
- Outcomes Following Acetabular Fracture
- Tumor Registry
- Distinguishing Cammedal Versus Pathologic Staphylococcus Species in Cases of Fracture Nonunion after Internal Fixation

In collaboration with other departments:
- Enhanced Detection of Staphylococcus Aureus Colonization in Patients Undergoing Prosthetic Joint Implantation
- Anterior Knee Pain after Intramedullary Nailing of Tibial Fractures by Suprapatellar Approach
- Acute Bracing of Humerus Shaft Fractures
- Incidences of Spondylolysis and Spondylolisthesis in Children with Osteogenesis Imperfecta
- Clinical Results of the Anatomic Compression Arthrodesis Technique with Anterior Tension Band Plate Augmentation for Ankle Arthrodesis
- Functional Outcomes after Plate Fixation of Humerus Shaft Fractures: Anterior Versus Posterior Approach
- Local Analgesia versus Conscious Sedation in Closed Reduction of Distal Radius Fractures
- Functional Outcomes Following a Quad Snip Approach in Knee Rviossion Surgery
- Factors That Influence Medical Students’ Choice of Residency
- Why Are Total Hip Arthroplasties Revisited?
- Surgical Treatment Outcomes for Whiplash Associated Disorder
- Evaluation of Functional Outcomes of Mini Open Rotator Cuff Repair Without Acromioplasty
- Glenoid Anchor Peg Component Fixation Utilizing Autologous Bone Graft in Total Shoulder Arthroplasty Follow-Up
- Functional Outcomes of Intrathecally Applied Distal Humerus Fixation Through an Extensor Mechanism Sparing Posterior Approach
- Follow-up of Shoulder Hemiarthroplasty with a CTA Head for Cuff Tear Arthropathy
- Orthopaedic Registry to Monitor Treatment Outcomes
- Changes in Bacterial Species and Resistances in Infected Total Hip Arthroplasty Revisions

**Completed Studies:**
- Utilizing Outcomes Studies to Improve Patient Outcomes
- Associated Disorders (WAD).
- The Orthopaedic Registry to Monitor Treatment Outcomes is continually evolving and improving.
- An effort to ensure that diagnosis and treatment are evaluated and compared.
LABS AND EDUCATIONAL OPPORTUNITIES

THE DEPARTMENT ALSO HOLDS ONGOING CADAVER LAB RESEARCH PROJECTS AND EDUCATIONAL SESSIONS ABOUT ONCE EVERY SIX WEEKS. THESE SURGICAL CADAVER LABS ARE NOT ONLY INVALUABLE EDUCATIONAL OPPORTUNITIES FOR OUR FACULTY AND RESIDENTS, THEY ARE OFTEN OPEN TO OTHER COMMUNITY PHYSICIANS AS WELL. THIS ONGOING RESEARCH, MADE POSSIBLE BY GENEROUS ANATOMICAL DONATION, ALLOW OUR SURGEONS TO DEVELOP AND PRACTICE NEW AND HIGHLY REFINED TECHNIQUES THAT BENEFIT LIVING PATIENTS WITHOUT THE ADDITIONAL RISK.

2010 LAB WORKSHOPS
January 5, 2010
- Dr. Kevin Garvin: (Clinical Practice) Periostomy acetabular
February 5, 2010
- Drs. Edward Fehringer and Annie Knierim: (Research) Nailing shoulder technique
May 15, 2010
- Drs. Edward Fehringer and Annie Knierim: (Research) Nailing shoulder technique
June 1, 2010
- Dr. Kevin Garvin: (Clinical Practice) Periacetabular osteotomy
September 14, 2010
- Dr. Ryan Hess: (Clinical Practice) Medial approach to a proximal tibia
September 16, 2010
- Drs. Lucas Burton and Jason Erpelding: (Education) Hand, wrist, finger dissection
September 15, 2010
- Dr. Michael Carlson: (Education) Elbow, shoulder, hip and knee

2011 LAB WORKSHOPS
January 20, 2011
- Dr. Sean McGarry: (Clinical Practice) New instrumentation
January 20, 2011
- Drs. Matthew Morrow and Miguel Daccarett: (Clinical Practice)
  New procedure (Dr. Khalid Azzam and Coughton physicians also in attendance)
February 1, 2011
- Dr. Kevin Garvin: (Clinical Practice/Teaching)
February 7, 2011
- Dr. Khalid Azzam: (Clinical Practice)
February 11, 2011
- Dr. Miguel Daccarett: (Clinical practice of new technique)
March 29, 2011
- Dr. Miguel Daccarett: (Clinical practice of new technique)
March 28, 2011
- Drs. David Minges and Nicholas Aberle: (Resident Education)
May 17, 2011
- Drs. Kevin Garvin and Dan Firestone: (Clinical Practice)
June 3, 2011
- Drs. Miguel Daccarett, Khalid Azzam, and Matthew Morrow: (Clinical Practice/Research)
June 21, 2011
- Dr. Miguel Daccarett: (Clinical Practice/Research)
October 19, 2011
- Drs. Edward Fehringer and Matthew Morrow: (Journal article regarding specific technique)
December 20, 2011
- Drs. Kevin Garvin and Paul Nielsen: (Clinical Practice – PAO)

2012 LAB WORKSHOPS
January 10, 2012
- Drs. Kevin Garvin, Brian Vernon, and Brent Hood: (Clinical Practice – PAO)
January 18, 2012
- Drs. Thomas Farlic and Todd Gaddie: (Clinical Practice/Teaching – Hand)
February 1, 2012
- Drs. Thomas Farlic and Todd Gaddie: (Clinical Practice/Teaching – Hand)
February 14, 2012
- Dr. Jeremy Toomey: (Clinical Practice – Ankle)
February 28, 2012
- Drs. Kevin Garvin and Miguel Daccarett: (Clinical Practice – Hips)
April 12, 2012
- Dr. Jeremy Toomey: (Clinical Practice – Upper Extremity)

FIRST IN NEBRASKA TO OWN THE BONE™
The UNMC Department of Orthopedic Surgery and Rehabilitation was selected in 2010, as the first in the state to launch a new quality improvement program to treat frailty fractures. Own the Bone™, developed by the American Orthopaedic Association, is focused on better identifying, evaluating and treating patients suffering from osteoporosis or low bone density-related fractures.

It is estimated that 50 percent of women and 25 percent of men over the age of 50 will sustain fragility fractures in their lifetime, and after sustaining one fracture, the likelihood of suffering another more than doubles. Therefore, the program helps streamline communication between orthopedists, patients and primary care physicians to ensure that those facing the severe implications of fragility fractures receive the most comprehensive care and reduce the incidence of future fractures.

COLLABORATIVE RESEARCH PROGRAMS

One-of-a-kind staphylococcus center
The UNMC Center for Staphylococcal Research (CSR), approved in 2010 by the University of Nebraska Board of Regents, is the first center in the nation dedicated solely to the study of staph infections, which claim the lives of roughly 180,000 Americans every year. The CSR is a collaborative effort of multiple UNMC departments to understand staphylococci and improve our ability to prevent, diagnose and treat staphylococcal disease – the leading cause of nosocomial and implant-related infections in the United States. The orthopaedic department’s research within the CSR focuses on the management of musculoskeletal infections caused by emerging multi-resistant strains of bacteria in the surgical setting.

Nebraska Arthritis Outcomes Research Center (NAORC)
Through a collaborative effort between the departments of rheumatology and orthopaedic surgery, researchers at the NAORC will determine the determinants of poor surgical outcomes among U.S. veterans with arthritis undergoing joint replacement. Findings from this study will guide the development of future interventions aimed at improving surgical outcomes in arthritis suffers and serve as a unique resource to arthritis researchers both in Nebraska and elsewhere. The NAORC was established in 2007 through a generous donation by Ruth and Bill Scott, strong supporters of the Department of Orthopaedic Surgery and UNMC.
THE DEPARTMENT OF ORTHOPAEDIC SURGERY AND REHABILITATION IS ENTHUSIASTICALLY ACTIVE IN OUR LOCAL, STATE, NATIONAL AND INTERNATIONAL COMMUNITY.

WE RELY ON GENEROUS INDIVIDUALS AND FOUNDATIONS WITHIN IT TO KEEP OUR DEPARTMENT IN FORWARD MOTION.
The U.S. Olympic Swim Trials returned to Omaha in the summer of 2012 and staff and physicians from UNMC Physicians, University of Nebraska Medical Center and The Nebraska Medical Center were again invited to team up and help the London Olympic hopefuls perform at their best. After overseeing the medical coverage of the 2008 U.S. Olympic Swim Trials, the UNMC Department of Orthopaedic Surgery and Rehabilitation and UNMC Physicians received an award from the Omaha Sports Commission for “providing exceptional care and service to the 2008 Olympic Swim Trial participants” and were eager to support the world-class athletes once again.

This year’s trials attracted over 1800 athletes and 167,048 spectators (nearly 7,000 more than in 2008) to CenturyLink Center Omaha between June 22 and July 2, 2012. Preparation for the event – recruiting volunteers, collecting medical supplies and coordinating adequate coverage for the athletes, coaches and trainers from across the country – began in January 2012. More than 160 individuals from within the organization, including physicians, physical therapists, massage therapists, pharmacists and staff, volunteered their time. Among them were 10 physicians from the UNMC Department of Orthopaedic Surgery.

Medical teams were on-site to assist with any health concerns from 6 a.m. until the pools closed each day, much like an outpatient clinic. Both a primary care physician and an orthopaedic surgeon were in the arena during each set of preliminaries and finals, and on-call between race times.

In November 2011, the Operation Walk – Nebraska team took its second annual mission trip to Antigua, Guatemala, to care for patients suffering from debilitating arthritis who might otherwise never have regained their mobility. The 11-person UNMC team joined other North American teams to perform 73 surgeries on 63 patients in five days. The Guatemalan patients’ fortitude was impressive and humbling. The team distributed less than 100 Vicodin while in Antigua. “We would have gone through thousands of narcotic pills for the same number of patients in the U.S. It’s really a testament to the strength of the patients we have encountered on these missions,” Dr. Kevin Garvin said.

To hear the Operation Walk–Nebraska team describe the graciousness and gratitude from the people of Guatemala, it is clear that the lifelong impact was mutual. Operation Walk, a private, not-for-profit volunteer medical services organization, has helped more than 6,000 patients in developing countries since it was founded in 1994. Operation Walk–Nebraska, a team developed by Dr. Garvin, took its first trip to Guatemala with 16 people in 2010, and intends to travel there again in coming years. The UNMC Department of Orthopaedic Surgery and Rehabilitation also helped bring the organization’s life-changing mission home to local patients, by participating in Operation Walk USA in 2011.

On December 2 and 3, the Operation Walk USA program (sponsored by The Hip Society, The Knee Society and the American Association of Hip and Knee Surgeons) provided free joint replacement surgeries to 85 people in the U.S. who were otherwise unable to receive the necessary surgical care due to financial circumstances.

Dr. Beau Konigsberg was one of 60 surgeons in 26 hospitals nationwide who participated in the first annual Operation Walk USA mission. Dr. Konigsberg performed pro-bono hip replacement surgery for Charles Jones of Omaha, a chef and minister who had been forced to take a medical leave of absence because of crippling pain caused by avascular necrosis in his left hip. Mr. Jones has since regained the ability to walk and returned to his normal way of life.

To learn how you can support Operation Walk–Nebraska and Operation Walk USA, contact Meg Johnson at the University of Nebraska Foundation at (402) 502-4107 or email at mjohnson@nufoundation.org. You may also utilize the enclosed remittance envelope or donate online at http://ow.ly/cZPTP.
Each year, the Department of Orthopaedic Surgery and Rehabilitation hosts speakers from throughout the region, country and world to enhance residents’ well-rounded educational experience. These visitors present seminars for faculty, residents, staff and area surgeons—sharing their knowledge and expertise in a variety of disciplines. Private contributions to the department’s Development Fund from alumni and supporters allow us to continue to bring guests who offer unique insights about patient care, surgical techniques and research topics.

Below is a list of the names and topics of the visiting speakers who presented in the department from January 2010 – June 2012.

FEBRUARY 2010
22 Dr. Scott McMullen GIKK Ortho Specialists Omaha, NE "Charcot Arthropathy"

APRIL 2010
7 Dr. Adam Reinhardt Pediatric Rheumatology Children’s Hospital & Medical Center Omaha, NE "Pediatric Rheumatology"
12 Dr. David Inda GIKK Ortho Specialists Omaha, NE "Achilles Tendon Ruptures"

MAY 2010
3 Dr. Erik Otterberg GIKK Ortho Specialists Omaha, NE "Management of Knee Arthritis without TKA"
10 Dr. Timothy Fitzgibbons GIKK Ortho Specialists Omaha, NE "Foot Injuries in the Collegiate Athlete"

JUNE 2010
18-19 Graduation Ceremonies Dr. Brian Adams University of Iowa Iowa City, IA "Evolution of Orthopedic Implants Used in Hand Surgery" "Wrist Arthritis: Expanding Treatment Options"
24 Dr. Brian Cole Rush University Chicago, IL "Cartilage Transplantation (knee)"

MARCH 2011
14 Dr. Jennifer Adams UNMC Anesthesia Omaha, NE "Regional Anesthesia"

APRIL 2011
22 Dr. Frank Liporace University of Medicine and Dentistry of New Jersey Newark, NJ "Biomechanics and the Evolution of Locked Plating"

MAY 2011
16 Dr. Kimberly Apker UNMC Radiology Omaha, NE "Hip MRI"

JUNE 2011
6 Dr. John McClellan Nebraska Spine Center, LLP Omaha, NE "Spondylolysis"
17-18 Graduation Ceremonies Dr. C. Parker Gibbs University of Florida Gainesville, FL "Allograft Reconstruction in Musculoskeletal Oncology" "Intra-tumoral Heterogeneity in Osteosarcoma: Implications for Tumorigenicity and Maladaptation"
Dr. Lee Simmons Henry Doorly Zoo Omaha, NE "Field Work in Russia and at the Moscow Zoo"
24 Dr. Eric Phillips Nebraska Spine Center, LLP Omaha, NE "Cervical Spine: Surgical Indications and Sawbones Labs"

JULY 2011
29 Dr. Kenneth Taylor Tripler Army Medical Center Honolulu, HI "Deployment to Baghdad"

AUGUST 2011
1 Sandi Anderson UNMC Physicians Omaha, NE "Compliance Training for Billing and Documentation"
This honor roll lists individuals and organizations that supported the department during the 2010 and 2011 calendar years. Those who have contributed in 2012 will be recognized in the next biennial report, as well as upcoming issues of our departmental newsletter, Breaking News.

$10,000+
- Anne Connelly
- Dr. Paul W. Epasto
- Dr. Edward V. Fehringer
- Dr. Kevin L. Garvin
- Dr. Brian P. Hasley
- Mrs. L. Thomas Hood
- Dr. Jun Nishio
- Dr. Lori K. Reed

$5,000 - $9,999
- Dr. Miguel S. Daccarett
- Dr. Mark E. Dietrich
- Dr. and Mrs. Roy Guse
- Dr. Curtis W. Hartman
- Dr. Beau J. Kosinkovich
- Dr. Sean V. McGarry
- Dr. and Mrs. Jeffrey S. Moore
- Dr. Matthew A. Mormino
- Dr. Judah J. Neoom
- Dr. & Mrs. Wayne O. Southwick
- Dr. & Mrs. Kirk D. Green
- Dr. James & Karen Linder
- Heartland Orthopaedic & Sports Medicine Clinic LLC
- Ortho Development: “A Simulator Study of the Wear of Vanguard SSK Constrained ArCom Tibial Bearings” $160,000
- Ortho Development: “A Simulator Wear Study of Metallic-on-Plastic and Ceramic-on-Plastic Total Hip Replacement Systems from Japan” $150,000
- ETC: “Characterization of the Wear of Aged vs. Un-Aged Polyethylene, A Pin on Disc Study” $12,000
- ETC: “Characterization of the Wear of Aged vs. Un-Aged Polyethylene, A Pin on Disc Study” $12,000
- Biomet: “A Simulator Study of the Wear of Large Size Vanguard SST Constrained Articulating Total Hip Replacement Systems” $60,000
- Arthrex Inc.: “WO2011-001 Friction Characteristics of Two Polyurethane Materials against Canine Cartilage” $10,000

$5,000 - $9,999
- Dr. Miguel S. Daccarett
- Dr. Mark E. Dietrich
- Dr. and Mrs. Roy Guse
- Dr. Curtis W. Hartman
- Dr. Beau J. Kosinkovich
- Dr. Sean V. McGarry
- Dr. and Mrs. Jeffrey S. Moore
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$1,000 - $4,999
- Harold & Marian Andersen
- Michael R. & Michelle M. Berlin
- Dr. and Mrs. David E. Brown
- Dr. Charles & Mrs. Julie Burt
- Dr. Chris A. Cornett
- Dr. & Mrs. Paul J. Duwelius
- Fidelity Charitable Gift Fund
- Dr. Brett W. Fischer
- Dr. & Mrs. Kirk D. Green
- Heartland Orthopaedic & Sports Medicine Clinic LLC
- Ortho Development: “Wear Testing of 2 Types of UHMWPE Using Force-controlled Knee Simulators per ISO 14243” $110,000
- Ortho Development: “Pin-on-Disk screening wear test of four types of UHMWPE” $15,000

$1,000 - $4,999
- Harold & Marian Andersen
- Michael R. & Michelle M. Berlin
- Dr. and Mrs. David E. Brown
- Dr. Charles & Mrs. Julie Burt
- Dr. Chris A. Cornett
- Dr. & Mrs. Paul J. Duwelius
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- Ortho Development: “Pin-on-Disk screening wear test of four types of UHMWPE” $15,000

UP TO $999
- Dr. & Mrs. James P. Devney
- Ms. Kristine Gottula
- Dr. Anthony J. Lauder
- Linder Family Foundation
- Dr. & Mrs. Michael J. Sicuranza
- Theodore C. Yee, M.D.
- Material Science Smart Coatings $275,057
- Simplified Orthopaedic Surgery $4,095,340

ENDOWMENTS

Achievement of our mission, as with any academic medical center, is dependent on effective integration of medical education, scientific research and patient care. Gifts, funds and endowments help us successfully link these three functions.

The UNMC Department of Orthopaedic Surgery and Rehabilitation has a national reputation for preparing outstanding orthopaedic surgeons. Likewise, our research program has garnered attention nationwide. By combining resources in these two areas, we are able to offer the most advanced diagnosis, treatment and surgical techniques for our patients. Our faculty members also conduct research in basic science, biomedical engineering, computer simulation and nanobiotechnology.

The following list includes the names, sources and funding of grants received by the Department of Orthopaedic Surgery and Rehabilitation between 2010 and early 2012.

FEDERAL:

2010
- Material Science Smart Coatings $275,057
- Material Science Smart Coatings $275,057
- Simplified Orthopaedic Surgery $4,095,340

INDUSTRY:

2011
- Biomet: “A Simulator Study of the Wear of Posterior Stabilized Tibial Bearings” $50,000
- Biomet: “A Simulator Study of the Wear of Posterior Stabilized Tibial Bearings” $50,000
- Simplified Orthopaedic Surgery $4,095,340

2012
- Gruppo Bioimplanti: “A Simulator Study of the Wear of Posterior Stabilized Tibial Bearings” $50,000
- Gruppo Bioimplanti: “A Simulator Study of the Wear of Posterior Stabilized Tibial Bearings” $50,000
- Simplified Orthopaedic Surgery $4,095,340

Endowment Report
CLINICAL TRIALS: 2011

Smith & Nephew: “A Multi-center, Randomized, Clinical Outcome of Viosaire Patient Matched Technology vs Standard Surgical Instrumentation in Total Knee Arthroplasty” $ 81,144

“CSSG Multi Center Retrospective and Observational Data Registry for Clinical and Radiographic Outcomes of Spinal Surgery Comparing Instrumentation and Procedures (K2M CSSG Data Collection Project Agreement)” $ 7,429

OTHER: 2011

Pilot Grant Review Committee of the UNMC Clinical Research Center: A continuation study of “Can Stem Cells Predict Orthopaedic Outcomes?” $ 42,267

Endowments provide much-needed perpetual resources for a variety of departmental education and research activities. When an individual establishes an endowed fund through the University of Nebraska Foundation to benefit the Department of Orthopaedic Surgery and Rehabilitation, the principal of the fund is invested with a portion of the earnings providing support for assistantships, resident education, equipment and technology purchases, library resources, scientific research project seed money, endowed faculty chairs and much more, depending on the interests of the donor.

The department also maintains several endowed and non-endowed funds that have been established or pledged to the University of Nebraska Foundation. Some funds have been established for specific purposes, while our department’s Development Fund is an unrestricted resource applied depending on the interests of the donor.

Establishment, benefit and support of the Robert G. Volz, M.D., Chair of Musculoskeletal Oncology

Benefit and support of the Department Chair

Benefit and support of the Nebraska Arthritis Outcomes Research Center

Benefit and support of the Resident Fund

Benefit and support of the Robert G. Volz, M.D., Chair of Biomechanics

Benefit and support of the Orthopaedic Surgery Department Development Fund

GREATER THAN $12,000,000

Endowments

GREATER THAN $10,000,000

Endowments

GREATER THAN $5,000,000

Endowments

GREATER THAN $1,000,000

Endowments

GREATER THAN $350,000

Endowments

GREATER THAN $100,000

Endowments

GREATER THAN $10,000

Endowments

GREATER THAN $350

Endowments
HAROLD AND MARIAN ANDERSEN LECTURESHIP FOR ORTHOPAEDIC SURGERY

Harold and Marian Andersen have been long-time supporters of the Department of Orthopaedic Surgery and Rehabilitation. Their contributions—both professional and pure altruistic—have touched many lives.

The Andersens have also been frequent UNMC patients. “We have great respect and appreciation for the Department of Orthopaedic Surgery and Rehabilitation and everyone affiliated with it,” Mr. Andersen said.

Mr. Andersen began working for the Omaha World-Herald in 1946 as a reporter, and ultimately served as president, chief executive officer and publisher from 1986 to 1989. He served as the first American president of the International Federation of Newspaper Publishers, the first and only Nebraskan elected as chairman of the American Newspaper Publishers Association; director of the Associated Press and chair of its Foreign Operations and World Press Freedom Committee chairman. He has held many other board positions around the country.

Mrs. Andersen was the first woman to head the Heartland Chapter of the American Red Cross. She served as vice chairman of the American Red Cross Board of Governors and served on the board of the Public Broadcasting System. She has received numerous honors, including the Perry Branch Award from the University of Nebraska Foundation and the Nebraska Builders Award from the University of Nebraska. She has held many board and chair positions, and was the first female chair of the University of Nebraska Foundation Board of Directors.

In their tradition of humanitarian service, the Harold and Marian Andersen Lectureship seeks to inspire broad interests, enriching experiences and ongoing community outreach. Harold Andersen was the 2012 speaker. He delivered a witty, befittingly journalistic inauguration to what will undoubtedly be a memorable part of resident graduation for years to come.

Department residents enjoyed the first annual Harold and Marian Andersen Lecture at the 2012 graduation ceremony. The lectureship, funded by Mr. and Mrs. Andersen, was generously established to focus on “non-scientific issues that enhance the education, diverse interests and community involvement of faculty and residents in the Department of Orthopaedic Surgery and Rehabilitation.”

Harold and Marian Andersen have been long-time supporters of the department and the University of Nebraska system as alumni, donors and community advocates. Mr. and Mrs. Andersen are trustees of the University of Nebraska Foundation, and have served as chairs of the University of Nebraska Foundation Board of Directors. Their contributions—both professional and purely altruistic—have touched many lives.

Dr. Robert Volz is a distinguished alum of the University of Nebraska College of Medicine, long-time friend of the Department of Orthopaedic Surgery and Rehabilitation, and renowned orthopaedic surgeon.

In 2012, he endowed funding for a new department Chair of Biomechanics, including an annual salary stipend and support for scholarly research and creative activities. This future gift will be funded through Dr. Volz’s estate—leaving a remarkable legacy to the department.

“I am extremely appreciative of the education I received from the University of Nebraska College of Medicine,” said Dr. Volz. “As loyal alums, I think it is our obligation to pay back the institutions to which we credit our careers. I also have the utmost respect for Dr. Kevin Garvin and consider this contribution a tribute to him and the wonderful department he has created, with a national and international reputation.

If there is anything I can do to expand the Department of Orthopaedic Surgery and Rehabilitation, and the reputation of the department and UNMC, I am pleased to do so.”

Thank you for your support.

Dr. Volz graduated from UNMC’s College of Medicine in 1957 and went on to complete his orthopaedic specialty training at the University of Kansas Medical Center. It was during his time in Kansas that Dr. Volz met the late Dr. James Neff, who served as chair of the UNMC Department of Orthopaedic Surgery and Rehabilitation from 1991-2000. A lasting friendship between the two pioneering surgeons grew out of shared passion for developing innovative techniques and devices to further the field of orthopaedic surgery. Their camaraderie was the catalyst for what became a long-standing relationship between Dr. Volz and the UNMC Department of Orthopaedic Surgery and Rehabilitation.

After his completing his training in Kansas, Dr. Volz went on to practice for several years in Denver, CO, where he served as the head of the orthopaedic service at Denver Children’s Hospital. In 1973, he was recruited to build a total joint surgery program—part of the newly founded orthopaedic program—at the University of Arizona Health Sciences Center (AHSC). While at AHSC, Dr. Volz designed some of the earliest joints used in the U.S., including the first artificial wrist deemed by the American Hospital Association as one of the nation’s 10 most important hospital advances in 1976), elbow and knee implants.

Throughout his career, Dr. Volz has shown remarkable ongoing support for the university and the department. He previously created the Robert G. Volz, M.D., Research Fund, which generates annual funding for research and educational initiatives that bolster the orthopaedic residency program and, in 2000, he was honored with a Distinguished Alumnus Award from the UNMC College of Medicine Alumni Association.

The Department of Orthopaedic Surgery and Rehabilitation would not be able to be on the forefront of research, education and patient care without such extraordinary ongoing commitment from the community. Thank you for your support.
Displaced acetabular fractures are known to require anatomic or near-anatomic reduction to achieve a satisfactory clinical outcome and to minimize the risk of post-traumatic arthritis. Minimally displaced acetabular fractures, however, can be difficult to treat. These are fractures with less than 3 mm of displacement [1]. Percutaneous screw fixation has been advocated for some minimally displaced acetabular fractures with the potential benefit of allowing early mobilization and preventing further displacement. This mode of fixation can also be useful at the time of open reduction to secure a minimally displaced (or openly reduced) column fracture in order to avoid a more extensive exposure. It could also be employed when the soft tissue condition precludes major open surgery, such as in the case of burns or Morí-Lavolel lesion [2]. Opponents to this method of fixation question its indications. Do none or minimally displaced fractures require fixation, or are they inherently stable and therefore not prone to any further displacement? Retrograde posterior column screw fixation has been reported in few studies [3-5]. It has been shown to provide satisfactory results with no intraoperative or postoperative complications in the geriatric population with less than 2 mm of displacement [3]. Retrograde posterior column fixation in conjunction with an open approach for a displaced portion of the acetabulum has been described with no incidents of injury to the sciatic nerve [5].

The purpose of this cadaveric study was to determine the proximity of the neurologic structures, in particular the sciatic nerve, to the path of a percutaneously placed retrograde posterior column acetabular screw utilizing a guide wire into the ischial tuberosity. Three male and two female lightly embalmed cadavers (ten hips) were used. In each hip, a 3.2 mm guide wire was inserted percutaneously into the ischial tuberosity under fluoroscopic guidance. The leg was held by an assistant in about 90 degrees of hip flexion to simulate the usual positioning of the limb during surgery. An anteroposterior view of the pelvis was first obtained to ensure that the guide wire was on the tuberosity. Next, the obturator oblique view was used to make any adjustments to the position of the wire in the AP plane. Finally the iliac oblique view was taken to guide the position of the guide wire in the coronal plane. After a central entry point in the tuberosity was confirmed on all three views, the wire was then advanced into the posterior column guided by the iliac oblique view (Figure 1). We noted the angle made by the wire in both the sagittal and coronal planes to obtain a central pathway in the posterior column. Then, a skin incision was made to allow the introduction of a 3.2 mm cannulated drill bit that was advanced over the guide wire. A 7.3 mm cannulated screw was then inserted over the guide wire down to the ischial tuberosity. No soft tissue sleeves were used during the procedure. Final fluoroscopic views demonstrated appropriate, extracapsular placement of the screw. The wire was then left in place to facilitate identification of the screw head.

The distance from the center of the screw head to the sciatic nerve averaged 58 mm (range, 40 to 70 mm). The average distance between the center of the screw head and the posterior cutaneous nerve of the thigh averaged 42 mm (range, 30 to 60 mm). The inferior cluneal branches were the closest to the path of the screw with an average distance of 3.5 mm in six specimens (range, 1 to 6 mm). The inferior cluneal branches ranged from one to four in our cadaver specimens. An inferior cluneal branch was injured by the screw in three hips. The screw went straight through the nerve in one specimen. The nerve was found to be crushed between the screw head and the bone of the ischial tuberosity in two other specimens. We failed to identify the posterior cutaneous nerve of the thigh in one specimen. We were also unable to find the inferior cluneal branches in another specimen (Table 1).

Figure 2: Cadaver photograph showing relationship of the wire to the sciatic, posterior cutaneous nerve of the thigh, and the inferior cluneal branches.

Table 1: Distance (in mm) from the screw head to the sciatic, posterior cutaneous nerve of the thigh (PCNT) and inferior cluneal nerves in each of the ten cadaver hip specimens. (NI: Not Identified, L: Left, R: Right)

<table>
<thead>
<tr>
<th>Cadaver</th>
<th>Sciatic</th>
<th>PCNT</th>
<th>Cluneal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-L</td>
<td>35</td>
<td>40</td>
<td>NI</td>
</tr>
<tr>
<td>1-R</td>
<td>43</td>
<td>30</td>
<td>NI</td>
</tr>
<tr>
<td>2-L</td>
<td>55</td>
<td>35</td>
<td>NI</td>
</tr>
<tr>
<td>2-R</td>
<td>45</td>
<td>40</td>
<td>30</td>
</tr>
<tr>
<td>3-L</td>
<td>55</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>3-R</td>
<td>65</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>4-L</td>
<td>70</td>
<td>60</td>
<td>3</td>
</tr>
<tr>
<td>4-R</td>
<td>60</td>
<td>50</td>
<td>1</td>
</tr>
<tr>
<td>5-L</td>
<td>70</td>
<td>60</td>
<td>5</td>
</tr>
<tr>
<td>5-R</td>
<td>65</td>
<td>55</td>
<td>NI</td>
</tr>
</tbody>
</table>

Figure 3: Obturator and iliac fluoroscopic images showing placement of guide wire up the posterior column.

The sciatic nerve and the posterior cutaneous nerve of the thigh appear to be safe during retrograde percutaneous screw fixation of a posterior column acetabular fracture through a central entry point in the ischial tuberosity. However, the inferior cluneal nerves, which are responsible for the cutaneous sensitivity of the lower half of the gluteal region, are at risk of injury.

References:

PERCUTANEOUS RETROGRADE POSTERIOR COLUMN ACETABULAR FIXATION, IS THE SCIATIC NERVE SAFE? A CADAVERIC STUDY.
Azam, K; Siebler, J; Bergmann, K; Daccaret, M; and Marmion, M
INTRODUCTION:
Navigated freehand cutting (NFC) technology has proven to simplify the bone cutting process in laboratory experiments. While overall cutting for total knee replacement (TKR) was faster with NFC than with conventional jigs, studies on the femoral reshaping process using NFC with an oscillating bone saw or drill indicated that initiating each planar cut or hole (i.e. creating the first bone indentations) took most of the cutting time. Further experiments indicated that marking a physical line with a navigated marker pen on the bone surface as a starting point for each cut reduced the cutting time considerably. In order to improve the accuracy of the marking process and to reduce the possibility of human error, a ‘smart’ navigated touch-less ink-jet marker was invented in our laboratory, with a prototype developed and tested in house. This “smart” device would mark the bone only if the marker is properly located within a suitable firing range according to a pre-surgical plan. Only the appropriate ink-jet nozzles of the printer’s ink-jet head matrix are fired to ensure precise marking.

MATERIALS AND METHODS:
Navigated ink-jet implementation:
The navigated marker was implemented as a wireless handheld device, powered by a 9 volt nickel metal hydride (NiMH) rechargeable battery. The navigated marker integrates three entities: a small ink-jet cartridge, electronics for wireless communication and control, and a tracking reference frame.

To guide the user, the device is tracked in real time with an infrared tracking system (NDI-Polaris) and the user is presented with a three-dimensional representation of the bone, the target lines and the marking device. As the device lines up with a predefined location where a bone cut will be initiated, the computer communicates with the device to dispense the ink.

Testing:
To assess the overall operation of the device, electronic bench tests were performed. In addition, to evaluate roundness and consistency/uniformity of ink dots, different users performed marking exercises on various surfaces, including paper, skin, and synthetic and animal (fresh porcine) bones. The following are the experimentation parameters:

- Irregular, non-uniform, or spread out dots were considered failures.
- Nozzle-to-target distance: Tested from 0 to 50mm.
- Nozzle-to-target angle: Tested from 0 to 180º (inverted).
- Speed relative to target: Measured through navigation.

RESULTS:
Well-defined lines were obtained with the marker, even when located up to 8.5mm away from the target surface, and moving at a linear speed of 3.5mm/s. As expected, sharper lines resulted on dry rather than moist surfaces; nonetheless, lines were perfectly legible on fresh animal bone surfaces. Users successfully controlled the thickness of the lines by selecting the number of ink cartridge nozzles to activate via software.

DISCUSSION:
A ‘smart’ navigated touch-less ink-jet marker was successfully created and tested. These results (combined with those of the conventional navigated pen) open up possibilities for saving time and improving accuracy of bone cutting, not only in navigated arthroplasty but also in other areas such as osteotomies, etc. Mounting the device as an integral or modular part of a navigated cutting instrument is an option, and perhaps another step towards the “smart” bone cutting instrument of the future.
INTRODUCTION:
Navigated freehand cutting (NFC) technology simplifies bone cutting in laboratory trials by direct navigation of implants and power tools [1]. Our pioneering experiments showed NFC being faster than conventional jigs, but could have been even faster without some hesitation and delays at the start of each cut [2]. Therefore, we have further reduced starting times and gained more accuracy with a NaviPen and a ‘smart’ Navi-Printer [3]. Utilizing image-guided navigation, these tools are used to physically mark a line on the bone surface indicating where each cut should start (Figure 1). Further gains are targeted with our introduction here of the On-Tool Marker (OTM): A touch-less laser marking technology that may be used either as a stand-alone device or mounted on the cutting instrument (e.g., on the bone saw). The OTM directs the desired cut by projecting a laser image on the bone. That image (usually a line or cross) changes dynamically, so that for any given cut the line projection remains stationary on the bone regardless of the relative location of the device.

MATERIALS AND METHODS:
The OTM is a stand-alone wireless module composed of three main parts: a small laser projector, electronics for control and communication (Wi-Fi), and a tracking frame. It is navigated in real time with a Polaris tracker. Software routines on a proprietary NFC system compute its relative position to the target and dynamically re-calculate the image parameters. Such parameters are sent to the OTM for processing, image generation, and projection (Figure 2).

Bandwidth and data integrity were evaluated through bench tests. To assess accuracy of the projection, a target planar cut was defined on a flat surface (a line drawn on grid paper pasted to a navigated board), and the NFC system was fed with this geometrical information. The OTM was moved within a volume of ~50cm in diameter (distance to the target plane from 5cm to 50cm), and at various angles up to +/- 80º (in roll, pitch and yaw). The projected line coincided with the target line on paper regardless of the relative positioning of the OTM. Errors (target vs. projected) were measured on the grid paper.

RESULTS:
Well-defined lines were projected at a rate of 17fps. Projected lines remained within +/- 2 mm from the target (average “0mm”). Errors, largely caused by a lag in the image, were imperceptible after a fraction of a second if OTM remained still. Among different colors tested, green was the most suitable, based on brightness and visibility (Figure 3).

DISCUSSION:
A ‘smart’ navigated laser marker was successfully created and tested. The limited refresh speed and lag was not much of a concern, as common use would not require fast motion. However, continued research will focus on improving these, and devise solutions for projection on non-planar bone models. OTM would decrease surgical time with the use of the NaviPen or the NaviPrinter. We estimate this time savings could reach 2.3 minutes, based on some preliminary experiments conducted but not reported here. Finally, OTM can further reduce the number of instruments in surgery (less inventory, less sterilization, less cost and less worries).

References:
**(COMPLETE TKR SURGERY EXPERIMENTS ON CADAVERS CONFIRM FEASIBILITY OF NAVIGATED FREEHAND CUTTING (NFC))**

**Hartman, CW; Barrera, OA; Garvin, KL; Haider, H**

**INTRODUCTION:**

Computer-aided surgery aims to improve surgical outcomes with image-based guidance. Navigated Freehand Bone Cutting (NFC) [1] takes this further by eliminating the need for cumbersome mechanical jigs. Multiple previous experiments on plastic and porcine bones performed by surgeons with different levels of expertise suggest that the NFC technique is feasible.

One of the most relevant studies [2] involved seven independent surgeons that prepared five synthetic femurs. The results showed that the mean (+ SD) time to prepare a distal femur with the NFC system was 10.2±4.28 minutes and the median time was 8.70 minutes. A fast learning curve became evident when comparing the mean time required for each surgeon to complete each successive specimen (Figure 1). The mean time required to cut the first specimens (13.4±4.39 minutes) was higher (p = 0.018) than the time to complete the fourth specimen (8.75±2.62 minutes), although the times to cut the fourth and fifth specimens were not different (p = 0.167).

All specimens were between 2° of varus and 94% were within ± 2° of it. All specimens were rotationally aligned within ± 1° of the epicondylar axis. Ninety-seven percent of the specimens were sagittally aligned between 0° and 5° of flexion with no specimens in extension. The custom ‘smart saw’ was built in our lab (Figure 2) by integrating a navigated smart saw system that used, with real time graphics to indicate where/how to cut the bone without jigs. The system was comprised of a navigated smart oscillating saw, reciprocating saw and drill without any of the conventional jigs typically used in TKR. The custom ‘smart saw’ was used in our lab (Figure 2) by integrating a navigated smart saw (Stryker Sag 2000), a programmable microcontroller (ARM-Care, Cambridge, UK), infrared reflective optical trackers (Polaris, NDI, Ontario, Canada), and a 4 x 6 cm touch screen. Bidirectional wireless communication was established between the saw and our custom navigation system that provided dynamic blade speed control. The main graphical aids resembled a flight simulator interface, showing errors of the saw blade (alignment roll and pitch in degrees, position distance in millimeters) relative to the target planar surface being cut. The blade speed control reduced the blade speed within a selectable envelope of instrument alignment/location error, beyond which the blade was stopped.

The tasks performed included pre-surgical planning, incision, placement of navigation pins and markers on tibia and femur, bone registration, marking and cutting, cut surface digitization (for quality assessment), implant placement and cementing, assessment of implant fit and location, and pin removal and wound closing.

**RESULTS:**

The mean time (from skin incision to completion of cementation) to perform a TKR in the cadaveric specimens using NFC was 70 minutes and 3 seconds. Coronal alignment for the hip-knee-ankle angle was 0.3° varus for both specimens. Sagittal alignment of the femoral component was 92° for the first specimen and 87° for the second. Rotational alignment for the femoral component as 1.2° of external rotation for the first specimen and 0.5° for the second. The posterior slope of the tibial component was 2° for the first specimen and 2.9° for the second.

We noted neither hardware nor software failures had occurred during testing of the ‘smart saw’. The screen located on the saw was deemed an improvement relative to alternative computer screen configurations and locations. The oscillatory blade speed control responded to the established thresholds selected for errors.

**DISCUSSION:**

The results indicate that Navigated Freehand Cutting (NFC) technology could eventually be used on patients, as surgical time, implant alignment, cut quality, and other metrics are consistent or better than those of conventional approaches, even with this prototype system. New computer-human interfaces under development are expected to reduce cutting, registration, and digitization times, promising a faster overall surgery. We speculate that NFC is no longer a dream or merely feasible, but clearly on the way to clinical trials in the not too distant future.

**References:**


![Figure 1: Times of bone cutting for all surgeons, broken down and averaged according to the order in which the bones were cut. Values are expressed as mean and SD. A very clear and steep learning curve is evident.](image1)

![Figure 2: (Left) Prototype smart saw electronics and housing configuration; (Center) Device implementation; (Right) Main graphical aids resemble a flight simulator interface, showing errors of the saw blade (alignment roll and pitch in degrees, position distance in millimeters) relative to the target planar surface being cut.](image2)
BONE GRAFT AND BONE GRAFT SUBSTITUTES IN SPINE SURGERY: CURRENT CONCEPTS AND CONTROVERSIES

1Grabowski, G and 2Cornett, C | 1University of South Carolina, Columbia, SC | 2University of Nebraska Medical Center, Omaha, NE

AFTERGLOW

Autograft is the gold standard to which all other graft substitutes have been compared, being the original graft to achieve bony fusion of the spine. Hibbs in 1911 described the first spinal arthrodesis in the setting of Potter’s disease and deformity; local bone graft was utilized in his orthopedic technique [2]. Historically, autograft has been used due to availability and what have long been considered its inherent fusion developing properties: osteogenic potential, osteoinductivity, and osteoconductivity. This is based on the concept that the harvested bone contains osteoblasts, bone matrix, and factors such as bone morphogen proteins and transforming growth factor beta. However, because the latter factors are found in relatively small quantities, autograft implanted within soft tissue will not generate new bone formation, unlike today’s more potent osteoinductive agents. This has led to the question: the long-standing mantra that autograft should be considered osteoinductive.

Autograft bone used in spinal fusions can be obtained from multiple categories: bone harvested from an extraspinal site such as ICBG, and salvaged bone that was removed during the spinal decompression, which is often referred to as local bone graft. The advantage of local bone graft over ICBG is that it does not require a separate harvest, and therefore may be used immediately at time and avoids the complications associated with bone harvest. Many times local bone graft cannot provide the volumes needed for larger lumbar surgeries, and therefore it is often combined with synthetic products or “bone extenders”. This is especially problematic for revision procedures where a prior laminectomy has been done. Furthermore, there have been concerns about poor fusion rates using local bone alone, but there are studies reporting fusion rates comparable to iliac crest graft, especially for single level fusions [4,6,7]. Sengupta et al, in a retrospective comparative study, showed overall fusion rates of 75% and 65% for ICGB and local bone graft respectively, in instrumented posterolateral fusions [4]. However, the fusion rates for ICGB and local bone were only 80% and 66%, when only multilevel fusions were included in the analysis. Despite the different fusion rates, no significant difference in overall clinical outcomes was noted between the two groups.

Iliac crest bone graft is the most commonly used extraspinal bone autograft. It may be harvested anteriorly or posteriorly, depending on the procedure being performed. This usually requires a separate incision, however, it can be done through the same incision as the approach to the spine, particularly in posterior lumbar procedures. Numerous complications have been reported with iliac crest bone graft harvest and this has led to the development and increased use of other agents. The most common complication is pain, but hematomas, panarthrosis, and wound complications can occur. Chronic graft site pain has been reported by some to occur up to 60% of the time [3]. Summers and Eisenschenk, using a questionnaire about donor site pain for anterior spinal fusion patients, reported that chronic pain at the donor site occurred in 25% [8]. However, those patients who had unsatisfactory relief of their back pain from their fusion also had significantly higher donor site pain, and they felt this may indicate a psychological component to donor site pain. There are other, more recent studies that question if iliac crest donor site pain may be overestimated. Debelai et al, in a retrospective cohort study, found that the incidence of donor site pain was 14.3% in patients with a higher level of fusion (T12-L2), versus 40.9% in those with lower level fusions, questioning whether donor site pain may really just be related to the lumbar procedure itself [9]. Another recent study found that the incidence of post-operative tenderness over either posterior operative level was 51% in patients that did not even have a crest harvest performed [10].

OSTEOINDUCTIVE AGENTS

BMPs

BMPs play a role in the differentiation, proliferation, and osteoinduction, and arrest of a wide variety of cells, with the various actions being dependent upon the cellular microenvironment and the interactions with other regulatory factors. They bind to and act via serine-threonine kinase receptors. BMPs have been shown to be osteoinductive agents. The most common complications is pain, but hematomas, panarthrosis, and wound complications can occur. Chronic graft site pain has been reported by some to occur up to 60% of the time [3]. Summers and Eisenschenk, using a questionnaire about donor site pain for anterior spinal fusion patients, reported that chronic pain at the donor site occurred in 25% [8]. However, those patients who had unsatisfactory relief of their back pain from their fusion also had significantly higher donor site pain, and they felt this may indicate a psychological component to donor site pain. There are other, more recent studies that question if iliac crest donor site pain may be overestimated. Debelai et al, in a retrospective cohort study, found that the incidence of donor site pain was 14.3% in patients with a higher level of fusion (T12-L2), versus 40.9% in those with lower level fusions, questioning whether donor site pain may really just be related to the lumbar procedure itself [9]. Another recent study found that the incidence of post-operative tenderness over either posterior operative level was 51% in patients that did not even have a crest harvest performed [10].

Multiple animal studies demonstrated the ability of implanted BMP-2 or implanted BMP-7 to generate the production of ectopic bone, produce spinal fusion, and/or induce fracture healing [10]. Subsequent human studies found BMP-2 (InFuse, Medtronic) and BMP-7 (Opisth, Stryker) safe for specific uses in spine surgery [11]. As a result, BMP-2 was approved for use in spine surgery by the FDA as a medical device used in conjunction with the LT-Cage tapered fusion device for anterior lumbar interbody fusions (ALIF) from L4-S1. Subsequently, BMP-7 was approved via a humanitarian device exemption for use in revision posterior lumbar spinal fusion in “compromised hosts” or those where “bone marrow harvest is not feasible or are not expected to promote fusion.” Examples of the latter include osteoporosis, and smoking and diabetes. Abundant subsequent reports support the use of these products in off-label capacities including anterior cervical discectomy and fusions, transforaminal lumbar interbody fusions, and posterolateral lumbar fusions. These studies describe fusion rates equivalent or greater than those achieved using autograft bone with no graft site morbidity and a favorable risk/side effect profile. Subsequent reports have demonstrated or suggested complications as a result of rhBMP-2 use, namely, life-threatening anterior neck swelling in ACDF, osteolysis, retrograde ejaculation and urinary retention in ALIF, and bone overgrowth, seroma formation and radiculitis in posterior lumbar interbody fusion [15,16,17,18,19]. The fervor created by these processes led to the dedication of an entire volume of The Spine Journal to “The Evolving Safety Profile of rhBMP-2 Use in the Spine” in June of 2011 [20]. Since that publication, another large case series has published, again supporting the safety of rhBMP-2 [21]. Compared to rhBMP-2, rhBMP-7 has been studied far less and the data supporting its use is sparse, as it is literature related to it adverse effects. A prospective, randomized, controlled, multicenter pilot study of rh-BMP-7, with 37 patients undergoing lumbar laminectomy and instrumented fusion for lumbar spondylolysis/lolisthesis, demonstrated successful radiographic fusion in 68% of patients treated with rhBMP-7 compared to 50% with iliac crest bone graft. The authors’ conclusions were that the safety and efficacy of rhBMP-7 was similar to autogenous iliac crest bone graft for this procedure at four-year follow-up [22].

Leech published a recent prospective cohort study of 131 patients, with 123 undergoing ACDF with PEEK interbody cages and rhBMP-7, while the remainder underwent ACDF surgery with iliac crest bone graft. The post-operative complication rate for the rhBMP-7 cohort was 2.4%, with dysphagia lasting greater than 3 months, recurrent anterior, and transient dysphagia and dysphonia as the listed complications. Additionally, the investigators obtained radiographs at 24-72 hours post-operatively and showed no statistically significant increase in prevertebral soft tissue swelling at C6 in the rhBMP-7 group (20.9mm) compared to the PEEK cage cohort (18.7mm) (p = 0.05) [23].

Demineralized Bone Matrix

DBMs are a family of commercially available products that are created through the process of demineralizing ground human cadaveric corticocancellous bone via acid extraction. The remaining matrix is composed of non-collagenous proteins, collagen fibers, and BMPs. This matrix is combined with a variety of carrier materials to produce the ultimate formulation; as a result, they provide varying degrees of osteoconductive potential based upon the carrier materials chosen. Because DBMs are derived from human tissue, the carry disease transmission rates are similar to allograft bone. Additionally, because of the proprietary nature of the demineralization process, actual techniques used in this process are not published, nor are these processes regulated. All of the available preparations in human animal studies supporting their ability to serve as fusion adjuncts. However, human studies are often lacking, as are comparative studies of these products. Peterson compared fusion rates using Grafton Putfy, DBX Putfy, and AlloMatrix Injectable Putfy in a rat model of spine fusion compared to a control model of demineralized spine, with six rats in each group. At eight weeks, 6/6, 3/6, 0/6, 0/6 rats had gone on to successful fusion in each of the groups, respectively. Those in the Grafton group had a statistically significantly higher rate of fusion than those in the control and AlloMatrix groups [24]. A follow-up study using the same rat model was subsequently performed using other DBM preparations. In this study, Osceolti obtained the highest fusion rate (14/18), followed by Leach (10/11), while Dynagraft resulted in no solid fusions (0/17). These results showed no statistically significant difference in the fusion rates achieved by Osceolti and Grafton relative to one another, but both showed significantly higher fusion rates than Dynagraft [25].
The biggest question regarding use of allograft versus autograft bone is the potential risk of disease transmission. In 1988, the authors list several guidelines for the non-union rate from 10% in the control group to 15% in the study group. This validates the prior findings of Castro, who demonstrated a 15% decrease in fusion rates of platelet gels to increase bone grafting. These gels contain local autograft and a graft expander, found to be overestimated. A study on spine fracture deformities.

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Initial cell adhesion is mediated by the fibronectin (FN) matrix, which is a precursor of the extracellular matrix (ECM) assembly. Our results indicate a clear correlation between cell adhesion and FN immobilization on engineered nanostructured coatings. To optimize these coatings, we examined mechanisms of enhanced protein absorption using quantum mechanical force field parameterization of protein-surface interactions and Monte Carlo simulations of the FN fragment (13FN3-14FN3) adsorption on designed nanostructured ZrO2 surfaces. These results show that the negatively charged patches are formed on the surface features. These features can induce destabilization following partial unfolding of the compact FN dimer, due to strong electrostatic interactions (EI) with oppositely charged 2FN3-3FN3 and 12FN3-14FN3 domains, which determine EI stabilization of the FN in compact conformation. This process facilitates the formation of the FN matrix on the surface, mimicking similar processes as in cell-cell interaction. These nanofeatures of the surface can enhance the adsorption and activation of FN, which facilitates the formation of ECM and promotes focal adhesion. Based on our simulation, pure cubic ZrO2 coatings are fabricated with 2.25 nm grain size, which is comparable to the protein dimensions by applying ion beam assisted deposition. We performed in vivo adhesion and proliferation experiments with a bone fide mesenchymal stromal cell line (OMA-AD) and SAOS-2 on 2D nanostructured cubic ZrO2 coatings and compared them to CoCrMo, Ti and HA. Our experimental results indicated that engineered coatings are superior in supporting growth, adhesion, and proliferation. The improved biocompatibility of nanostructured coatings was due to the improved initial FN adsorption on the engineered surface with simultaneous induced FN activation (converted compact FN to its extended counterpart form). Absorption experiments with FN from human plasma using an ELISA-based technique resulted in higher FN adsorption on engineered surfaces as compared to other conventional orthopaedic materials.

We have also carried out a comparative animal study [3] by using an intramuscular implant model and compared the undernourished older rats with younger rats. These results indicate that the maturation of the newly formed bone in the undernourished older rats with the engineered coated implant is comparable to that in the younger rats with only Ti implants. No inflammatory response markers were observed for CD1, CD8 and IgG for macrophage, neutrophil and T-cell, respectively.


Figure 1: Schematic representation of disulfide cross-linked fibronectin (FN) protein dimer in compact (soluble) form on the nano-structured negatively charged ZrO2 surface. The relevant FN domains of type-3 repeats 2FN3-3FN3: red color and postively charged 12FN3-14FN3: blue color FN domains – “electrostatic lock” (ELL). The 1FN3-2FN3 and 12FN3-14FN3 domains – “type-3 repeats” 1FN3-14FN3: responsible for activation of FN dimer are shown by numbered circles. RGD-amino acid residue motifs (10FN3 domain) can be bound to integrin cell receptors. The compact FN structure is stabilized by EI between negative (2FN3-3FN3: red color) and positive charged (12FN3-14FN3: blue color) FN domains – “electrostatic lock” (ELL). The 1FN3-2FN3 and 12FN3-14FN3 domains provide participation in inter-molecular FN-FN binding when FN dimer is converted into the extended (activated) form.
Medical and surgical interventions are commonly compared by their respective cost per quality-adjusted life year (C/QALY). This value is obtained by dividing the cost of the intervention by the QALY, which is a measure of the effectiveness obtained with the intervention. One way to calculate QALYs is to multiply health-related utility values by the number of years lived in that particular state. These utility values, which correspond to health-related quality of life, are represented on a scale of 0 to 1.0, with 0 being death and 1.0 being perfect health. During our review of the literature regarding ACI, we were unable to identify any specific health-related utility value with respect to focal chondral defects or outcomes after ACI. However, a recent study has shown that the quality of life of patients with a focal cartilage defect is affected to the same degree as patients with severe osteoarthritis awaiting total knee arthroplasty. The utility value of “end-stage osteoarthritis” has been determined and reported in the literature to be 0.7. We, therefore, estimated the utility value of patients with a focal chondral defect (the base case in this model) to be 0.7.

The utility value of patients doing well after ACI was subsequently determined utilizing Lysholm scores from studies representing the highest level of evidence available in the literature (levels I and II) regarding the outcome of patients undergoing ACI. Assuming that an otherwise healthy, young person with a perfect Lysholm score would have a utility value of 1.0 and that the utility value of those with focal chondral defects is 0.7, we were able to estimate a utility value representing outcomes following ACI (Table 1). The utility value representing the outcome of patients doing well after ACI was estimated to be 0.85. The Lysholm score has been determined to be both valid and reliable for use in assessing outcomes of chondral disorders of the knee. Comparing the outcome of patients who did well after ACI-P and ACI-C, there has been no high-quality evidence to suggest that there is a significant difference between these two groups, so their respective utility values were assumed to be the same. Patients who did well after revision arthroscopic debridement, while improved from baseline overall, were assumed to do slightly worse than those without graft hypertrophy or revision surgery, as shown by Henderson et al. The utility value of those who did well after revision surgery for graft hypertrophy was assumed to be 0.8. The quality of life of patients with graft hypertrophy and/or graft failure was assumed to be significantly affected, similar to having a focal chondral defect. Therefore, the utility value chosen to represent these states was 0.7.

Table 1

| Utility Values and Graft Hypertrophy Rates Utilized in Cost-Effective Model* |
|---------------------------------|-----------------|-----------------|-----------------|
| **Cost-Effectiveness Model**    | **Utility values** |
| **Focal chondral defect**       | 0.7             |                 |                 |
| **Doing well after ACI-P**      | 0.85            |                 |                 |
| **Doing well after ACI-C**      | 0.85            |                 |                 |
| **Graft hypertrophy**           | 0.7             |                 |                 |
| **Graft failure**               | 0.7             |                 |                 |
| **Graft hypertrophy rates**     | 25%             |                 |                 |
| **After ACI-P**                 |                 |                 |                 |
| **After ACI-C**                 | 10%             |                 |                 |

A sensitivity analysis was performed to determine how the results of the model change in relation to variations in the input values. Threshold sensitivity analysis was performed with regard to the additional cost of the type I/III collagen patch, the rate of graft hypertrophy following ACI (both ACI-P and ACI-C), and the utility values.

**RESULTS**

The $/QALY for ACI-P was $9,466 compared to $9,243/QALY for ACI-C. A sensitivity analysis was performed regarding the additional cost of the type I/III collagen patch ($780) in ACI-C as well as the rate of graft hypertrophy following ACI (both ACI-P and ACI-C), and the utility values.

**DISCUSSION AND CONCLUSION**

The cost-effectiveness of ACI has been studied previously by Minas in 1998, who reported the cost-effectiveness of ACI-P to be $6,791/QALY in 1997 dollars. Converted to 2011 dollars, that value would be $8,585/QALY, which is almost identical to the values obtained in the present study, with the cost-effectiveness of ACI-P and ACI-C being $9,466/QALY and $9,243/QALY, respectively. This analysis shows that ACI is a cost-effective procedure and compares favorably with many other commonly accepted medical and surgical treatments (Figure 2). It also reveals that while initially more costly than ACI-P, over the 10-year course of the model ACI-C is actually more cost-effective. The initial increased costs associated with using a type I/III collagen patch instead of periosteum are eventually recouped by reducing the rate of graft hypertrophy and subsequent arthroscopic debridement associated with ACI-P. The sensitivity analysis revealed that the cost of the type I/III collagen patch would have to increase significantly (more than double) or the rate of graft hypertrophy after ACI-P would have to be significantly reduced (25% to 11%) before ACI-P would become more cost-effective than ACI-C. While small differences in outcome between ACI-P and ACI-C significantly affect the results of the analysis, there has been no high-quality evidence in the literature to suggest there is a significant difference in outcome between the two procedures.
INTRODUCTION
Fractures of the proximal humerus are fairly common injuries accounting for approximately 4-5% of all fractures. There is a higher incidence of these injuries in patients with poor bone quality, especially the elderly and women (MF ratio 4:1). Most (approx. 80%) are relatively nondisplaced and can be treated nonoperatively; however, operative intervention is recommended in approximately 20% of cases. The purpose of this study was to compare the biomechanical properties of a 2-part surgical neck proximal humerus fracture treated with either a proximal humerus locking plate (PHLP) or an antegrade angular stable intramedullary nail (IMN), as well as to determine how the element of fatigue affects the fracture fixation constructs. The null hypothesis was that the pre-fatigue or post-fatigue, when used to capture bone when used in a clinical setting due to any one of a number of variables.

MATERIALS AND METHODS
Synthetic composite osteorhaphic humeral specimens were obtained and tested to ensure their anatomic and biomechanical properties. First, a representative specimen was sectioned at five parallel planes through the proximal humerus in order to measure the cortical thickness of the specimens. The average cortical shell thickness was 2.92 mm. This is comparable to the cortical thickness of elderly human proximal humeri as shown by Warnier et al. In addition, the elastic modulus and tensile strength of the synthetic cortical shell used in this study (16.9 GPa and 106 MPa, respectively) were similar to the material properties of human cortical bone as reported by Bogstie et al. The standard synthetic composite osteorhaphic bone model is filled with 20 pcf (0.27 g/cm³) solid rigid polyurethane foam, however, we elected to order custom made specimens filled with 10 pcf (0.16 g/cm³) solid rigid polyurethane foam to further lower the biomechanical properties of the synthetic bone model. This 10pcf polyurethane foam has an elastic modulus of 55-77 MPa and yield strength of 2.2 MPa which falls within the range of human cancellous bone and is the lowest grade of surrogate foam recommended by the ASTM (standard F1839) for modeling osteorhaphic trabecular bone.

Identical simulated fractures were made through the surgical neck of the humerus in 10 specimens using an oscillating saw with the specimen mounted in a custom cutting jig. The fracture fragments were then reduced manually and provisionally fixed with Kirschner wires. At random, the fracture fixation constructs were applied according to the manufacturer’s recommendations with either the intramedullary nail (IMN, n=4), the PHLP with seven screws (PHLP-7, n=4), or the PHLP with nine screws (PHLP-9, n=2) (Figures 1 and 2). The two screw holes left open in the PHLP-7 construct were from row C which, when placed, provide divergent screw fixation in the anterior and posterior regions of the mid-aspect of the humeral head and neck (Figure 1).

The biomechanical testing of all specimens was carried out on a MTS Bionix 858 (MTS Systems Corp., Eden Prairie MN) servohydraulic testing apparatus. The pre-fatigue stiffness of the fracture fixation constructs were tested under load control in cantilever systems of stress described above to determine the slope of their load-displacement curves. The fatigue protocol consisted of a random sequence of unique stresses applied to the specimen each second over a period of ten hours (36,000 cycles). Every second of unique stress consisted of three of the four modes (AP bending, compression, and torsion) of stress being either positive, negative, or zero (27 possible combinations). The random fatigue sequence applied to the first specimen was recorded and repeated for the remaining specimens to ensure all specimens were fatigue identical. The biomechanical properties of the specimens were then retested within the same four modes of stress described above to determine their post-fatigue stiffness.

The Kruskal-Wallis test was used to detect if there was a significant difference between the medians of at least two of the three groups (IMN, PHLP-7, and PHLP-9). If the p-value for the Kruskal-Wallis test reached statistical significance (p<0.05), the specimens were then compared pair-wise (i.e. IMN vs. PHLP-7, PHLP-7 vs. PHLP-9, and IMN vs. PHLP-9) using the Mann-Whitney test to determine which pairs were significantly different from one another.

RESULTS
The pre-fatigue stiffness of the specimens differed significantly with regard to two of the four modes of testing (Table 1). In these two modes of testing (anteroposterior bending & torsion), when comparing the three different groups against one another in a pair-wise fashion, statistical analysis revealed that the PHLP-7 demonstrated greater stiffness in anteroposterior bending and torsion when compared to the IMN (p=0.02 for both). There was no statistically significant difference when comparing the stiffness of the IMN to the PHLP-9 for the remaining two modes of biomechanical loading. The pre-fatigue stiffness values for varus-valgus bending and compression were not significantly different between the three fracture fixation constructs (p=0.11 and p=0.06, respectively, see Table 1).

Table 1: Statistically significant difference between the IMN and PHLP-7 when compared pair-wise with the Mann-Whitney test (there was no statistically significant difference between the other pair-wise comparisons IMN vs. PHLP-9 and PHLP-7 vs. PHLP-9).

Transverse 2-Part Proximal Humeral Fractures

<table>
<thead>
<tr>
<th></th>
<th>Pre-fatigue - Median (Range)</th>
<th>Post-fatigue - Median (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IMN</td>
<td>PHLP-7</td>
</tr>
<tr>
<td>VV-Bending (Nm/mm²)</td>
<td>7.32 (4.21-7.90)</td>
<td>6.68 (6.15-8.33)</td>
</tr>
<tr>
<td></td>
<td>5.15 (3.56-6.11)</td>
<td>3.46 (3.15-7.74)</td>
</tr>
<tr>
<td>AP Bending (Nm/mm²)</td>
<td>5.23 (4.98-5.57)</td>
<td>9.34 (8.22-11.64)</td>
</tr>
<tr>
<td></td>
<td>4.53 (4.35-5.05)</td>
<td>4.02 (3.91-4.98)</td>
</tr>
<tr>
<td>Compression (N/mm²)</td>
<td>2234 (1922-2557)</td>
<td>1472 (1273-1731)</td>
</tr>
<tr>
<td></td>
<td>1577 (1479-1984)</td>
<td>774 (222-1652)</td>
</tr>
<tr>
<td>Torsion (Nm/mm²)</td>
<td>1.48 (1.26-1.68)</td>
<td>1.90 (1.86-2.27)</td>
</tr>
<tr>
<td></td>
<td>0.78 (0.61-1.25)</td>
<td>1.37 (0.74-1.97)</td>
</tr>
</tbody>
</table>

Figure 1: Proximal Humerus Locking Plate (PHLP): red oval – row C screws that were not placed in the PHLP-7 fracture fixation construct.

Figure 2: Intramedullary Nail.

The PHLP-7 group was used to represent other proximal humerus locking plates that may not offer as many proximal screw options, the fact that some surgeons do not use all available proximal screw options, and/or that some proximal screws do not capture bone when used in a clinical setting due to any one of a number of variables.

The biomechanical testing of all specimens was carried out on a MTS Bionix 858 (MTS Systems Corp., Eden Prairie MN) servohydraulic testing apparatus. The pre-fatigue stiffness of the fracture fixation constructs were tested under load control in cantilever systems of stress described above to determine the slope of their load-displacement curves. The fatigue protocol consisted of a random sequence of unique stresses applied to the specimen each second over a period of ten hours (36,000 cycles). Every second of unique stress consisted of three of the four modes (AP bending, compression, and torsion) of stress being either positive, negative, or zero (27 possible combinations). The random fatigue sequence applied to the first specimen was recorded and repeated for the remaining specimens to ensure all specimens were fatigue identical. The biomechanical properties of the specimens were then retested within the same four modes of stress described above to determine their post-fatigue stiffness.
Comparing the post-fatigue stiffness of the fracture fixation constructs did not reveal a statistically significant difference between the groups (Table 1). Figure 3 shows the range of pre- and post-fatigue stiffness values for the three transverse specimen groups (IMN, PHLP-7, and PHLP-9) in the four modes of testing.

**DISCUSSION:**

With pre-fatigue loading in the surgical neck fracture model, the PHLP-7 demonstrated superior stiffness in AP bending and torsion compared to the IMN. This initial biomechanical advantage of the PHLP-7 construct was lost following the fatigue protocol and there was no statistically significant difference between the three groups post-fatigue. In addition, there appeared to be increased stiffness variability (difference between the minimum and maximum value) post-fatigue in the PHLP-7 specimens compared to the IMN specimens, despite the uniformity of specimen properties and fixation construct placement (Figure 3). The increased post-fatigue variability seen with the PHLP-7 specimens was not demonstrated in the PHLP-9 specimens. This data suggests that the PHLP-9 and IMN constructs may provide more consistent and reliable fixation than the PHLP-7, which may be beneficial in clinical scenarios where variability can be a concern.

In the PHLP-7 specimens, the authors suggested that rigid implants should only be used in young patients with good bone stock. We did not compare the IMN and PHLP fixation constructs to less rigid fixation constructs. In addition, this study did not evaluate the biomechanical properties of the constructs with a “gap” at the fracture site. This has often been evaluated in previous studies to simulate fracture comminution and to eliminate bone to bone contact, which increases inherent stability of the fracture site. However, we believe that the “gap model” does not accurately represent the clinical situation, as most fractures are fixed with adequate bone to bone contact; in addition, healing usually commences in the first few weeks following surgical intervention, likely increasing its inherent stability as long as the fracture fixation does not fail. Another weakness of the study was the low number of specimens in the PHLP-9 transverse surgical neck fracture fixation construct group (n=2), and we acknowledge that additional specimens may have changed the results.

**CONCLUSIONS:**

The goals of operative fixation of proximal humerus fractures include obtaining an adequate reduction, providing optimal fixation strength, minimizing soft tissue dissection, and preventing complications. Intramedullary nailing may be a potentially beneficial treatment option in this regard for the fixation of displaced osteoporotic surgical neck proximal humerus fractures, combining limited operative dissection, and possibly leading to fewer complications, with comparable biomechanical stability to locked plating.

**Figure 3:** Range of stiffness values for the three fracture fixation constructs in the four modes of testing both pre-fatigue (Pre) and post-fatigue (Post).

**Figure 4:** Radiographs of the IMN and PHLP-9 fracture fixation constructs.
WITH ALL THE METAL-METAL-FUSS, WHAT ABOUT FEMORAL HEAD WEAR IN METAL-ON-PLASTIC TOTAL HIP REPLACEMENTS – A STUDY OF SEVERAL DESIGNS

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INTRODUCTION:
Sub-micron polyethylene wear particles have been identified as a cause of osteolysis frequently found in the bone surrounding total hip replacements (THR). However, the wear of the hard femoral components is much less understood and is often assumed to be negligible; yet, metal particulate and ionic debris are of rising clinical concern as manifested by the recent controversy and recalls of some metal-on-metal hip systems. This study investigates not only the wear rates of ultra high molecular weight polyethylene (UHMWPE) acetabular liners, but also the wear rates of metallic femoral heads in several THR designs and sizes, which until now have usually been ignored in this type of wear study.

MATERIALS AND METHODS:
Conventional UHMWPE liners (three 40mm, three 44mm I.D.), highly crosslinked (HXL) UHMWPE liners (three 40mm, three 44mm I.D.), and HXL UHMWPE liners with vitamin E blended (four 36mm and six 40mm I.D.) were tested against CoCrMo femoral heads, appropriately sized and matched to the particular THR design (Figure 1), on a 12 station hip simulator (AMTI, Boston). The specimens were mounted in a physiologically correct manner on custom made fixtures, lubricated with bovine serum (20 g/l protein content, 37°C) and subjected to the walking cycle specified in ISO-14242-1 at 1 Hz for 5 million cycles (Mc). The femoral heads and liners were carefully cleaned and gravimetrically weighed at standard intervals, and the wear was corrected with the weight gain of active load soak control heads and liners, and calibration weights.

RESULTS:
The conventional UHMWPE liners showed the highest wear (40mm: 55.7±3.00mg/Mc, 44mm: 72.0±2.81mg/Mc) while HXL liners displayed much lower wear (40mm: 2.58±0.97mg/Mc, 44mm: 14.2±3.57mg/Mc), as expected. Vitamin E liners also showed very low wear (36mm: 20.1±2.00mg/Mc, 40mm: 5.97±0.50mg/Mc). The average wear rates of the acetabular liners are shown in Figure 2. Interestingly, however, the CoCr femoral heads also showed measurable wear for all liner types and designs (Conv. 40mm: 0.28±0.16mm/Mc, 44mm: 0.22±0.014mm/Mc, HXL 40mm: 0.041±0.006mm/Mc). The average wear rates of the metal-on-plastic material couples such as metal-on-plastic, the metal head wear should not be ignored.

CONCLUSION:
Our simulator results confirm low wear for HXL UHMWPE acetabular liners both with and without vitamin E. Wear of metal femoral heads, although much less in weight than liner wear, was still clearly detectable and measurable for CoCr heads articulating against all types of UHMWPE liners. Therefore, in wear studies focusing on hard-on-soft material couples such as metal-on-plastic, the metal head wear should not be ignored.

INTRODUCTION:
The addition of vitamin E has been shown to improve wear performance in highly crosslinked (HXL) ultra high molecular weight polyethylene (UHMWPE) total knee replacements (TKR) [1]. We set out to verify if a new type of vitamin E stabilized HXL UHMWPE would substantially improve wear performance, and we present our new results together with our previous ones to tell a fuller story. This paper therefore reports in vitro wear of tibial bearings of both conventional and HXL UHMWPE (with vitamin E) for a total of 16 specimens covering both ends of the TKR size spectrum, very large and very small.

MATERIALS AND METHODS:
Different designs, sizes and four material types/processes of UHMWPE were tested. In material type 1, tested previously, the polyethylene was machined from isostatic molded GUR1020 bar stock, crosslinked with 10 Mrad, and then doped with vitamin E. From this material, four samples of large posterior stabilized TKRs were tested. Material type 2 was HXL, where vitamin E was blended into the polyethylene (GUR1020) at the powder stage and the final irradiation was to 9 Mrad. From this material, two large cruciate retaining samples and two small cruciate retaining samples were tested. The above sample groups from both material types 1 and 2 were compared in the same simulator testing to corresponding identical design, size and sample numbers of conventional UHMWPE not highly crosslinked and with no vitamin E (material types 3 & 4, respectively). The four material types are shown in Figure 1, after testing.

Each test was run on a significantly upgraded (in house) 4-station Instron-Stanmore force-controlled knee simulator. The machine simulated flexion with anatomically realistic joint reaction forces and torques between tibia and femur, and included a spring-based system to simulate soft-tissue restraining forces and torques. The force-control waveforms of the walking cycle specified in ISO-14243-1 were applied for 5 million cycles (Mc) at 1 Hz, with bovine serum lubrication with 20 g/l protein concentration at 37°C). The tibial bearing inserts were weighed at various intervals standardized between all tests.

RESULTS:
No gross delamination or fracture of the tibial inserts was observed in any tests, but all inserts showed measurable wear (Figure 1). The vitamin E stabilized material type 1 exhibited an 85% reduction in wear for the large posterior stabilized design (p < 0.05, ANOVA) compared to its corresponding conventional poly control material type 3. The large and small cruciate retaining designs with the new vitamin E material type 2 exhibited wear reductions of 61% and 77%, respectively, when compared to their corresponding conventional bearings of material type 4 (p < 0.05, ANOVA). The average wear rates are shown in Figure 2.

CONCLUSION:
The vitamin E highly crosslinked UHMWPE tibial bearings significantly reduced overall wear when compared to conventional tibial bearings of the same design. Such level of wear reduction should translate to worthy clinical significance in preventing osteolysis. Highly crosslinked UHMWPE stabilized with vitamin E appears to be promising for use as a bearing surface in TKR, from at least two different technologies/processes.


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MORE THAN ONE TYPE OF VITAMIN E STABILIZED HIGHLY CROSSLINKED UHMWPE GREATLY REDUCES WEAR IN TKA
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Figure 1: Tibial bearing appearance after 5 million cycles. One single bearing of each design type is shown. Highly crosslinked vitamin E material types 1 and 2 shown in upper pictures, control materials shown in lower picture.

Figure 2: Average wear rates of UHMWPE tibial bearings calculated via the least squares error fit method, with 95% confidence interval bars. Control materials shown in blue, highly crosslinked vitamin E materials shown in gold.