



Orthopedic Update

Current trends from the Department of Orthopedic Surgery Vol. 7, No. 2, 2013

INSIDE THIS ISSUE

- 4 **Biomechanical Testing of Surgical Knots Reveals Superior Non-slip Knot**
- 6 **Sports Medicine Center Addition Expands Advanced Motion Analysis and Performance Enhancement Services**
- 7 **New Faculty Members Bring Expertise in Molecular Pathways, Gene Profiling, Infection Control**

Innovative Bone-Preserving Approaches to Manage Young Adult Shoulder Arthritis with Shoulder Replacement

Shoulder arthritis in the young adult population represents a common management dilemma. The widespread interest in sports involving the shoulder (golf, weightlifting, throwing sports) brings relatively young patients with shoulder arthritis to seek pain relief and long-lasting improved function.

Often, shoulder arthroplasty truly is the only reliable option for these patients. However, fear of implant loosening and the possible need for surgical revision has traditionally led to the avoidance of replacement in patients under 65 years old. As a high-volume center with expertise in the most recent advances of shoulder replacement surgery, Mayo Clinic Department of Orthopedic Surgery has shoulder specialists who have both the experience and outcome data to suggest otherwise.

Preserving bone, improving technique

Results from Mayo Clinic's orthopedic shoulder specialty team, led by Joaquin Sanchez-Sotelo, M.D., Ph.D., and John W. Sperling, M.D., indicate that carefully selected younger shoulder arthritis patients may, in fact, benefit from total shoulder arthroplasty (Fig. 1).

This is especially true when there is adequate glenoid bone stock and healthy soft tissue, such as a functioning rotator cuff, to help prevent malalignment of the glenoid component implant or imbalance or both. "We've been actively involved in the design of new implants and in their rigorous evaluation, and found that a well-done total shoulder arthroplasty in carefully selected younger patients is typically successful — and often preferable in the long term to a hemiarthroplasty or partial replacement procedure," explains Dr. Sperling.

Adds Dr. Sanchez-Sotelo: "Our experience is different at Mayo Clinic, principally because

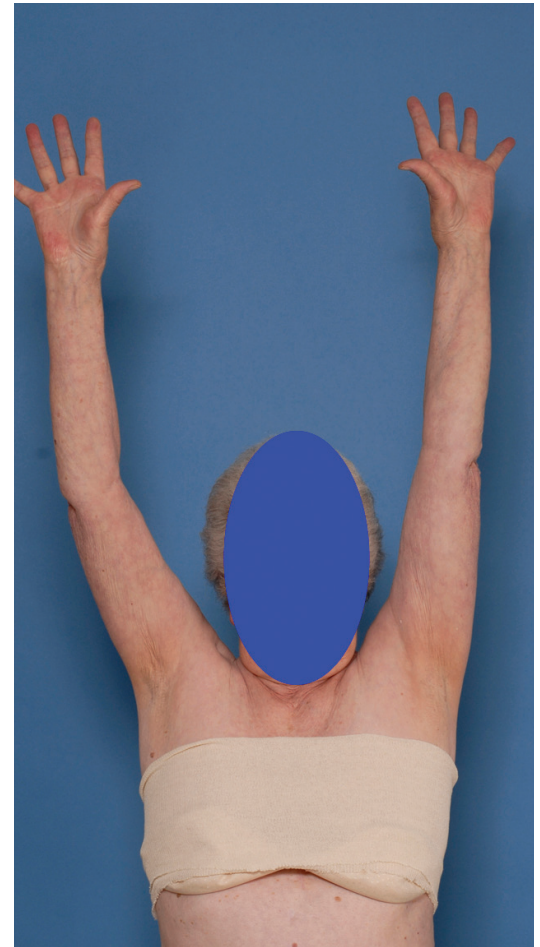


Figure 1. This postoperative photo shows the patient has recovered excellent range of motion and is easily able to extend arms overhead free of pain.

we have such broad and deep experience in performing all forms of shoulder arthroplasty, and in conducting research on the topic. We have had a long-standing interest in meeting the needs of the younger shoulder patient,



Joaquin Sanchez-Sotelo, M.D., Ph.D.



John W. Sperling, M.D.



Steven J. Hatstrup, M.D.



Figure 2. Improved materials, such as this bone-preserving ultrashort humeral component, contribute to the success of shoulder arthroplasty in young adults.

and we have made it a priority to innovate in the area of total shoulder arthroplasty for this patient population by selecting the least bone-invasive implant possible, saving bone for possible future revision surgery if needed.” (Figs. 2-5).

Evolving design and materials

The Mayo team offers the full range of evolving modern implant designs, individualized to each case. Options include high-performance, bone-preserving shoulder arthroplasty implants, second-generation reverse total shoulder arthroplasties, and fracture-

specific solutions.

“Careful attention to surgical technique combined with design improvements, such as ultrashort stem implants and bone-preserving glenoid components, allows us to perform the procedure in a way much less invasive than it was ever possible,” explains Steven J. Hatstrup, M.D., another Mayo orthopedic surgeon who specializes in shoulder repair.

The research edge

In addition to experience and expertise, another key factor contributing to Mayo Clinic’s success in total shoulder arthroplasty with younger arthritis patients is its research base. Investigators are constantly evaluating design, materials and methods in search of improving outcomes.

An important advantage of mastering

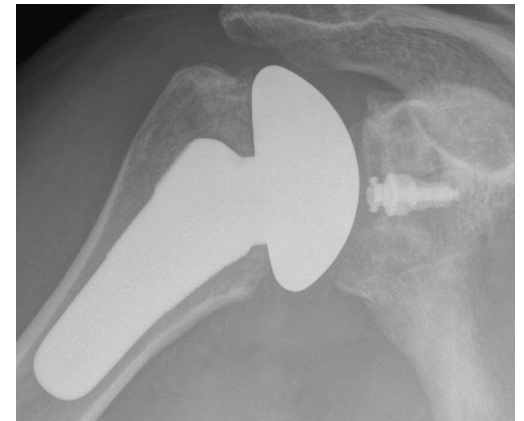


Figure 3. Postoperative total shoulder arthroplasty radiograph shows implant with an ultrashort stem and a modern hybrid glenoid component.

Points to Remember

1. At Mayo Clinic, total shoulder arthroplasty in carefully selected younger patients (<65 years) suffering from arthritis offers safe and reliable outcomes.
2. Mayo orthopedics shoulder specialists’ success is based on high-volume surgical experience; involvement in implant development; a multidisciplinary group practice that integrates rehabilitation services into each individualized care plan; and a commitment to research.
3. Advances in surgical approach and bone-preserving implant design are active areas of Mayo Clinic research, and factors driving the trend of improved outcomes in younger patients.
4. Physician reluctance to refer younger arthritis patients for a total shoulder arthroplasty consult is not warranted at centers of excellence such as Mayo Clinic, where clinical practice is supported by research and large joint replacement registries that provide information about implant performance over decades.



Figure 4. *This photograph shows a modern bone-preserving glenoid component, which, when placed by an experienced, advanced surgical team, helps improve shoulder arthroplasty outcomes.*

the latest techniques is the fact that Mayo specialists are active leaders collaborating in the innovation process that creates new procedures. Explains Dr. Sanchez-Sotelo: “Physicians may be reluctant to refer

patients under 65 years old for total shoulder arthroplasty due to the perceived risk and conventional teaching regarding implant failure and the prospect of revision. At Mayo Clinic, we believe that shoulder arthroplasty is approaching the long-term reliability of hip and knee arthroplasty thanks to the development and careful evaluation of bone-preserving implants. We collaborate with patients and their physicians to choose the implant design that works best for each individualized case, and have the widest set of options available anywhere, in terms of skills, experience, materials and methods.”

Indications for total shoulder arthroplasty

Indications for total shoulder arthroplasty in the young adult with arthritis include:

1. Pain that is refractory to nonsurgical treatments such as rest, anti-inflammatory medications and physical therapy
2. Intact, functioning rotator cuff and deltoid
3. Sufficient glenoid bone stock
4. Motivated patient able to follow aftercare reconditioning and rehabilitation protocols to recover stability and function

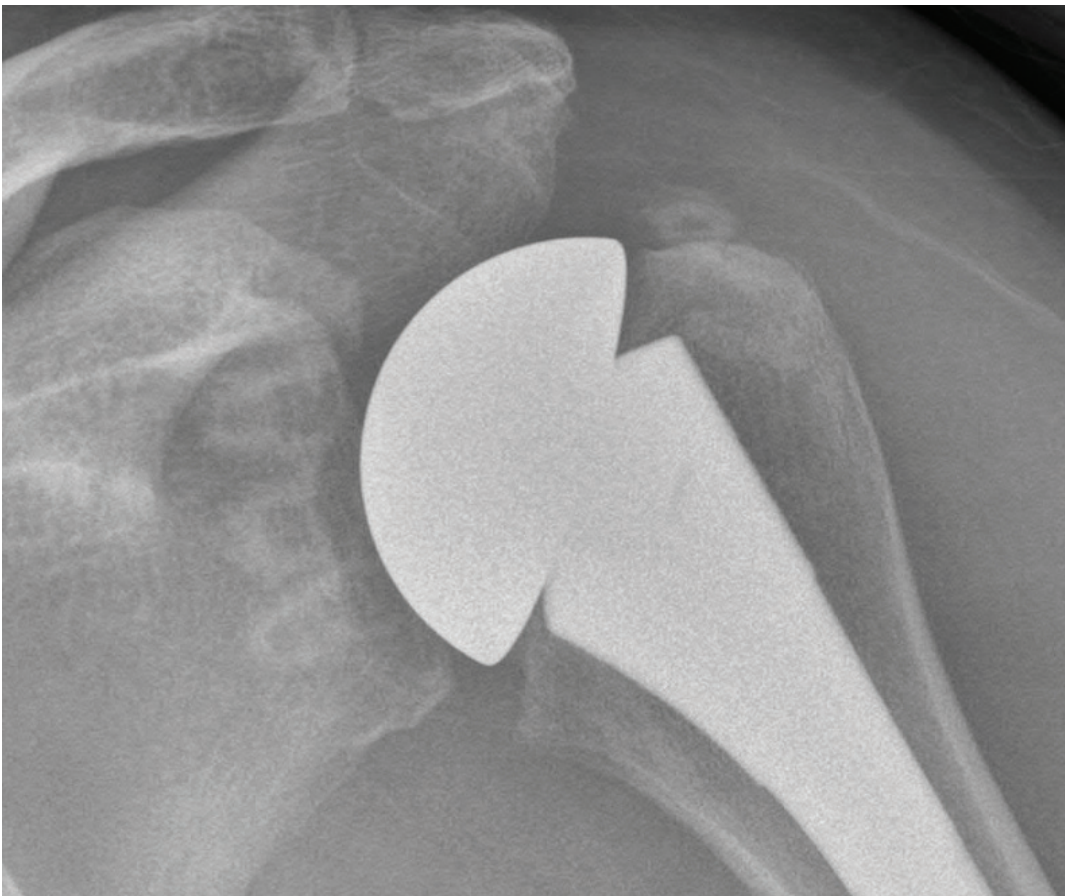
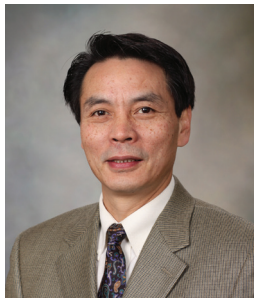


Figure 5. *Minimal bone is needed for implantation of new glenoid components, which is a significant advance that can help improve outcomes.*



Chunfeng Zhao, M.D.



Peter C. Amadio, M.D.



Kai-Nan An, Ph.D.

Biomechanical Testing of Surgical Knots Reveals Superior Non-slip Knot

Whether at work or the family home, knots are never far from the mind of Chunfeng Zhao, M.D., a specialist in the Department of Orthopedic Surgery at Mayo Clinic in Rochester, Minn., and a professor of orthopedics at Mayo Clinic College of Medicine. “My wife will be getting ready for a run and I will say to her, ‘Be sure your shoes are tied and your knots are strong — you can’t run your best race if they come untied,’” he says. Dr. Zhao has been fully engaged in orthopedic research at Mayo Clinic since 1997 after practicing orthopedic surgery for 15 years in China, where he was trained.

The importance of knots

As a researcher with a clinical background, Dr. Zhao knows how important a surgical knot can be. “One single knot unraveling can cause an entire surgery to fail, such as a tendon repair in which only a single stitch is used to repair a broken tendon. We observed this in 100 percent of the repairs in our recent study,” Dr. Zhao explains. “The surgical knots or square knots that are made every day in the OR may not be as strong as we thought, or we are just not making the knot right.”

In a 1984 study, of the 25 surgeons in the study, most believed they were tying a square knot, when in fact, 80 percent were tying sliding knots. Slippage and unraveling also are common sources of error. In high-tension closures, such as flexor tendon repairs, reports cite knot unraveling occurring 71 to 86 percent of the time, depending on technique.

To remedy these trends and safeguard patient care, Dr. Zhao with his Mayo orthopedic colleagues subjected a novel surgical knot to rigorous biomechanical testing: the two-strand overhand locking (TSOL) knot. (Fig. 1). Their report appears in the June 2013 issue of *The Journal of Bone & Joint Surgery*.

Unraveling knot failure

Knots and their holding strength have a history as old as civilization. As early as the first century A.D., knot strength was a topic of medical discussion. In his essay explaining how to tie 16 knots commonly used in surgical and orthopedic procedures, the Greek physician Heraklas described the “square” or “reef” knot still in use today. Knot failure is most concerning when it happens inside the body for internal tissue repairs. “If a knot fails externally, for skin closure, it’s undesirable, but you might have 10 sutures in place and can stand to lose one without affecting wound healing,” Dr. Zhao says. But an internal failure, such as to a tendon repair, is serious.

Adds Mayo Clinic orthopedic surgeon and Dr. Zhao’s collaborator, Peter C. Amadio, M.D.: “You need a very secure repair with high tensile strength to hold the tendon, especially during rehabilitation.” Increasing the number of throws is not an option in flexor tendon repairs because it creates bulk that can interfere with healing.

Biomechanical testing

The fundamental importance of a secure knot to successful flexor tendon repair motivated the team to review more than 50 flexor tendon repair techniques. The team then tested knots in Mayo’s Biomechanics Laboratory on a variety of custom-designed machines. (Fig. 2). The phenomenon of knot unraveling emerged as the common source of problems.

In recent years, suture materials have gotten stronger. What should be an advantage — increased strength to prevent breakage — actually contributes to knot failure because the stronger materials tend to be low friction and therefore slippery. Explains Mayo Clinic Biomechanics Lab Director Kai-Nan An, Ph.D.:

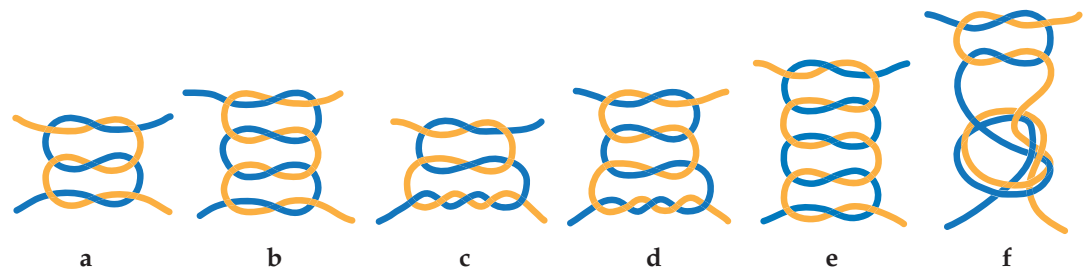


Figure 1. Left to right, the knots the Mayo team tested: (a) 3-throw square knot, (b) 4-throw square knot, (c) 1-throw surgeon’s knot with a 2-throw square knot, (d) 1-throw surgeon’s knot with a 3-throw square knot, (e) 5-throw square knot, (f) Mayo’s TSOL knot.

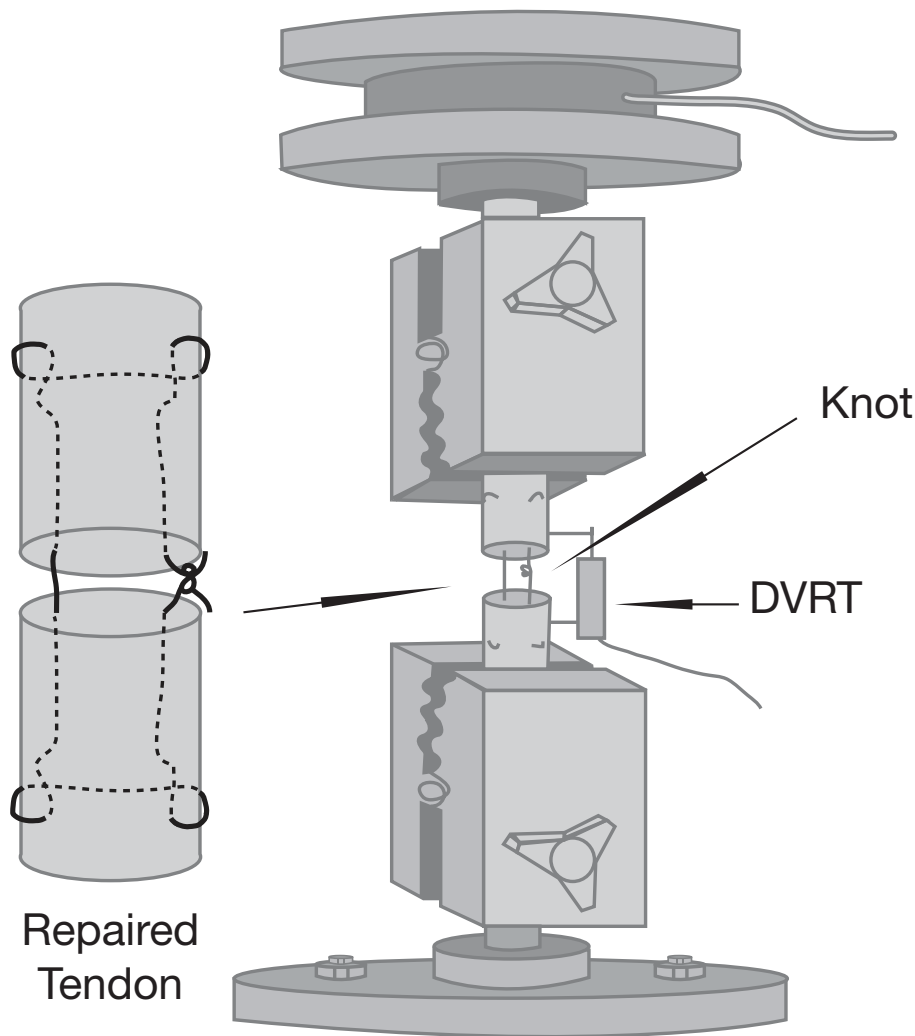


Figure 2. To mechanically test knot strength, a transected tendon is repaired by modified Pennington technique, with the knot (either a 4-throw square knot or a TSOL knot) buried between the tendon ends, and mounted on the testing apparatus. A differential variable reluctance transducer (DVRT) measures gap formation in the repaired tendon and the stiffness of the repair.

“In the past, the suture materials were not that strong, so the weak link of the repair was suture failure. Now the suture materials are much stronger, but tend to be slippery, so the weak link of the repair has shifted, and is now the knot unraveling.”

A new twist: TSOL

To overcome the unraveling problem, researchers experimented with tying knots and testing them for failure force. Says Dr. Zhao: “The idea of the TSOL knot stemmed from experiments in which we needed to tie a suture as a cable to pull a tendon for a thousand cycles of motion under a high load. One knot never failed during our testing. I didn’t know the name of it. I don’t remember learning it. I just know it because I’ve done it thousands of times. I always teach it to my fellows, saying,

‘Make this knot. It won’t fail you.’” Mayo’s test results show that the failure strength for the TSOL knot was much greater than that of five other knot groups tested.

Dr. Zhao considers the findings to be “just one more tool. It is not practice-changing, but it is a help, especially for tricky repairs like the flexor tendon where you have room to put in only one or two stitches. Those knots have to stick for the best clinical outcome to occur.”

For more information

Zhao C, et al. Beyond the square knot: A novel knotting technique for surgical use.

The Journal of Bone & Joint Surgery. 2013;95:1020. <http://jbjs.org/article.aspx?articleid=1690129>



Edward R. Laskowski, M.D.



Michael J. Stuart, M.D.

Sports Medicine Center Addition Expands Advanced Motion Analysis and Performance Enhancement Services

Mayo Clinic in Rochester, Minn., is expanding its sports medicine practice to meet the growing regional, national and international demand for advanced expertise. The expansion is part of the 100,000-square-foot Mayo Clinic Dan Abraham Healthy Living Center building project, and is scheduled to open in the spring of 2014. (Fig. 1).

The Mayo Clinic Sports Medicine Center is a global leader in sports and musculoskeletal injury prevention and rehabilitation, concussion research, diagnostic and interventional ultrasound, and surgical and nonsurgical management of sports-related injuries.

Serving patients' varied needs

"Mayo Clinic is able to serve athletes of all levels in a multidisciplinary environment that can manage the entirety of our patients' needs," says Edward R. Laskowski, M.D., co-director of Mayo's Sports Medicine Center, who has served on the President's Council on Fitness, Sports, and Nutrition under two administrations. "We have long served professional and amateur athletes involved in a wide variety of sports. This expansion will allow us to better serve our athletes with cutting-edge technology, facilities and programs."

The Mayo Clinic Sports Medicine Center at the Dan Abraham Healthy Living Center will contain state-of-the-art sports medicine

and performance enhancement capabilities necessary to train all levels of athletes.

Enhancing athletic performance

The center includes advanced motion analysis and strength equipment. It will feature multiple playing surfaces, such as wood for basketball and volleyball, artificial grass for turf sports, artificial ice for hockey, and specialized lifting platforms to enhance performance. Further, it is designed to be one of the premier hockey training centers and will include a Woodway skating treadmill and stick-handling and shooting-specific equipment.

"Our new, state-of-the-art training equipment along with the expertise of our physicians, athletic trainers, physical therapists and strength and conditioning specialists creates the premier environment for hockey injury management and performance enhancement," says Michael J. Stuart, M.D., co-director of Mayo's Sports Medicine Center and chief medical officer for USA Hockey.

Clinical offerings

Clinical offerings in the new space will include Mayo Clinic's integrated, subspecialty practice, regenerative injections and diagnostic procedures, digital radiography, sport-specific rehabilitation, sports psychology, sports nutrition, and concussion diagnosis, treatment and prevention.



Figure 1. Mayo Clinic sports medicine practice is growing to meet regional, national and international demand for advanced expertise. The expansion is part of the 100,000-square-foot Mayo Clinic Dan Abraham Healthy Living Center building project scheduled to open in spring of 2014.

New Staff Members Bring Expertise in Molecular Pathways, Gene Profiling, Infection Control

Two new faculty members have joined Mayo Clinic Department of Orthopedic Surgery. They are:



Matthew P. Abdel, M.D.

Matthew P. Abdel, M.D. Dr. Abdel graduated from the University of Minnesota in 2003 with a B.S. in biochemistry, and a business minor. He received his M.D. from the University of Wisconsin School of Medicine and Public Health, Madison, Wis., from 2003-2007, where he graduated with Honors in Research and as an AOA member.

He completed both his internship and residency in orthopedic surgery at the Mayo Clinic School of Graduate Medical Education, Rochester, Minn. In addition, Dr. Abdel obtained his M.S. in Biomedical Sciences from the Mayo Graduate School in 2012. He completed an adult hip and knee reconstruction fellowship at the Hospital for Special Surgery (HSS) in New York, from 2012-2013, where he was awarded the HSS Fellow of the Year Award. Dr. Abdel then completed the Müller Foundation/Hip Society European Fellowship in Hip Surgery, visiting multiple centers in England, France, Germany, and Italy. Dr. Abdel has received numerous awards at both the undergraduate and graduate levels. In medical training at the University of Wisconsin, he received the Dr. Everett Carl Burgess Surgery Award and the University of Wisconsin Medical School Academic Award. At the Mayo Clinic, he was the recipient of the Patrick J. Kelly Basic Science Research Award twice, the Mark B. Coventry Clinical Research Award twice, the Mayo Clinic Chief Resident Outstanding Clinician Award, and the first Mayo Clinic Hoover Award. At the Orthopedic Research and Education Foundation (OREF), he has been awarded several honors for his clinical and basic science research. Contributing to orthopedic surgery practice and knowledge with over 100 international and national presentations and over 40 peer-reviewed articles and book chapters, Dr. Abdel holds a patent for developing a personal allergy detector. His research interests center on the genetic expression profiles of people predisposed to arthrofibrosis, osteolysis, metal reactions, and deep periprosthetic infections through the use of both animal models and human studies. He and his team have created and validated a novel animal model of arthrofibrosis, determined the most comprehensive temporal genetic expression profile of genes and pathways involved in arthrofibrosis of the rabbit model, tested three potentially anti-fibrogenic pharmaceutical agents, determined the single most comprehensive genetic expression profile of genes and pathways involved in humans with elbow arthrofibrosis, and recently discovered the SNPs, genes, and pathways involved in arthrofibrosis after total knee arthroplasty (TKA).

He joined the Mayo Clinic Department of Orthopedic Surgery as an Assistant Professor.



Mark E. Morrey, M.D.

Mark E. Morrey, M.D. Dr. Mark Morrey received his bachelor's degree in elementary education with a natural science minor from St. John's University, Collegeville, Minn., in 1995. After a first career as an elementary school and special education teacher, he entered the University of Wisconsin School of Medicine and Public Health, Madison, Wis., in 2003. He was awarded his M.D. in 2007. Completing both his orthopedic surgery internship and residency at Mayo Clinic College of Medicine, Rochester, Minn., from 2008 to 2012, Dr. Morrey served as chief resident in 2012. An accomplished scholar and athlete, Dr. Morrey has received numerous awards. At the Wisconsin School of Medicine

and Public Health they include the Shapiro Research Award, the Rowe Scholar Award, Cash Scholar distinction and the Everett Carl Burgess Surgery Award. At Oxford University, Oxford, England, he received the Girdlestone Scholar and Fellowship. Dr. Morrey has authored and contributed to approximately 30 peer-reviewed articles and book chapters, as well as presented to dozens of conferences in the U.S. and Europe. His research interests include enhancing tendon-to-bone attachments, gene and protein expression profiles in acute versus chronic elbow contractures, and genetic expression in osteolysis, metalosis and infection. He joined the Mayo Clinic Department of Orthopedic Surgery as an Assistant Professor of Orthopedics.

Medical Editors:

Daniel J. Berry, M.D.
Arlen D. Hanssen, M.D.
Michael J. Stuart, M.D.

Mayo Clinic *Orthopedic Update* is written for physicians and should be relied upon for medical education purposes only. It does not provide a complete overview of the topics covered and should not replace the independent judgment of a physician about the appropriateness or risks of a procedure for a given patient.

Contact Us

Mayo Clinic welcomes inquiries and referrals, and a request to a specific physician is not required to refer a patient.

Arizona

866-629-6362

Florida

800-634-1417

Minnesota

800-533-1564

Resources

mayoclinic.org/medicalprofs

Clinical trials, CME, Grand Rounds, scientific videos, and online referrals

Education Opportunities

TransFuse 2014: Transformative-Fusion of Innovative Patient Blood Management

March 25 - 28, 2014 - JW Marriott Desert Ridge Resort, Phoenix, Ariz.

In a three-day multidisciplinary conference, participants will explore state-of-the-art techniques and strategies for developing programs to implement hospital blood management programs. This is a one-of-a-kind summit organized by leaders in blood management from Mayo Clinic, Hartford Hospital, Loyola University, and Cleveland Clinic, with faculty participation from all four organizations.

Contact: Call 507-288-5620 or email tracy@matrixmeetings.com

Shoulder Arthroscopy, Arthroplasty and Fractures

May 2 - 3, 2014 - Mayo Clinic, Rochester, Minn.

This is an advanced course for orthopedic surgeons who treat disorders of the shoulder, teaching the principles and techniques for management of rotator cuff tears, SLAP lesions, instability and arthritis. Coursework includes didactic sessions and laboratory experience using cadaver specimens. Live video demonstrations and panel discussion are an integral part of the overall learning experience.

Contact: Call 800-323-2688 (toll-free) or email cme@mayo.edu

Diagnostic and Interventional Musculoskeletal Ultrasound

July 10 - 12, 2014 - Mayo Clinic, Rochester, Minn.

A collaboration between Mayo Clinic and the American Institute for Ultrasound in Medicine (AIUM), this three-day course is appropriate for physiatrists, sports medicine physicians, radiologists, orthopedic surgeons, anesthesiologists, rheumatologists, sonographers and other clinicians who evaluate and treat patients with musculoskeletal and neurological diseases. Teaching format consists of lectures, live demonstrations and extensive hands-on experiences on live models and unembalmed cadavers. The course format accommodates learners at the beginner and intermediate/advanced levels. Registration will be available online at www.aium.org in March 2014.

Contact: Call 800-323-2688 (toll-free) or email cme@mayo.edu

MAYO CLINIC | mayoclinic.org

4500 San Pablo Road Jacksonville, FL 32224	200 First Street SW Rochester, MN 55905	13400 East Shea Boulevard Scottsdale, AZ 85259
---	--	---

©2013 Mayo Foundation for Medical Education and Research. All rights reserved.
MAYO, MAYO CLINIC and the triple-shield Mayo logo are trademarks and service marks of MFMER.

