

# ORTHOPAEDIC CONNECTIONS



The newsletter of the Carl J. Shapiro Department of Orthopaedics at Beth Israel Deaconess Medical Center

## Leading techniques for foot and ankle surgery

Casey Hassenstein, 44, had lived with a bunion on her right foot for about 20 years. Over time she had tried wearing more forgiving shoes and stopped running and biking. “My foot was just too sore and it was becoming increasingly difficult to wear running shoes—even the touch of the shoe on my bunion caused it to ache severely,” she said. When Hassenstein came to Chris Miller, MD, orthopaedic foot and ankle surgical specialist at Beth Israel Deaconess Medical Center (BIDMC), he thought she might benefit from minimally invasive surgery to correct the problem. The surgery required two small “poke” holes instead of several two- to four-inch incisions when performed with other techniques.

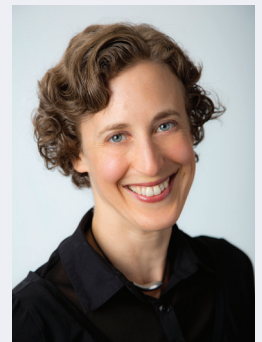
Two months after surgery, Hassenstein reported positive functional and cosmetic outcomes. “I’m going to physical therapy each week and my foot and muscles around it are getting stronger. Now I’m walking on my own without a limp and biking, and hope to be back to running in the next couple of weeks,” she said. “I’m really pleased with the surgery—my foot looks and feels much better than before.”

Over the past 30 years orthopaedic surgeons have transitioned from making large incisions to access bones, ligaments and joints to ever smaller incisions, often using tiny cameras or arthroscopes to visualize the anatomy. Until recently, these minimally invasive approaches have been limited to repairing body parts at and above the knees. Now BIDMC offers such leading edge techniques to patients who need treatment of the smallest bones and joints: Miller is among the pioneers in the Boston area using this approach for foot and ankle surgery.

“When we look at orthopaedics several decades ago, all surgeries were open. For instance, if someone had a rotor cuff tear, surgeons made big incisions to repair them,” Miller explained. “Over time, these open rotator cuff tear repairs became a shoulder arthroscopy with a smaller open incision, and then a mini-open

## Tamara Rozental appointed full professor of Orthopaedic Surgery at Harvard Medical School

The BIDMC Orthopaedics Department is pleased to announce that Harvard Medical School has appointed Tamara D. Rozental, MD, as professor of Orthopaedic Surgery. Rozental, who serves as chief of the Division of Hand and Upper Extremity Surgery and program director for the Hand and Upper Extremity Fellowship at BIDMC, is the medical center’s first orthopaedic surgeon to attain this position since the current Department was re-established in 2003.



Rozental is recognized internationally for clinical expertise on fragility fractures and research on bone health. She has received numerous grants and awards for her research and has spoken and written widely on it. She serves as editor in chief of the *Journal of Hand Surgery Global Online* and research director for the American Society for Surgery of the Hand.

“Dr. Rozental has been a thought leader in the field of orthopedics at Harvard and BIDMC,” said Department Chief Mark Gebhardt, MD. “We couldn’t be happier that she has been acknowledged for her expertise in hand surgery, important exploration of bone fragility causes and treatments, and remarkable ability to teach and share her knowledge with others.”

rotator cuff repair. Today, it’s usually done entirely arthroscopically through a minimally invasive approach.”

A similar evolution has occurred with surgery to address torn anterior cruciate ligament (ACL), a common knee injury.

“The foot and the ankle, because of smaller joints and the need to perform more osteotomies, where bone is cut and reshaped, also historically required open incisions. Now we’re seeing the same trends in minimally invasive techniques and instrumentation that we’ve seen in surgery for the other parts of the body,” said Miller.

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## ORTHOPAEDIC CONNECTIONS

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## Letter from the Chair

As the summer rolls on, I expect many of you are taking well-earned vacations. Whether working or relaxing somewhere fun, we hope you partake in this newsletter packed with announcements about our professional team, an interview with the fascinating leader of our clinical research team, and two articles on the leading edge orthopaedic surgery techniques we offer to our patients and their physicians.

You may have already noted the page one announcement: Tamara Rozental, MD, head of our Hand and Upper Extremity team, has been named full professor at Harvard Medical School—the second Orthopaedics Department member to receive the prestigious title this year. The new appointment conveys formal recognition of her formidable achievements as a practitioner, bone fragility researcher, and teacher.

I also take great personal pride and delight in welcoming orthopaedic oncologist Carrie Heincelman, MD, to our Department. After completing a year-long fellowship in this critical subspecialty that spanned BIDMC, Boston Children’s Hospital and MGH and included training under both Megan Anderson, MD, our chief of Orthopedic Oncology, and yours truly, she chose to become a permanent part of the Orthopaedics Department in September. She is also fellowship trained in orthopaedic trauma surgery. We look forward to having this highly qualified specialist available for physician referrals to tackle complex diagnoses and skeletal issues related to cancer.

In the Winter 2019 issue of *Orthopaedic Connections*, we relayed that HMS named Mary Bouxsein, PhD, a full professor. An interview with Dr. Bouxsein, who directs BIDMC’s orthopaedic research laboratory, offers a glimpse of the path that led her to where she is today and a deeper dive into her ongoing research, approach to mentorship and aspirations for the future.

Surgeons in all specialties continually seek to make procedures—emergent or elective—safer, more effective and a better overall experience for patients. One avenue of advancement has been reducing the invasiveness of surgery. While minimally invasive techniques are now standard in many types of orthopaedic procedures, our cover story relates how BIDMC’s Chris Miller, MD, is joining other pioneers in extending them to an anatomical area that so far has been most challenging: the foot and ankle.

Our final feature examines one of the most common injuries professional and recreational athlete’s experience: ACL tears. There are several choices for surgical reconstruction of the knee ligament, based on patient preference. Joseph DeAngelis, MD, was trained in a technique involving the quadriceps tendon that enables BIDMC to provide the complete range of grafting options for patients eager to get back in the game.

Enjoy the remainder of the summer!

*Mark C. Gebhardt, MD*

Chief, Carl J. Shapiro Department of Orthopaedics



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<b>ONLINE</b>	<b>Visit: bidmc.org/orthopaedics</b> Click “Make an Appointment” in the menu on the left.	
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# Orthopaedic oncologist joins Department

Growing up in Albuquerque, New Mexico, Carrie Heincelman, MD, knew she wanted to be an orthopaedic surgeon from a young age. In high school she played tennis competitively and took a sports medicine class taught by the school's athletic trainer. The class piqued her interest in the field, and led her to ask if she could shadow an orthopaedic surgeon after school—her own orthopedic surgeon. "I finally got to make a connection between school learning and how it applies in the real world. I honestly fell in love with orthopaedics then," she said.



Heincelman's interest didn't waiver much in medical school. "I kept an open mind throughout med school about different specialties, but I always ended up coming back to orthopaedic surgery."

In her last year of medical school, she did a rotation in medical oncology. "At the time, there was a patient with a musculoskeletal tumor on service whose case led me to think oncology within orthopaedics could be stimulating," said Heincelman.

Meanwhile an interest in orthopaedic trauma from her student athlete days was still strong. She completed a fellowship in that specialty prior to beginning a fellowship in orthopaedic oncology in Boston at Massachusetts General Hospital this year. Beginning in September, Heincelman joins the Department of Orthopaedics at Beth Israel Deaconess Medical Center, dividing her time between BIDMC and Children's Hospital. Heincelman will also see trauma patients as a secondary practice.

The fields of orthopaedic oncology and orthopaedic trauma overlap, she pointed out. "Sometimes complex fractures occur in cancer patients because of bone lesions. There's a lot of reconstructive effort in both specialties as well, whether it's a result of bone loss from a tumor or a bad injury," she said. "I hope to use techniques from each specialty to help with the other and come up with solutions for complex problems."

As an orthopaedic oncologist, Heincelman sees patients with various types of sarcomas that can impact bone or soft tissues, or both. When she first sees a patient, she assesses their risk of fracture. She will then perform preventive surgery if needed. "For example, if a patient has breast cancer that's spread to their bones, I will make sure there's no risk for fracture and if there is—if they've got a spot in their limbs or pelvis that's weakening so much we're worried it's going to break, for example—I will place nails or rods in the bone to prevent it," Heincelman said.

In other cases the medical problem isn't clear. "A tumor may have been incidentally found, or a patient noticed a lump and got an MRI," she explained. "Our first job when we see something on imaging is to say, 'Is this a benign growth that we're not worried about, or does it concern us?' Our other job is to figure out could that problem—even if the growth is benign—be causing their symptoms and is there something we can do for that?"

Additionally, patients often arrive with musculoskeletal pain related to cancer when there is no bone tumor at all. She brings to bear all of her orthopedic training to help solve the problem or

## Fellowships

### **Orthopaedic Oncology**

Massachusetts General Hospital, Boston, Mass.

### **Orthopaedic Trauma**

Indiana University Methodist, Indianapolis, Indiana

### **Residency, Orthopaedic Surgery**

University of Cincinnati Medical Center, Cincinnati, Ohio

### **Medical School**

University of Cincinnati College of Medicine, Cincinnati, Ohio

ameliorate the symptoms while being mindful of how the diagnosis of cancer should affect the musculoskeletal treatment plan.

Heincelman is keenly aware that everyone coming to her thinks "this can be something bad." "The first thing I do is try to set patients at ease and let them know that even if they have a cancerous growth or something that is going to need a lot of treatment, they are in the right place. We have the team around us; regardless of the problem, we will help get to the bottom of it," she said. "My goal is to give patients the confidence that we will help them to figure out a solution or direction to go with for whatever they're dealing with."

BIDMC, like most academic medical centers, takes a team approach to cancer treatment. Orthopaedic oncologists, radiologists, pathologists, medical oncologists, radiation oncologists, and surgical oncologists meet weekly to review patients with active issues and get input from other team members. "That way we're all looking at things at the same time and can come up with care plans for specific patients," said Heincelman.

When it comes to executing the plan, BIDMC also applies the team approach. According to Heincelman, her ability to work side by side with other specialties—especially when patients have widespread cancer—is critical to a successful outcome. If there is a problem in a patient's pelvis, for example, she can work with general surgeons, urologists and vascular surgeons, depending on the tumor's exact location. Also, she can share patients with spine surgeons and thoracic surgeons. "If patients have disease in their lungs, we can time the chemotherapy and different surgeries they need. It's definitely a team effort."

Heincelman receives referrals from a variety of physicians including primary care providers, other orthopedic surgeons and oncologists.

"I'm very excited to get to stay here following my fellowship. I've loved Boston and have loved BIDMC during my fellowship year," she said. "Orthopaedic oncology is a unique specialty—even within orthopedics—because of how many other specialties we work with. It's important for cancer patients and their teams to know that we're out there and always willing to weigh in on a difficult orthopedic problem or an unusual musculoskeletal finding."

Heincelman lives in Boston, and enjoys exploring the city—including adventures like kayaking on the Charles River and attending Red Sox games as often as possible. She also still plays tennis whenever she can.

For an appointment with Dr. Heincelman, call 617-667-3940 or email [orthooncology@bidmc.harvard.edu](mailto:orthooncology@bidmc.harvard.edu). 

# Dialog with Mary Bouxsein, PhD: prolific biomechanics investigator, leader and mentor

*Mary Bouxsein, PhD, is the director of the Center for Advanced Orthopaedic Studies at BIDMC. Newly named full professor of Orthopaedic Surgery at Harvard Medical School, Bouxsein is known around the world for her expertise in the biomechanics of skeletal fractures. She is an accomplished investigator, international speaker, and honored teacher at Harvard Medical School and MIT. She holds a doctorate in mechanical engineering from Stanford University and completed a post-doctoral fellowship in orthopaedic biomechanics at Beth Israel Hospital. In the interview below, Bouxsein shares perspectives on her career in the cross-walk of biology and mechanical engineering.*

## **What influenced your decision to go into orthopaedic research?**

I was studying general engineering and economics as an undergraduate at the University of Illinois. Just before I graduated, I realized I wanted to focus on mechanical engineering and went onto graduate school at Stanford University. There I had the opportunity to work with Dr. Robert Marcus, an endocrinologist, on the effects of exercise on the skeleton. The biological processes that kick in and make your bones stronger when you exercise over a long period of time are fascinating. This connection made me realize how much I found the combination of engineering and biology exhilarating and challenging, and continued on that course as a post-doctoral fellow at Beth Israel Hospital's orthopaedic research lab.

## **What continues to motivate you?**

Being able to work at the boundary of engineering and medicine is something that excites me even today. Osteoporosis has a huge impact on women's health and quality of life, so that has always been meaningful to me. Although men get osteoporosis, I realized early in my studies there was a need for women to be represented as thought leaders in the field of osteoporosis, particularly since hormonal changes at the menopause play such a big role in osteoporosis. Also, my father had a hip fracture and died five months afterward, so that certainly motivated me to stay in this field to try to learn more about the causes of these fractures in order to reduce their incidence and the suffering that comes along with them.

## **You have published close to 300 peer-reviewed articles and papers. What are your main areas of research?**

Broadly, I aim to use biomechanical principles to understand skeletal fragility. Until recently, I mainly

focused on understanding fractures in osteoporosis. That is, understanding the structural changes that lead to skeletal fragility, and how treatments possibly influence bone structure and therefore prevent bone fractures. I've done both preclinical work [research using animals] as well as imaging studies in volunteers and patients to understand how aging leads to skeletal deterioration and how new treatments influence bone. I also devote a great deal of time to understanding how skeletal loading plays a role in fractures. It's not just bone strength, but it's also how you fall or how you lift things that may influence your risk of fracture.

More recently, I've looked at another aspect of skeletal fragility: what happens to bones during disuse, or lack of exercise. An extreme example of disuse is space flight. NASA has funded studies in which we are trying to understand the



**Bouxsein confers with post-doctoral fellow Fjola Jóhannesdóttir.**

musculoskeletal response to unloading. The studies examine the effects of microgravity, or zero gravity, on the space shuttle and International Space Station, as well as develop unique animal models to understand how various degrees of unloading affects the skeleton [see sidebar for more on space research]. The research relates directly to aging, as we all are less physically active with increased age—they tie together well.

My latest projects have led me into some new directions. One project aims to better understand

the impact of diabetes on the skeleton. Recently we've recognized that diabetes complications not only include cardiovascular disease, neuropathy and nephropathy, but also include skeletal fragility. The unique part of diabetes is that those individuals have normal bone density but increased risk of fracture. It's a conundrum to figure out why. We've conducted several studies and are conducting more in that area.

The other newer area, which goes in a completely different direction, is understanding skeletal fragility in young adults by examining the factors that increase the risk of stress fractures in military recruits. We have a number of research projects going on in collaboration with the U.S. Army.

## **In what ways do you teach or mentor students?**

I teach a required course for the first year medical students on musculoskeletal pathophysiology. It's super fun to interact with the students and teach them about the skeletal system; I co-teach that class with a rheumatologist. Most of my other teaching involves mentoring undergraduate, graduate, and post-doctoral fellows, training them in research principles and advising them on study design and interpretation.

### ***What do you tell young people drawn to orthopaedic research?***

If you have a dream and a vision, being persistent and hardworking goes a long way. You have to be open to opportunities as they come along, because your path may not be linear. After my post-doc in the Orthopaedics Department here, I worked at a biotech company—the Genetics Institute—for five years to learn how to conduct animal studies, then came back to academia. That seems to have worked out okay for me and confirms that there are different paths that can be taken. My primary message is be sure you are checking in with yourself along the way. Make sure your work is still getting you up in the morning and that you have questions you're excited about and areas where you feel you want to make a difference. That will keep you going.

### ***Do you have advice for women going into the sciences?***

Since women are underrepresented in orthopaedics and other scientific fields, it's important to find mentors who are going to support you, give you good advice, and challenge you. It's also crucial to find a peer group who are undoubtedly going through many of the same challenges that you are and provide a great sounding board. Several books relate how having a peer group to share your challenges with makes them more bearable and gives you new ideas for solving problems and overcoming hurdles along the way.

### ***You have received many academic and other recognitions over your career so far. Which are most memorable?***

The awards I'm most proud of are the mentorship awards. A number of years ago I received a mentorship award from the Harvard-MIT Program for Health Sciences and Technology (HST) program for mentorship of MD students, and a Harvard-wide mentorship award called the Clifford Barger Excellence in Mentoring Award. This May, I received the Thomas A. McMahon mentorship award, also from the HST program.

On the leadership side, I serve on the board of the International Osteoporosis Foundation, which is an elected position. I also have served on the board of the American Society for Bone and Mineral Research, also an elected position.

An award I got from my hometown high school in Princeton, Illinois, last fall was also quite meaningful. I was the second recipient of their award for academic and career achievement. Often high schools tend to focus on sports achievements, so it was great that they have created this honor. I was invited back to my hometown and gave a lecture to the entire student body where I talked about how coming from a small town you may think you can't do significant things, but you can. And then, the best part was that I got to ride in a convertible in the town's parade!

### ***And you also teach outside of academia?***


The other part of my legacy has been educating physicians at conferences around the world about biomechanical principles and how they relate to fractures. I have given hundreds of talks that are unique in that an engineer is teaching physicians—endocrinologists, internists, rheumatologists, primary care doctors and gynecologists. One of my gifts is to be able to take complex engineering principles and describe them to the physician audience so they have some practical

things to take home and understand how and why their patients might be getting fractures.

### ***What else is critical to your role?***

I spend a fair amount of time writing grant proposals—most of us in academic leadership roles do. One of my other major roles is mentoring junior faculty and post docs, including teaching them how to write grant proposals and develop their independent research programs.

### ***What research is coming up in the future?***

We have several studies examining novel approaches to better identify those who are at highest risk for suffering a fracture. If we can identify them before they fracture, hopefully they can be offered treatments to improve their bone strength and prevent any fractures from occurring. Also, we recently received a grant from NASA to study astronauts who are going to go on one-year missions to the International Space Station, so we'll be able to see whether bone loss plateaus or accelerates with additional time in microgravity. This is key as NASA is preparing for missions to Mars and beyond. We're also working with the Japanese space agency and a few other U.S. investigators to examine the possibility of using artificial gravity induced by a centrifuge to prevent musculoskeletal deterioration in microgravity. 

## **Clues to bone loss are found in space**

*Excerpted from Harvard Medicine, Spring 2015: "Star Guide: Biomedicine reaps rewards from scientific pursuits in space" by Jake Miller*

On average, space-traveling astronauts lose bone mass at the rate of 1 percent a month. That's ten times faster than the rate of bone loss among postmenopausal women.

"Without mechanical loading on the bones," says Mary Bouxsein, an HMS professor of orthopedic surgery and a faculty member of the bioastronautics program in the Harvard-MIT Division of Health Sciences and Technology, "biochemical changes that signal bone loss can be found in the blood in just a couple of weeks."

For decades, NASA has been investigating ways to stem bone loss among astronauts. Medical research has also sought a means to prevent such loss in patients immobilized by stroke or spinal-cord injury, or in children with cerebral palsy or muscular dystrophy. Now, NASA-funded work by Bouxsein and colleagues at the University of North Carolina and the University of Colorado in Boulder, in collaboration with the California-based biotech firm Amgen, may provide an answer.

Researchers have been testing a novel drug that uses an antibody to block sclerostin, a protein that acts as a natural brake to bone formation. Preventing sclerostin's action allows new bone to be laid down. In July 2011, Bouxsein tested the drug in 15 mice on board the shuttle Atlantis. When she compared bone-mass data from these test mice against bone measures from shuttle-based controls as well as Earth-based mice receiving treatment or serving as controls, Bouxsein found that the drug not only helped the test mice maintain bone mass but appeared to induce new bone to form, even in low-gravity environments. If these results hold true in humans, the danger to bone health brought by space travel—or disease—could become a thing of the past.

➔ **FOOT AND ANKLE SURGERY** *continued from page 1*

Minimally invasive foot and ankle surgery is generally comparable to open surgeries from a functional standpoint with potentially fewer complications and a higher level of patient satisfaction. The benefits of smaller incisions include less pain and reduced need for opioids post-operatively, less swelling and stiffness, faster recovery and smaller scars.

Smaller incisions have another benefit: lower risk of wound complications. “Your feet are as far away from the heart as you can get. They have the least perfusion of any part of the body and significant risk of swelling, so wounds are an issue with open surgeries. By using special instruments via smaller incisions, we can decrease the risk of wound complications.”

### Minimally invasive surgery

As with any orthopaedic problem, the first course for foot and ankle issues is always conservative or non-surgical treatment such as a splint or brace, but surgery is an option in moderate to severe cases. When surgery is needed, Miller strives to use minimally invasive surgery whenever possible. “Not every situation allows for minimally invasive techniques, but for many of my patients who require corrective surgery, these procedures are ideal. They are just beginning to be offered as more providers are trained to perform them,” he said.

The term “minimally invasive” includes arthroscopy and percutaneous techniques, which involve making minimal incisions. “We’re able to do complex surgeries with minimal incisions, thanks to improvements in our technology, understanding of the techniques and the anatomy—that is, where in the foot and ankle areas a surgeon can safely make an incision. So far, these surgeries have been mostly limited to the hindfoot—the ankle and heel. Now we’re including forefoot surgery such as bunion corrections,” said Miller.

One condition that can be treated with arthroscopic surgery is ankle instability, which causes individuals to twist and roll their ankles easily when walking on flat ground. Chronic ankle instability occurs in 20 to 30 percent of people with a history of ankle sprains—often those who play sports like soccer and basketball and ballet dancers. “For these patients, we tighten the ligaments and give them their stability back with a lateral ligament repair,” said Miller. “Previously, that required a 3- or 4-inch incision on the side of the ankle; now, we can make three small keyhole incisions and perform an all-arthroscopic procedure.”

The result is substantially less swelling and pain, as the smaller incision causes less disruption of tissue, and minimal scarring—all without compromising the function of the repair.

Miller may also use an arthroscope when performing a hindfoot fusion, a treatment for arthritis of the ankle. The procedure involves fusing the subtalar joint, consisting of two bones, to improve the ankle’s range of motion from side to side. “Instead of a large incision on the side of the foot, we can do it percutaneously through keyhole incisions. We’re trying to get as minimal as possible to decrease the swelling and scarring and increase the cosmetic appearance.”



Prior to day surgery at Beth Israel Hospital-Needham for a painful bunion, foot and ankle surgeon Chris Miller, MD, reviews the procedure with patient Casey Hassenstein.

Another approach available to Miller is tendoscopy. “It’s the same idea as arthroscopy, only it’s for tendons, not joints. When people have inflammation of tendons and resulting pain, we look inside the tendon sheath with a scope and debride them—remove scar tissue around them—to let the tendons function more normally without having to do a large incision.”

Some of the latest foot and ankle surgery techniques do not rely on arthroscopy, but enable surgeons to perform complex deformity corrections percutaneously while using X-ray imaging simultaneously to guide them. Miller is one of the few foot and ankle surgeons in the Boston area using this method.


“We’re now able to do osteotomies using a technology that is brand new to the United States,” said Miller. “We can do surgery with incisions that can be less than a centimeter.” That technology utilizes a special minimally invasive electronic bur that can cut bone without damaging soft tissues. It has been used in Europe for 15 years with excellent results, and was approved for use in the U.S. by the FDA in the past year.

### Less on the horizon

Beyond using advanced techniques in foot and ankle surgery, Miller is helping to further their evolution: he is developing a technique for repairing Achilles tendon ruptures. Such repairs are now performed with the patient lying face down, using anesthesia that requires intubation to help with breathing. The new technique enables the patient to lie on their back and doesn’t require anesthesia.

“It’s a way to perform Achilles tendon repairs through a 15 mm incision with excellent outcomes,” said Miller. “It can now be done under light sedation with a localized nerve block. It’s a faster OR experience, takes less time in the recovery room, and there’s minimal pain post-operatively.”

Together with BIDMC’s Center for Advanced Orthopedic Studies, Miller modified a standard surgical instrument that allows him to use this approach in his practice. His article describing the new technique will be published in the fall.

Miller’s work exemplifies how the Department continually seeks and adopts new ways to optimize patient care. “When I entered my fellowship at Brigham and Women’s Hospital several years ago, minimally invasive foot and ankle approaches were not a part of my training. After much studying and practicing, I’m teaching the next generation of surgeons coming through our training program about these exciting new approaches.” 

# Complete range of options for ACL treatment

“49ERS’ JIMMY GAROPPOLO SAYS HE’S ‘GOOD TO GO, FINALLY’ AFTER ACL TEAR”

“WARRIORS’ KLAY THOMPSON HAS ACL TEAR”

“SPEED SKIER BREEZY JOHNSON STARTS ANOTHER RECOVERY: IDAHO RACER SUSTAINS KNEE INJURY AT MAMMOTH”

Stories about high profile athletes garner attention because the recovery from an ACL injury requires a long time off the field—typically a year. But tears of the ACL—anterior cruciate ligament—don’t just happen to the pros: they occur in people who play sports competitively or recreationally, as well as in children. Each year, one out of every 3,000 Americans suffers an ACL injury, with women more likely to injure their ACLs than men when playing the same sport.<sup>1</sup>

The Sports Division at Beth Israel Deaconess Medical Center offers a comprehensive approach to a torn ACL, including one option not regularly performed at other local institutions that uses the quadriceps tendon to reconstruct the affected ACL.

## Injury and healing

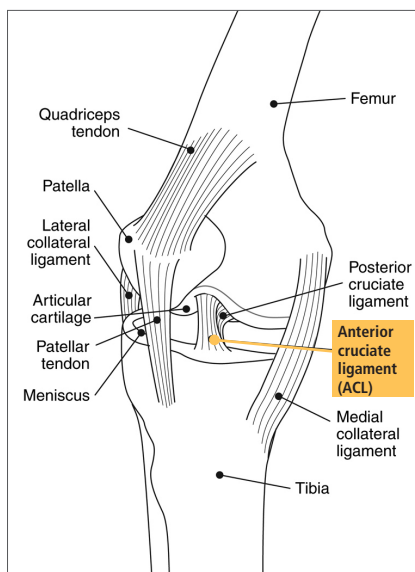
An anterior cruciate ligament injury can occur when the knee moves side-to-side quickly, twists or hyperextends. That’s why ACL injuries occur during basketball, football, soccer, tennis, volleyball, dancing or skiing, all of which can lead to a sudden twist or blow to the knee. They can happen when a ski twists and the boot doesn’t release, changing directions playing soccer, or grabbing a rebound while playing basketball.

Another cause of ACL injuries is traumatic accidents, when the knee is bent or struck during a collision or fall.

At the time of injury, people may hear a pop and the knee may swell noticeably from bleeding. The knee may buckle or feel unstable, because the ACL is one of the four ligaments that keep the bones of the knee in place.

When a person visits an orthopedic surgeon following a knee injury, the physician takes a medical history and performs a physical examination. “If there is damage, the first priority is getting the patient’s knee better. Before anything else, we try to get our patients healthy—reduce the swelling, strengthen the muscles surrounding the tear, and get you moving,” said BIDMC orthopaedic surgeon Joseph P. DeAngelis, MD.

Following physical therapy and the initial recovery, the orthopedic surgeon may order X-rays and an MRI to look at the ligaments, cartilage and other elements of the knee.



If the orthopedist confirms a torn anterior cruciate ligament, the next step is a discussion with the patient about whether they want or need surgical reconstruction. DeAngelis emphasized that past attempts to *repair* ACL tears by suturing the ligament back together have not been successful in adults, and today’s standard of care is to *reconstruct* the ligament using other parts in the body—in other words, to build a new ACL.

Some individuals, despite rehabilitation, experience continued instability and can’t walk safely. They often chose to have an ACL reconstruction.

DeAngelis pointed out factors for other individuals to consider when thinking about surgical options. First, what activities do you enjoy? “If you spend most of your time going straight ahead—walking, running, biking, swimming, rowing—you may not need to have your ACL reconstructed,” he said.

However, an unforeseen twist or turn of your knee is always possible—for example, when running after a young child or stumbling over a curb. “If you have an instability event and your knee slips, you can do more damage to your joint—injure the articular cartilage, tear the meniscal cartilage, or strain another ligament,” said DeAngelis. So even individuals who aren’t at risk based on their usual activities may opt to have surgery to prevent an accidental injury in the future.

Individuals with a torn ACL who want to get back to playing a sport almost always choose surgical reconstruction.

## High success rate

ACL reconstruction is a very safe outpatient procedure with success rates reported to be as high as 98 percent, DeAngelis explained. “We’re very good at reconstructing the ligament, putting the tissue in the best possible position. The challenge is not the surgery: the recovery is the hard part.” The surgeon tells patients that to ensure a full recovery, they should plan for the entire process to take a year.

If a patient decides to have surgery, the next choice they face is when to have it. “The surgery itself is about 90 minutes, and with preparation and recovery, you are in the hospital for about six hours,” DeAngelis said.

For the next six months, while the body is converting the reconstructed tissue into new ligament, patients must move only straight ahead. The new ligament then allows them to start learning how to play sports and begin moving in ways that challenge the ACL. At about nine months, patients can often start to compete. “At a year, you are where you want to be and you’ll continue to improve moving forward,” said DeAngelis.

He related the cautionary tale of Pro Football Hall of Famer Jerry Rice. In 1997, during his time with the San Francisco 49ers, the wide receiver tore his ACL and had it reconstructed. Unfortunately, he came back to the game just 14 weeks later, landed on his kneecap and broke his patella.

DeAngelis himself is a poster child for ACL reconstruction. “I tore my ACL playing indoor soccer in medical school. Now I am 19 years from my ACL reconstruction and my knee is better than it was 10 years ago,” he said.

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## Reconstruction choices

Orthopaedic surgeons have been performing ACL reconstruction for decades, continually making them safer and improving outcomes.

“We have learned through a large study funded by the NIH that using cadaveric tissue, or allograft, works fine in people over the age of 40. But in younger people the rate of it re-tearing is significantly higher than if you use your own tissue,” stated DeAngelis.

Another advancement in orthopaedic surgery occurred in the 1990s with the refinement of arthroscopic techniques. An arthroscope is a lighted camera inserted into the body through an incision smaller than the circumference of a pen. This scope gives surgeons a clear view of the anatomy during a procedure. Today, all ACL reconstructions are performed arthroscopically.

Regardless of age, patients have three graft options if they opt for using their own tissue—an autograft—for the reconstruction:

- **Bone-patella tendon-bone (BTB):** This technique involves harvesting a piece of the patella (kneecap), the central third of the patellar tendon (below the kneecap), and a piece of the tibia (shinbone). This approach is considered to be the gold standard in ACL reconstruction and it is commonly performed in elite athletes.

*Considerations:* Because a large incision is made in the front of the knee and the surgeon removes some bone, the patient may experience anterior knee pain, particularly if their work, sport or religious practice requires repeated squatting or kneeling. There’s also a risk of a patella fracture if there’s an accident—like Jerry Rice’s.

- **Hamstring (HT):** The hamstring graft involves making a small incision on the inside of the knee where the hamstring, the muscle in the back of the thigh, is attached to the shinbone. The surgeon takes two of the hamstring tendons, folds them in half, and uses them to reconstruct the ACL. This approach is used commonly in ACL reconstruction.

*Considerations:* This graft is the strongest, mechanically. The incisions are minimal, resulting in less scarring than with other choices. However, once harvested, the hamstrings may be weak or feel crampy—particularly for those who water ski or sprint—so this choice requires continued attention to keep the hamstrings healthy.

- **Quadriceps Tendon (QT):** The quadriceps, or thigh muscle, becomes the quadriceps tendon just above the kneecap. With this option, the surgeon makes an incision above the knee, harvests the center third of that tendon and reconstructs the ACL. The popularity of the QT autograft is increasing.



Orthopaedic surgeon Joseph DeAngelis, MD

*Considerations:* Like the hamstring, the QT is a soft tissue graft. Patients experience little pain at the harvest site. The quadriceps tendon is wide—up to 4 or 5 centimeters—and the tissue removed is about 20 percent of the total tendon. Patients do not experience weakness in the thigh. This option does require an incision above the kneecap as well incisions below it, while other options don’t.

“I share the decision with patients,” said DeAngelis. “I let them know all of the autograft choices have great success rates two years from surgery, but each one has a limitation. Because the patient has to live with the downside, I want them to understand their options and make the best choice for themselves.”


## QT gaining interest

The popularity of the quadriceps tendon as an ACL graft is growing nationally. One reason for the trend is that more ACL reconstructions are being performed annually—in part because people in their 50s and 60s are expecting to maintain an active lifestyle as they age. “As a result, the number of people who have an injury to their previously reconstructed ACL has risen. The QT provides a good alternative for people who have already had an ACL reconstruction and need a revision—we can’t harvest the same tissue twice,” said DeAngelis.

The rise in QT procedures for revisions has led to more use for first-time injuries. “As it is used more for revision surgeries successfully, the more credibility it has in the field. Surgeons are realizing that if it’s safe for revisions, it’s safe for first-time ACL procedures,” DeAngelis said.

DeAngelis performs between 60 and 80 ACL reconstructions a year; he estimates two-thirds of them are QT procedures. He has been performing quad tendon ACL reconstructions at BIDMC for over 10 years, and is among the few in the Boston area who offer this choice to patients. “I learned the technique—which originated in Germany more than 40 years ago—during my orthopaedic residency at the University of Connecticut from Dr. John Fulkerson. The clinical results have been very good.”

Some of DeAngelis’ patients are referrals by other orthopedic surgeons when those individuals are not candidates for one of the more common grafts.

The QT and other ACL graft choices represent incremental advancements of past research. Now orthopedic researchers and practitioners are working to improve the patient experience further—likely with a renewed focus on repair. “Fundamentally, we’re aspiring to improve quality of life,” said DeAngelis. “We’re trying to be thoughtful about what we do, leveraging what we have learned.” 

1. Kiapour AM, and Murray MM. Basic science of anterior cruciate ligament injury and repair. *Bone Joint Res.* 2014 Feb; 3(2): 20–31. Published online 2014 Feb 1. doi:10.1302/2046-3758.32.2000241.