

Orthopaedic Connections

Beth Israel Lahey Health
Beth Israel Deaconess
Medical Center

The newsletter of the Carl J. Shapiro Department
of Orthopaedics at Beth Israel Deaconess Medical Center
WINTER 2023

BIDMC launches Global Orthopaedic Health Initiative to improve trauma care access

Beth Israel Deaconess Medical Center (BIDMC) has launched an orthopedics health program that aims to improve access to musculoskeletal care for under-resourced communities around the world. The first initiative of its kind at the medical center, it will bring together the Orthopedic Department's surgeons and researchers, as well as other Harvard affiliated and non-affiliated resources, to develop innovative orthopedic and trauma solutions that are affordable and sustainable in those settings.

The newly created BIDMC Global Orthopaedic Health Initiative is headed by Kiran Agarwal-Harding, MD, MPH, who joined the department in October. Agarwal-Harding holds a master's from the T.H. Chan School of Public Health and completed a hand and upper extremity fellowship at New York-Presbyterian/Columbia

University Irving Medical Center. He will split his time between directing the global initiative and practicing as an upper extremity trauma surgeon.

HGOC networks there are strongest, and our portfolio of research projects is quite robust."

As director of the BIDMC Global Orthopaedic Health Initiative, he will continue the multinational work of HGOC and expand its portfolio of collaborations through the BIDMC Orthopaedic Department.

Trauma care is the biggest need when it comes to orthopedics in the developing world, according to Agarwal-Harding.

"It's essential, and it's inadequate in a lot of low- and middle-income countries. For example, in Malawi, the orthopedic wards are full of patients

with open fractures and complex fractures that are desperately in need of surgery. And that surgical capacity is still very much in its early stages of development."

Agarwal-Harding plans to continue the Malawi projects and build on early-stage collaborations with other nations such as Cameroon, Ethiopia, Kenya, Ghana, Gambia and Haiti.

"All of these potential projects are aimed at improving orthopedic trauma care or orthopedic surgical capacity," he said.

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Kumbukani Manda, MD, (left) of Kamuzu Central Hospital teaches orthopedic clinical officers (non-physician clinicians who manage the majority of orthopedic cases in Malawi) to perform external fixation of ankle fractures as part of a course sponsored by HGOC and the Malawi Orthopaedic Association.

Improving orthopedic and trauma care

Agarwal-Harding has long held a passion for global healthcare along with his medical specialty of orthopedic surgery. In 2017, he founded the Harvard Global Orthopaedics Collaborative (HGOC) while a resident and has directed it since. In that role, he has led successful collaborative orthopedic health improvement projects in Malawi, Haiti, Cameroon and Ethiopia.

"I began working in Malawi as a resident. I've been there six or seven times, spending one to two months each trip," said Agarwal-Harding. "The

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Orthopaedic Connections

is published by the Carl J. Shapiro Department of Orthopaedics at Beth Israel Deaconess Medical Center for primary care providers, patients, faculty, trainees, staff, alumni, affiliates and friends.

Sponsor Edward K. Rodriguez, MD, PhD, Chief of the Department of Orthopaedic Surgery and Orthopaedic Surgeon-in-Chief, Beth Israel Deaconess Medical Center

Editor/Writer Marian Mostovy

Designer Ricki Pappo

Please send comments or requests to be added or removed from the mailing list to: gpatton@bidmc.harvard.edu

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In addition to phone and online requests, referring physicians can send an email including the patient's name, birth date or BIDMC medical record number, phone number and presenting problem, and we will contact the patient within one business day to schedule an appointment.

Letter from the Chair

Dear Friends and Colleagues,

It was a busy end of the year in the Orthopaedics Department as our practice headed back to a near pre-COVID pace. I am enthusiastic about our prospects for a very exciting new year, and driving that enthusiasm are the wonderful additions to our clinical and research faculty. In this issue of Orthopaedic Connections, we are pleased to introduce you to our new team members and the wealth of talents they bring to BIDMC.



We recently welcomed Kiran Agarwal-Harding, MD, MPH, to our team. He brings not just his skill as a trauma surgeon specializing in upper extremity injuries to the department but also introduces a whole new dimension to the work we do: implementing a global health initiative in orthopedic care. This is a direction I made part of our mission when I first took on the role of chair in 2020, and we are delighted to have found an especially talented surgeon to lead it.

Dr. Agarwal-Harding's passion for improving how under-resourced countries meet their most pressing orthopedic needs dates back to his pre-medical years. Our cover story explores some of the remarkable strides he and his colleagues have made so far and from which BIDMC's multi-faceted global orthopedic health program will evolve.

We also feature another new face in the department—this time in our research lab. Ben Freedman, PhD, is a bioengineer who has developed unique bio-adhesive technologies. His adhesives can hold together torn tissues of many types and can also deliver small molecules to them to hasten healing. This promising technology, still in the pre-clinical trial state, is generating excitement in the tissue engineering and reconstruction communities.

Finally, we profile Mindy Nguyen, MD, a skilled sports medicine specialist from the Providence, Rhode Island, area, whom we welcomed to BIDMC this past fall. She is now seeing adults presenting with a wide variety of orthopedic issues in our Boston, Chestnut Hill and Lexington locations.

Wishing you and yours a happy New Year!

Edward K. Rodriguez, MD, PhD

Chief, Department of Orthopaedic Surgery
Beth Israel Deaconess Medical Center

Pioneer of biomaterial for tendon repair joins department's translational innovation initiative

Since the department launched the Musculoskeletal Translational Innovation Initiative two years ago, its resources have grown to encompass a clinical research administrator, a biostatistician, research assistants and regulatory support. The latest addition to the team is Ben Freedman, PhD, a bioengineer spearheading the development of cutting-edge biomaterials that have the potential to improve tendon repair and a broad range of musculoskeletal tissues.

Freedman earned his PhD in bioengineering from the University of Pennsylvania and BS in biomedical engineering from the University of Rochester. His research focuses on developing new biomaterials to improve tissue healing, with a special focus on tendons. Freedman joins BIDMC from the Wyss Institute for Biologically Inspired Engineering at Harvard University, where he pursued this line of investigation during his post-doctoral fellowship.

Creating better tendon therapy

Tendons are tough but flexible bands of tissue that connect muscle to bones and enable movement of joints and body parts. Torn or strained tendons—most commonly Achilles, flexor or rotator cuff tendons—can cause persistent pain and take a long time to heal after surgeries, especially in older people.¹ Scientists are seeking ways to improve the effectiveness of current treatments to tendon injury, which include pain-relieving drugs and physical therapy.

Freedman and colleagues at the Wyss Institute, along with Harvard School of Engineering and Applied Sciences and Novartis researchers, have developed a material that may be a significant advancement over available solutions. Together they created “Janus Tough Adhesive,” a biomaterial-based tendon therapy that addresses key challenges in the healing and regeneration of tissues.



Unique bio material inspired by slugs

Janus Tough Adhesive is a unique two-sided hydrogel patch that is non-toxic and sticks to wet surfaces. While one surface firmly adheres to tendons, the other surface of mechanically strong yet stretchable gel allows normal gliding of healing tendons. The hydrogel material was inspired by a sticky mucus that Dusky Arion slugs create when they feel threatened.

“We don’t use any snails or slugs in our material, but they served as bioinspiration to try to create materials that behave in a similar way,” said Freedman.

Importantly, the hydrogel patch can be loaded with a high volume of a drug that slowly releases into tendon tissue to provide targeted therapy—vs. oral or injectable drugs—to facilitate healing.



Credit: Wyss Institute

Applying the patch can be likened to applying a Band Aid®.

“A surgeon receives the patch in a pouch, opens the pouch, cuts it to whatever size or shape is desired on the surgical field, and then pushes the adhesive side against the torn tissue,” explained Freedman. “They apply pressure for a couple of minutes and then continue with the surgery.”

“I am interested in understanding age-related injury and developing new therapies to try to restore age-related deficit in tendon and ligament with existing biomaterials and new versions of these materials.”

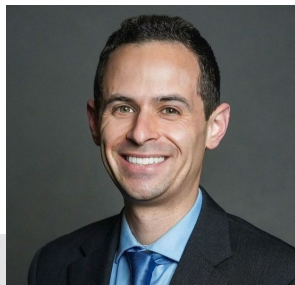
Ben Freedman, PhD

In a recent article in [Nature Biomedical Engineering](#), Freedman and colleagues reported on a pre-clinical study that demonstrated the Janus material to more effectively reduce scar tissue formation and inflammation and promote tendon healing when compared to the existing standard of care. While other hydrogels are used in tendon repair, Janus is stronger, can release drugs continuously vs. in spurts and adheres without the need for suturing it to the surrounding

tissues.

According to Freedman, the researchers are excited about the breakthrough results of the study and

are continuing to expand preclinical studies with the goal of ultimately translating this work into humans. In the future, hydrogels with “Janus” surfaces and sustained-drug-release functionality could be designed for a range of biomedical applications.



Ben Freedman, PhD

Freedman also plans to continue his research on tendon degeneration in older people, an area he has been exploring throughout his studies and career with support from the NIH National Institute on Aging.

“I am interested in understanding age-related injury and developing new therapies to try to restore age-related deficit in tendon and ligament with existing biomaterials and new versions of these materials,” he said.

A related, but longer-term aim, is to develop technology that enables

Learn more

- A Drug Delivering Hydrogel Adhesive with Two Faces [blog post](#)
- Tough Gel Adhesives for Wound Healing [video](#)
- Janus Tough Adhesives for Tendon Repair [video](#)



Credit: Wyss Institute at Harvard University

Looking forward

At BIDMC, Freedman will build on this groundbreaking bioengineering work. One area of interest is improving the reinforcement properties of the hydrogel he and colleagues created by making them stronger and biodegradable.

“We’d like to make these hydrogels act like tendons and start to mimic many of their multiscale properties,” said Freedman. “One of my longer-term goals is to try to make them more closely mimic the native properties of many tissues throughout the body.”

hydrogels that go beyond sealing areas and delivering therapeutics to the tendon to regenerating the tendon.

“The goal is to fundamentally recreate a damaged tendon with hydrogel materials,” Freedman said.

As part of the BIDMC orthopedics research group, Freedman welcomes opportunities to try to improve the healing process through the cross-disciplinary collaboration promoted by the Musculoskeletal Translational Innovation Initiative, led by Ara Nazarian, DrSc.

“There’s a lot of expertise in surgery within BIDMC,” commented Freedman. “I am hoping to have close interactions with clinicians and be able to take the next steps to not only ask and answer some fundamental basic science questions in orthopedics but also be able to develop and translate new technologies that can improve clinical practice.”

1. Towards more effective tendon repair with a multifunctional biomaterial. Press release. Wyss Institute. January 3, 2022. <https://wyss.harvard.edu/news/towards-more-effective-tendon-repair-with-a-multi-functional-biomaterial/>

BIDMC Orthopedics Services available at Mt. Auburn Hospital

The Department of Orthopedics recently expanded its practice to offer services at Mount Auburn Hospital. Offerings include:

- Total joint replacement surgery
- Hand surgery
- Musculoskeletal medicine
- Spine surgery

- Non-operative orthopedics/sports medicine

The BIDMC office is located at 725 Concord Avenue in Cambridge. To schedule an appointment, call 617-667-3940 or email orthoappointments@bidmc.harvard.edu.



Department welcomes non-operative sports specialist



Mindy Lai Nguyen, MD

Education and Training

Fellowship: Medical Sports Medicine

Boston Children's Hospital, Boston, Mass.

Residency: Pediatrics

Children's Hospital Colorado, Aurora, Colo.

Medical School

University of Colorado School of Medicine, Aurora, Colo.

to do a lot of sideline medicine—emergency type medicine—at games and for the Division 3 athletes as well. That's when I veered toward a career in musculoskeletal injuries and management."

Sadly, during the same period, her father passed away from a preventable chronic illness, an event that deepened her resolve to go into medicine.

"I wanted to help promote wellness to keep the loss like I had experienced from a preventable illness—whether that be addiction, illness or injury—from affecting other families."

By early in her undergraduate years at Colorado College, Mindy Lai Nguyen, MD, had decided sports medicine would be the career path for her. She was majoring in neuroscience, captaining the club softball team and playing with the club hockey team

when she took advantage of the school's EMT class for undergrads.

"I got my EMT license when I was a junior, and that enabled me to be a student athletic trainer on the campus," she explained. "I got

While Nguyen is board certified in pediatrics as well as medical sports medicine, she decided to focus on athletes and adult patients several years ago. "Working with adults is a parallel with my own life as I try to prevent injury and overuse,

We asked Nguyen a few questions about her professional perspectives and life outside the clinic.

What is the most rewarding part of your job?

Being able to literally get people back on their feet when they are injured and having pain—most often it's knee or ankle pain—and it's affecting their daily lives. Being able to give the freedom and the ability to participate in the things they love, even if it's as simple as walking around the block with their grandkids or children; that's the most rewarding thing for me.

What is your clinical practice approach?

When I see any patient, I try to figure out what they want to get back to and then I do everything I can to get them there. It's a partnership in which I ask, "What are your goals? What are my goals to help you get there? How do we get to our destination together?" In addition to taking a collaborative way, I like to approach patient care in a holistic manner. For example, not just focusing on your knee pain but also what it means for your daily life and for everything else that comes with feeling like you can't do what you want to do or love to do.

How do you work together with PCPs?

Being able to see the patient in a reasonable amount of time—within a week is our goal—so we can be responsive to the PCP and to the patient and their needs. Any time I

share a patient with a PCP I will always, besides develop my rapport with the patients, look to the PCP and make sure they are on the same page with what I'm thinking as well. It gives them an opportunity to advocate for their patient in case they have other needs or concerns.

What attracted you to BIDMC?

It was the great group of physicians that I've met through my specialty training. I really loved the culture, how caring the group is about their patients and how passionate they were about sports medicine and orthopedics in general. That really resonated with me.

Are you involved in research?

I just had an article accepted for publication in *Sports Health*. The paper focuses on hip pain in ice hockey athletes as it relates to sports specialization.

What do you enjoy doing outside of work?

Besides working at an ice hockey rink as part of my Northeastern coverage, I play a lot of ice hockey still. I am active in the Boston ice hockey community—both the women's and co-ed.

Also, I have two lovely dogs, a husky, Zephyr, and an Australian cattle dog mix named Artemis. They are very high energy, which means we like to spend a lot of time hiking, being outdoors, exploring the trails around the Boston area and sometimes venturing up north into New Hampshire towards the White Mountain National Forest.

particularly when I am playing sports. That usually resonates well with my patients, and I enjoy helping them be the best that they can be.”

Nguyen joined BIDMC this fall and is now seeing patients in Boston, Chestnut Hill and Lexington. As a non-operative orthopedic specialist—also known as a sports medicine specialist—Nguyen evaluates patients, often using ultrasound and imaging, and provides injections into joints or around tendons or recommends other treatments.

Nguyen welcomes patients 16 and older with pains or injuries related to any physical activity—not just sports.

“I see the gamut of people because we’re all active, we all move about whether our levels of activity are high or we’re walking around the Boston area,” she said. “Everyone at some point in their life has some sort of orthopedic issue, whether its knee, ankle, back or shoulder pain or other issue. I’m happy to be there to help resolve it.”

In addition to her role at BIDMC, Nguyen continues as the team physician for the Northeastern University men’s and women’s ice hockey teams when they play at Matthews Arena.

To make an appointment with Dr. Nguyen, contact 617-667-3940 or orthoappointments@bidmc.harvard.edu.

Global Orthopaedic Health Initiative continued from page 1

Two-way research and education

The BIDMC initiative structure is one Agarwal-Harding developed over the past five years. Two key pillars of the framework are research and education.

“We work with local surgeons to understand the local situation, their challenges, how they’ve addressed a certain challenge or innovations they have developed, and whether the interventions in place to improve care are effective. Then we build an academic collaboration to support research and education,” said Agarwal-Harding. “It’s an exchange of ideas in both directions—we all grow and learn how to improve care of the poor and vulnerable.”

As an academic medical center, BIDMC can provide the research needed—and tap into a network of other groups as well. The BIDMC global orthopedic health program will have access to resources such as a biostatistician, Harvard Chan School of Public Health students, and Harvard Medical School-affiliated research and advocacy groups.

On the clinical education side, BIDMC surgeons will share their expertise and stimulate idea sharing across the network of providers in limited resource settings.

“The BIDMC program will provide a platform through which orthopedic surgical residents, medical students and young surgeons all over the world will be able to access the knowledge and expertise of the surgeons in our



BIDMC surgeon Paul Appleton, MD, (left) scrubs in with Leonard Branza, MD, for an orthopedic case at Kamuzu Central Hospital, Malawi

orthopedics department who are willing to train the next generation of surgeons working in under-resourced areas,” explained Agarwal-Harding.

Advocacy and innovation

Beyond research and education, Agarwal-Harding plans to expand two other pillars in his new role at BIDMC: developing policy to expand healthcare access and making resources more available through innovative systems or products.

“We want to translate the knowledge we gain from research and educational projects into policy work and advocacy work, at an international or national level,” Agarwal-Harding said. Tactics to expand access through system-level changes might include

developing policy statements, working with ministries of health and working with donors.

To achieve resource innovation, the program can develop systems to make orthopedic care resources more available or design low-cost devices for deployment in low-resource settings. For the latter, he will coordinate with the biomechanical experts at BIDMC’s Center for Advanced Orthopaedic Studies.

Making impactful contributions

One of the many benefits of the BIDMC Global Orthopaedic Health Initiative is that it will provide a fertile pathway for BIDMC faculty to share their extensive knowledge to help solve global problems.

“BIMDC surgeons have a lot of interest and enthusiasm for helping in limited resource settings. But with busy clinical practices and the demands of our academic lives, it’s difficult for every surgeon to meaningfully contribute in a sustainable way,” said Agarwal-Harding. “What I am trying to create is a mechanism through which any orthopedic surgeon in the department can find a way to make a significant contribution.”

He gave an example of how this can happen. As a resident, Agarwal-Harding was operating with a colleague in Malawi on a patient in his 50s who had tripped and twisted an ankle, fracturing the two bones that form the ankle joint. The patient’s immediate care was at a rural hospital that was unable to perform an X-ray

and did not perform a reduction (physically moving the bones back into place without surgery) or apply a splint. The patient was referred to a surgeon in the capital city but didn’t have the money to pay for transport to get there until five weeks after the injury.

“He finally came to see my colleague five weeks later. There was no way for us to fix the ankle. We had to salvage his ankle by fusing the bones together, which is obviously not ideal,” said Agarwal-Harding.

The experience led Agarwal-Harding on a quest to learn how Malawian providers manage ankle fractures—the most common musculoskeletal injury among adults in that country according to previous research he

had conducted—and if there’s a way to improve it to prevent similar situations. That led him to do an assessment of the local providers, mostly non-physician clinicians trained in non-operative treatment methods only. This identified deficits in their knowledge of diagnosis, treatment and anatomy.

Next, Agarwal-Harding assembled a team of Malawian and Harvard-affiliated surgeons to design an educational curriculum addressing those deficits and launching a standard treatment protocol feasible in Malawi. To help execute it, John Kwon, MD, an orthopedic surgeon then with BIDMC, became a collaborator.

“John Kwon was extremely interested in helping improve ankle fracture care

CASE STUDY

How a low-cost pump made with a fish tank bubbler evolved from Haiti to Cameroon and back

Situation: At the Haitian Annual Assembly of Orthopaedic Trauma in Port-au-Prince in 2018, an orthopedic resident presented her innovation to a long-proven concept used in the care of open fractures and complex or infected wounds: a fish tank bubbler retrofitted to work as a negative pressure wound therapy pump.* Members of the Harvard Global Orthopaedic Collaborative (HGOC), which helped organize the conference, encountered colleagues from Cameroon who expressed a need for negative pressure wound therapy devices to address a huge problem with open fractures and complex wounds.

Action: HGOC built pumps exactly like the one presented in Haiti and shipped them to Cameroon.

**Negative pressure wound therapy is used to temporize or treat large open wounds. Providers fill the soft tissue defect with gauze or foam, seal the wound with a plastic film, puncture a hole in the film and insert a tube. The other end of the tube is attached to a suction pump that applies very low negative pressure to the wound, which draws away fluid, collapses the wound and stimulates growth.*

They worked well according to the feedback from the Cameroonians, but not as well as they had hoped. So HGOC revised the pumps and improved on some of the limitations, creating a model they dubbed VATARA for Vacuum Assisted Therapy Affordable for All. While a commercial pump is available for about \$40,000, the VATARA version costs \$100.

Results: The new model pumps were sent to Cameroon Baptist Convention Health Services hospitals. HGOC ran a case series there: the study showed they were clinically effective. Since then, the VATARA pumps have been used successfully in Haiti following the earthquake there in August 2021 as well as in hospitals on the frontlines of Ukraine during the 2022 Russian invasion.

Next steps: Regulatory approval is underway to make it globally available. Colleagues in Ethiopia have proposed a long-term cost-effectiveness study looking at the use of VATARA for a variety of plastic surgery and orthopedic



VATARA technology in use at Mutengene, Cameroon, April 2022

surgery patients with open or complex wounds. The BIDMC Global Orthopaedic Initiative, building on HGOC’s work, will continue to refine the VATARA model to increase its efficiency and potentially create a totally innovative design.

for Malawi. He came to Malawi for four days to participate in the educational course,” explained Agarwal-Harding.

In those four days, the ankle fracture education conference, and specifically Kwon’s involvement, measurably improved the providers’ knowledge of ankle fractures.

“If John had wanted to go to Malawi for four days on his own, he could have helped a little—maybe do a few surgeries, helped a few patients, done a little bit of teaching, helped a few surgeons he was teaching,” Agarwal-Harding said. “But more than 50% of the orthopedic providers in the country of Malawi were there listening to John give his lectures, seeing him do the ankle fracture reductions, learning specifically the points we identified as high priority during our research. That was really powerful.”

Looking forward

At BIDMC, Agarwal-Harding plans to continue building the collaborations and designing interventions that address significant needs. In turn, BIDMC faculty will be able to “find

BIDMC Global Orthopaedic Health Initiative

What: A program of clinical service to collaborate with, advocate for, train, and help build and improve orthopedic surgical care delivery in under-resourced and under-served communities and governments in the US and around the world, building on the work of the Harvard Global Orthopaedic Collaborative

Goal: To develop innovative solutions that make quality orthopedic and trauma care affordable, accessible and sustainable in these settings



Kiran Agarwal-Harding, MD, presents his global orthopedics vision at an educational forum.

ways of plugging themselves in and making a substantial impact without needing to go through the entire process of developing those collaborations. Their act can be more sustainable, more long-lasting.”

It is the vision of Edward Rodriguez, MD, PhD, chief of orthopedic surgery at BIDMC, and Agarwal-Harding to grow and develop the global initiative.

“There’s a huge need out there for clinical service work and there’s

tremendous value to what we’re bringing to the field. If we can continue to make it sustainable, get people interested and invested in supporting us, then we can grow,” said Agarwal-Harding. “That’s the big challenge I have: to find a way of building the program over time. I am lucky to work with many students and residents who are exceptionally talented and very committed to improving global orthopedic surgery, and hopefully, will follow this path.”

NEWS AND NOTES

AWARDS AND HONORS

Tamara Rozental, MD, Chief, Hand and Joint Surgery, was elected Vice President of the American Society for Surgery of the Hand. This is the beginning of a 4-year term.

Kiran Agarwal-Harding, MD, was selected as a 2022 STAT Wunderkind. STAT Wunderkind awards celebrate innovative scientific and medical researchers. The organization’s editorial staff consider hundreds of nominations from across North America seeking “the most impressive doctors and researchers on the cusp of launching their careers, but not yet fully independent.” Read more at [STAT](#) and in this newsletter.

APPOINTMENTS

The President and Provost of Harvard University have approved the appointment of Orthopaedics Department Chair **Edward K. Rodriguez, MD, PhD**, as Professor of Orthopedic Surgery, full time, effective September 1, 2022, in acknowledgment

of his achievements and contributions to Harvard Medical School and the Beth Israel Deaconess Medical Center.

Fadi Badlissi, MD, has been selected by the Division of Rheumatology and the Department of Medicine as the new **Rheumatology Clinical Chief**. His mission is to integrate the research and clinical programs of the division, develop further their industry-sponsored clinical trials and expand their joint clinical programs with other services in the hospital.

PUBLICATIONS

“[Longitudinal changes in serum markers of bone metabolism and bone material strength in premenopausal women with distal radial fracture.](#)” authored by chief of hand surgery **Tamara Rozental, MD**, hand surgeon **Carl Harper, MD**, director of the Center for Advanced Orthopedic Studies **Mary Boussein, PhD**, investigator **Fjola Johannesdottir, DrPh**, and others appeared in the *Journal of Bone Joint Surgery* in January 2022.

Foot and ankle surgeon **Chris Miller, MD**, was first author of “[Endoscopic](#)

[insertional Achilles reconstruction with double row suture bridge reconstruction: a technique tip.](#)” The study was published in the January 2022 *Foot & Ankle Orthopaedics*.

Sports medicine specialists **Joseph P. DeAngelis, MD**, and **Arun Ramappa, MD**, along with Musculoskeletal Translational Innovation Initiative Director **Ara Nazarian, DrSc**, collaborated on “[Lateral release associated with MPFL reconstruction in patients with acute patellar dislocation](#)” in *BMC Musculoskeletal Disorders* in February 2022.

Joint replacement surgeon **Jacob Drew, MD**, and other BIDMC orthopedic specialists contributed to “[Use of a smart-phone mobile application is associated with improved compliance and reduced length of stay in patients undergoing primary total joint arthroplasty of the hip and knee](#)” published in the March 2022 edition of *Journal of Arthroplasty*.