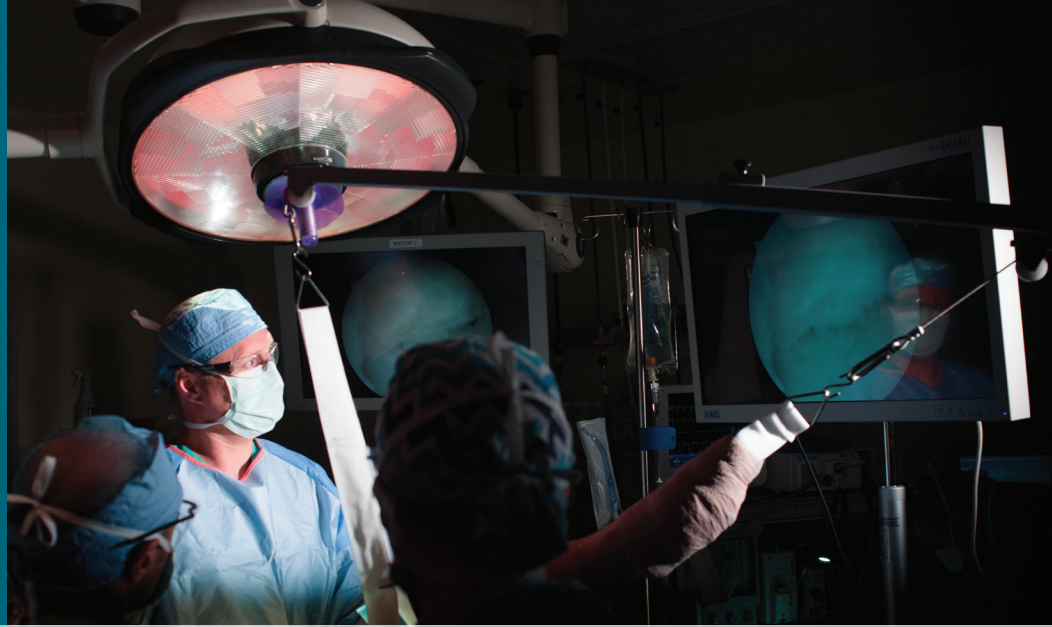


MILITARY SCIENCE SPOTLIGHT

SUMMER 2019



Dr. Matthew T. Provencher performs a shoulder surgery in the operating room

Science for Servicemen and Women

Research for Veterans and Active-Duty Military Personnel

Steadman Philippon Research Institute (SPRI) has always been committed to conducting research that promises impactful outcomes, including the science projects dedicated to active-duty military and veterans. In this edition of *SPRI News*, we'll share two innovative research studies focused on helping soldiers recover and rehabilitate from injuries and the story of a veteran who was treated at The Steadman Clinic.

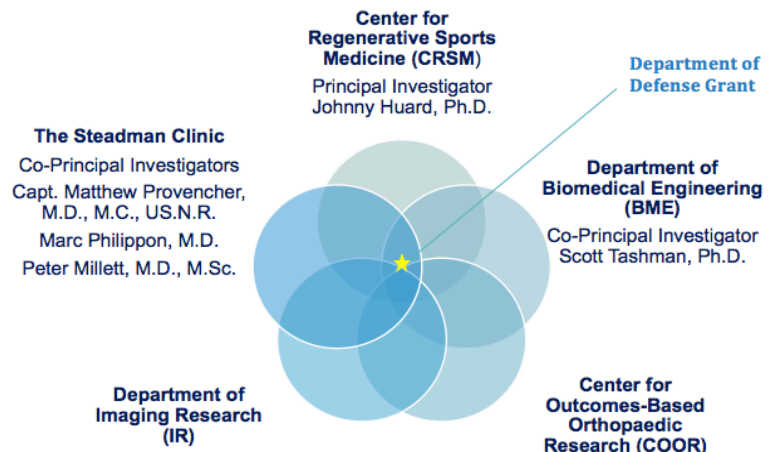
FEDERAL FUNDING NEWS

This year, SPRI has committed to applying for more federal funding, including grants from the Department of Defense (DOD). In 2019, SPRI was awarded a multimillion-dollar award from the DOD to conduct four projects with direct impact for military personnel. Including clinical trials, these projects are designed to improve healing following ACL reconstruction, improve cartilage repair following injury, use therapeutics to repair cartilage degeneration and optimize return-to-duty protocols after knee injury.

The projects in the award will be performed through SPRI's Center for Regenerative Sports Medicine (CRSM), Department of Biomedical Engineering (BME), Center for Outcomes-Based Orthopaedic Research (COOR) and Department of Imaging Research (IR). The studies also involve several physicians from The Steadman Clinic: Captain Matthew T. Provencher, M.D., M.C., U.S.N.R., Marc J. Philippon, M.D.—SPRI Co-Chair and Managing Partner of The Steadman Clinic—Peter J. Millett, M.D., Chief Medical Officer at SPRI, Thos A. Evans, M.D., Raymond H.

Kim, M.D., Armando F. Vial, M.D. and David A. Koppersmith, M.D. This grant demonstrates a truly comprehensive and team approach to science.

With these projects now underway, scientists, researchers and physicians are conducting valuable research that will directly impact military personnel, veterans and civilians as well. Over the next three years, scientists, engineers and clinicians will work together on these projects, and the SPRI team looks forward to sharing future updates on their progress.





The SPRI outdoor course in Vail utilizes natural mountain features to replicate real, outside terrain

A New Take on Return-to-Duty Protocols

SPRI’s M-POWR Study is a Game-Changer for Military Personnel

WHAT IS WEARABLE SENSOR TECHNOLOGY?

SPRI’s Biomedical Engineering (BME) team enhances its work in the Biomotion Lab by utilizing wearable sensor technology, which allows researchers to record the movements of joints and ligaments outside of the lab. Portable and wireless, the sensors are strategically placed on key points on the body to accurately measure whole-body movement patterns.

WHAT IS THE M-POWR STUDY?

Mobile Platform for Optimizing Warfighter Rehabilitation (M-POWR) is a study designed to help reduce the rate of re-injury following ACL reconstruction. Re-injury rates occur in 10–15% of surgical cases, and with ACL injuries occurring frequently in military personnel, BME and The Steadman Clinic collaborator Dr. Matthew Provencher considered whether or not existing return-to-duty protocols were effective. These tests often occur in a controlled environment, which don’t do an adequate job of replicating what movement will truly be like in the field. A military member may pass an indoor test and be sent back to the field before he or she is truly healed, greatly increasing the risk of reinjury to the knee.

With this problem in mind, SPRI’s BME team made use of the natural mountain features in Vail, Colorado—including creeks, boulders, logs and hills—to create an outdoor course that could more appropriately imitate the terrain a soldier could encounter in the field. Placing wearable sensors on the foot, ankle, knee, hip, chest and arms, researchers captured body movements and assessed how the ACL and other ligaments and joints performed on the outdoor course.

INITIAL FINDINGS & FUTURE STEPS

SPRI scientists tested 26 healthy volunteers on the outdoor course in the summer of 2018 and will continue testing through the summer of 2019. The summer 2019 participants will include both healthy volunteers and patients who have received an ACL reconstruction and have been cleared to return to full activity.

In its first rounds of testing, researchers found that the body was challenged more significantly than in the indoor lab; in the SPRI outdoor test, for example, subjects constantly moved in directions other than straight ahead, as well as on uneven terrain, requiring quick biomechanical responses. This is important following ACL reconstruction,

and the findings validate the need for more realistic testing for military personnel during their rehabilitation.

The results from this study will enable scientists and clinicians to create improved return-to-duty testing protocols that reflect the true demands military personnel face in the field. Researchers are also working to determine the minimal number of wearable sensors that can be used in assessment tests to make these protocols more affordable and realistic for future use. With improved protocols, researchers are hopeful that military personnel will only return to service when they are biomechanically ready, reducing reinjury risk and helping to keep active-duty military safer.



A research participant jumps from a log on the outdoor M-POWR course

Improving Fracture Healing: Zooming in with a Military Lens

SPRI Scientist and The Steadman Clinic Physician Collaborate to Solve Pervasive Problem

A SCIENTIST AND A PHYSICIAN TALK IN THE LAB...

In our spring edition of *SPRI News*, we introduced you to Chelsea S. Bahney, Ph.D., a scientist who joined the Center for Regenerative Sports Medicine (CRSM) in August 2018. Dr. Bahney has committed much of her career to investigating and solving poor fracture healing.

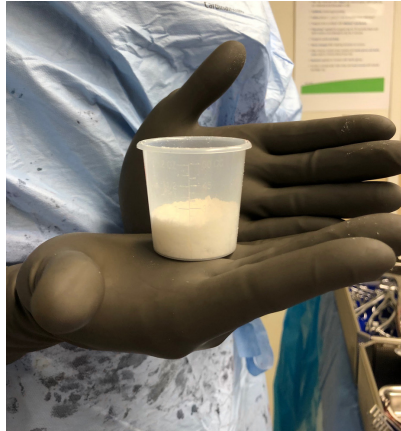
The Steadman Clinic physician Dr. Matthew Provencher was in the CRSM lab while Dr. Bahney was working on a project utilizing microrods (microscopic, rod-shaped biomaterial vessels) to accelerate fracture healing by delivering novel therapeutics—and posed a question: Could these microrods be used to deliver antibiotics to a patient during surgery? The current “state-of-the-art” technology for antibiotic delivery is applying crystalline (powdered) antibiotics into the surgical area from a sterile plastic cup. Knowing the ability of the biomaterial to deliver medicine within the body, Dr. Bahney agreed—microrods could be a more effective and precise method for controlled and local delivery of antibiotics to the patient. A chance demonstration of biomaterial technology at a lab bench sparked an investigation that could solve a major clinical problem.

NEW TECHNOLOGY FOR POOR FRACTURE HEALING

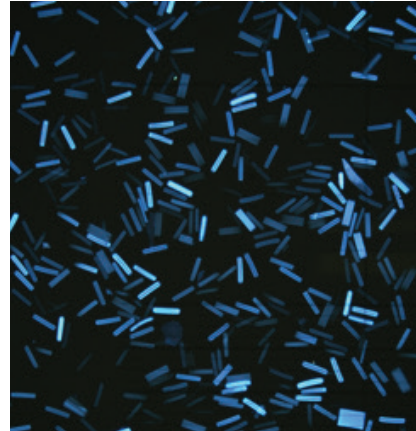
Dr. Provencher and Dr. Bahney are taking their initial research question and using the condition of poor fracture healing to investigate it further. The research study has a three-prong approach: 1) Will the

shape of the microrod be more effective than other biomaterials (commonly a sphere shape) in the human body? 2) Will microrods be an effective point-of-care delivery technology for antibiotics? 3) Can microrods be optimized with a therapeutic to accelerate fracture healing?

This project is also strongly rooted in addressing a critical problem in combat wounds—Dr. Provencher knows that the problem of delayed fracture healing and non-union (failed healing) is even higher in the military where bone injuries are often very large and penetrate the skin, leading to a high risk of infection.



LEFT: A surgeon holds a cup of crystallized vancomycin; applying powder directly into the wound during surgery is the current standard for administering antibiotics in surgery. RIGHT: These microrods represent a new method for antibiotic delivery, which would be a tremendous technological improvement.



With 15 million fractures occurring each year in the United States alone—and 10-20% of fractures resulting in poor healing or non-union in the civilian population, **non-union rates as high as 50% have been reported one year after injury** for open tibial fractures sustained during combat. **Return-to-duty rates of only 22%** are reported for U.S. soldiers with isolated Type III open tibial fractures—**less than half of the return-to-work rate** for similar injuries in the civilian population. On top of that, **infection following open fractures**

is a leading risk factor for non-unions in injuries sustained in combat. Research has shown that for soldiers unable to return to duty, their orthopaedic injuries caused the greatest amount of permanent disability.

INITIAL RESULTS AND NEXT STEPS

Dr. Bahney’s research into the therapeutic optimization of microrods is well underway, and findings from a preclinical trial have demonstrated improved healing in models. This research was presented at a podium presentation at the 2019 Orthopaedic Research Society (ORS) meeting in Austin, Texas.

Alongside Dr. Provencher, CRSM scientists are beginning their investigation into the use of microrods for antibiotic delivery in the laboratory in Vail, Colorado. After these initial studies, scientists will apply the technology in a preclinical trial, and with successful findings, will pursue a clinical trial in human patients.

Alongside these studies, researchers are investigating the microstructural cues of the microrod, comparing

the efficacy of this biomaterial with microsphere technology.

CLINIC AND SCIENCE SYMBIOSIS

This study is a fundamental example of the way SPRI and The Steadman Clinic work together. The close proximity of both organizations allows for effective communication of the current opportunities for improving surgical outcomes through the collaboration of science and medicine, enabling accelerated translation of research into practice.

A Soldier Finds Support at The Steadman Clinic

Eddie Wright, a 43-year-old military veteran, had grown to expect living with pain as his reality. Eddie served in the Marine Corps, during which time he suffered a major loss when a grenade exploded during an attack in Fallujah, Iraq in 2004. Eddie lost both of his hands in combat, and began a lengthy, painful journey to recovery.

“I’ve always been a really positive person,” Eddie explained, “I try to be mindful and work through the pain. I’m not afraid of it. I find that a positive attitude can help me through any situation.” But as his shoulder pain continued to increase over time, Eddie found it challenging to remain positive about the pain he experienced each day. Although his previous experiences with hospitals and surgeries during his recovery left him apprehensive—he feared a failed surgery—he began to consider his options.

“A friend of mine was familiar with The Steadman Clinic,” said Eddie. “His wife had a successful surgery on her shoulder with Dr. Matt Provencher after many failed surgeries at other facilities. They said The Steadman Clinic was the best.”

Eddie learned that the clinic also had a relationship with the Vail Veterans Program, a local non-profit that has supported military veterans and their families through a variety of programs for fifteen years. When Eddie learned of this connection—and he had his friend’s referral to The Steadman Clinic—he knew it was time to reconsider surgery to help his shoulder.

“They took care of everything,” Eddie said, of the Vail Veterans Program. “We stayed at the amazing Sonnenalp Hotel, free of charge. I would have been happy with a Motel 6!” Eddie also reflected on being a patient at The Steadman Clinic. “Everyone was so nice,” he said. “From the front office staff to the team that worked



Veteran Eddie Wright received treatment at The Steadman Clinic

with me while I was there, I was treated like a person, not a problem. You can tell everyone takes pride in their jobs.” Eddie knew that the unique combination of the clinic in Vail and its relationship with the Vail Veterans Program made his experience so unique. “I want to thank Cheryl Jensen, in particular, for founding the Vail Veterans Program. My family is so grateful.”

Eddie wants to encourage other veterans to step out of their comfort zones and look more closely at Vail, where they can be treated by an elite team at The Steadman Clinic—including Dr. Provencher, a Captain who served in the U.S. Navy and continues his duties as a Reservist—and receive the support of the Vail Veterans Program. “A lot of guys are afraid to go in and ask for help, but kicking down the road only hurts you more,” he said, noting that Dr. Provencher worked on him during surgery for twice as long as he anticipated, as the damage was more extensive than

he previously thought. “He didn’t rush me or the procedure. He did it right the first time and did what he needed to do so that I could have the best quality of life moving forward.”

After being treated at The Steadman Clinic, Eddie returned to Texas, where he lives with his wife Alder. He said that his “experience with Dr. Provencher and everyone at The Steadman Clinic has restored my faith in the medical system.”

Eddie is currently retired, but he consults and advocates for the importance of mindfulness to various groups, including young people in detention centers. “I look at my situation as an advantage,” he said. “Because I don’t have my hands, I gain attention, which provides a platform to speak on what’s important in life.” And what’s important in life? “Be present. Be grateful for what you have. You have much more than you realize.”

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