



THE SCIENCE OF PREVENTING INJURIES IN SPORTS

STEADMAN PHILIPPON RESEARCH INSTITUTE SCIENTISTS, RESEARCHERS AND PHYSICIANS COLLABORATE IN WINTER SPORT INJURY PREVENTION EFFORTS

Nestled at the foot of Vail Ski Resort, it's no surprise that there's a natural connection between Steadman Philippon Research Institute (SPRI) and winter sports. Two of The Steadman Clinic's world-class orthopaedic surgeons—Dr. Randy Viola and Dr. Tom Hackett—serve as head physicians for the United States Ski & Snowboard Teams, and physicians and SPRI's clinical fellows work closely with Team USA on and off the hill. While The Steadman Clinic treats many winter sport athletes and recreational skiers and snowboarders, the dedicated researchers at SPRI investigate ways to reduce the pervasiveness of injuries in athletes—someday maybe preventing injuries from ever happening at all.

SPRI'S INJURY PREVENTION EFFORTS: A GLOBAL EFFORT

In partnership with the United States Olympic & Paralympic Committee (USOPC) and the University of Utah, SPRI is a member of the United States Coalition for the Prevention of Illness and Injury in Sport—a joint research venture that is dedicated to injury prevention efforts. In January 2019, this coalition was officially named one of 11 research centers worldwide to be recognized by the International Olympic Committee (IOC) as a member of the IOC Medical Research Network. SPRI and its coalition partners will hold this honor through 2022, collaborating with the 10 other international centers to establish long-term research programs, not only to benefit Team USA, but also to serve athletes from all over the world.

Each spring, SPRI welcomes scientists, researchers, medical providers and surgeons to Vail for the Annual Injury Prevention Symposium. Now in its 4th year, this symposium gathers the best minds in injury prevention research to collaborate on ways to be proactive, rather than reactive, to orthopaedic injuries. As a part of its commitment to injury prevention, SPRI's departments have dedicated programs and projects that engage with local athletes and look at ways to apply their findings to a broader audience. In this edition of *SPRI News*, we'll take a closer look at just a few of SPRI's winter sport injury prevention efforts.

Outcomes Research and Injury Prevention: A Perfect Match

Since its founding in 1988, SPRI has been committed to conducting outcomes research; the Center for Outcomes-Based Orthopaedic Research (COOR) is now tracking over 40,000 patient surgeries, and this information is used to better understand patient outcomes following treatment, and how to use that knowledge to provide personalized, evidence-based medicine to future patients. This department is also on the forefront of injury prevention efforts and has several programs that utilize surveillance and practice regimens to not only better understand orthopaedic injuries—how they develop and why they occur—but also how to reduce their likelihood of happening to youth athletes. Here, we take a closer look at two of COOR’s innovative injury prevention programs that work with local, elite athletes.

Screening Youth Hockey Players to Track a Prevalent Problem

A focus on sports medicine and orthopaedic injuries means that The Steadman Clinic physicians and SPRI researchers see patterns in the athletes they treat and study. Femoroacetabular Impingement (FAI) is a bony abnormality that often occurs in athletes like hockey players. Due to repetitive motions, hockey players often experience bone growth along the femoral head or in the hip’s joint socket, so the bones do not fit together perfectly. Because of this, the bones rub against each other, causing both pain and a limited range of motion for the athlete.

In collaboration with SPRI Co-Chair and The Steadman Clinic’s Managing Partner Dr. Marc J. Philippon, SPRI’s COOR is screening local youth hockey players this season, building off of years of previous screening work—the Institute previously published a paper sharing the data from the screenings of 61 youth ice hockey players. Screenings just began with players from the Vail Mountaineer Club youth hockey program, and it includes rigorous four-phase testing including range of motion (ROM) measurements, impingement tests, strength testing and magnetic resonance imaging (MRI).

The ultimate goal of this youth screening program is to gain insight into the age of onset and etiology of FAI. Currently, FAI cannot be detected until a person becomes symptomatic—SPRI researchers are hoping that in screening young athletes and studying the condition, they will be able to not only detect it sooner and begin to treat it earlier in an athlete’s career, but also be able to prevent it from occurring in future athletes.

SPRI is looking to expand this program further to other winter sports where FAI is common—like skiing, snowboarding and figure skating—as well as sports like wrestling, volleyball, baseball, football and soccer (to name a few). In broadening its recruitment to other sports, SPRI will not only track more young athletes, but will also be tracking different movements, helping to uncover more understanding about the causation of FAI and how it can be prevented in the future.

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PREPPING TO PREVENT INJURIES: THE SLIP PROGRAM

With injury rates in youth alpine skiers high, it was clear to SPRI researchers and Chief Medical Officer Dr. Peter J. Millett that a specific injury prevention program should be employed to help these young athletes reduce their injury risk. In partnership with Ski and Snowboard Club Vail (SSCV), SPRI launched a program that focuses on athlete-related modifiable factors—working to activate sport-specific muscles to provide strength and protection from injury-inducing forces that athletes sustain during training and competition. This program—Snow-sport Lower extremity Injury Prevention program (SLIP for short)—includes implementation of targeted exercises and training protocols across the athlete population. Injury rates will be assessed year over year to determine the efficacy of the program.

Now in its first year of implementation, SLIP is working with 145 alpine athletes. COOR researcher and former Dartmouth College ski team captain Thomas Woolsen traveled to Europe at the beginning of October to pilot the program with a group of adult skiers at an indoor facility. In this piloted program—which will continue this season at the SSCV training facility at Golden Peak in Vail—athletes began with a dynamic warmup, followed by specific exercises to help reactivate lower extremity muscles throughout training sessions and during competition. As trainers work with local athletes at Golden Peak, the program will monitor compliance with the dynamic warmup and compare injury rates season to season, hoping to see a decrease each year. A reduced injury incidence among athletes engaged in the program is the ultimate goal and would correlate to successful training protocols.

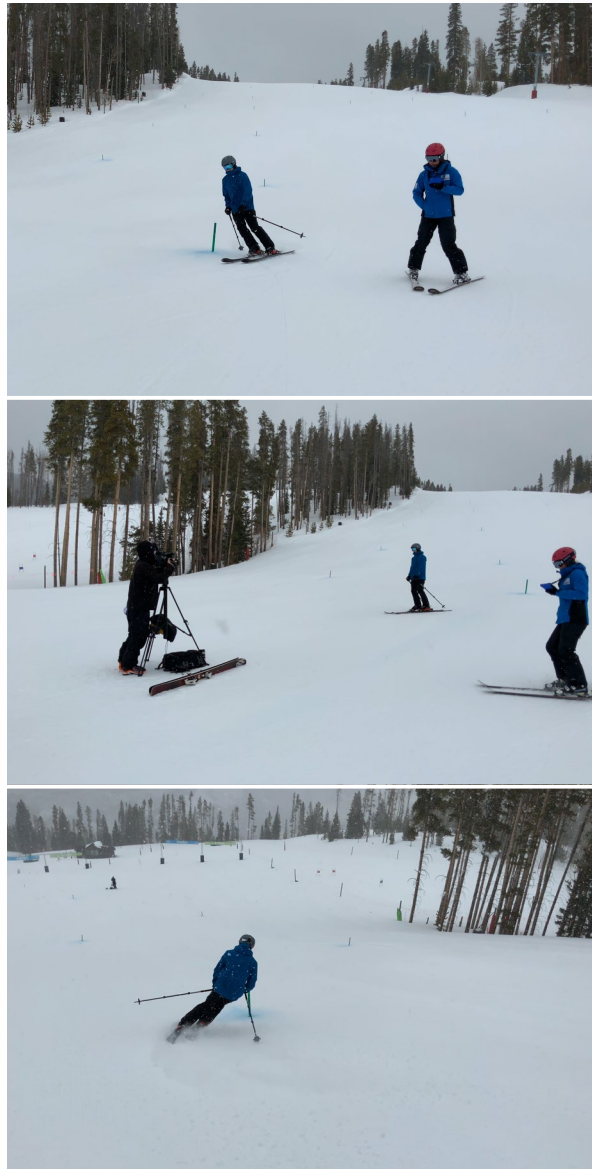
According to Dr. Millett, injury prevention programs like SLIP have the potential to make real impact in the community. “Providing coaches and trainers with the dynamic warmup and exercises is a tremendous resource for them. And with our research team tracking results and recording the data, we’re supporting this program with credible evidence. Beyond that, we’re equipping these elite youth athletes with this program, helping them to prevent injuries now and in their athletic careers beyond Vail. We’re effectively teaching these young athletes how to strengthen their muscles to protect themselves and reduce their injury risk, which will benefit them throughout their skiing careers.”

While the initial work is focused on alpine skiing, COOR researchers are looking to bring this methodology to all snow sports. Woolsen is currently conducting a literature review to compare injury pathology across snow sports. The goal is to understand if SLIP can encompass all disciplines—including alpine, free skiing and snowboarding—or if each sport would need its own unique program.

As SPRI researchers implement SLIP and measure the results, the Institute is hopeful that these protocols will not only help reduce the injury rates in local Vail youth skiers; this program could also help curtail injury in skiers all over the world.



(TOP) A local youth skier signs up for the SLIP program
(BOTTOM) SPRI Clinical Fellow Dr. Adam Johanssen works with a local SSCV athlete at the 2019 athlete physicals



BALANCING ACT:

SPRI's Biomotion Team Investigates Ski Boot Modifications to Reduce ACL Injury

SPRI's biomotion team has just embarked on Phase 3 of its **Effects of Ski Boot Alignment Adjustments on Balance and Biomechanics in Recreational Skiers**—a study that looks at injury prevention in skiing in an entirely new way. According to Biomotion Research Engineer Sarah Wilson, “traditional skiing injury prevention research has focused on ski binding release. When somebody is in a fall situation, how do we get their ski to fall off at the right time? And we thought that it was looking at it a step too late.” Sarah went on to explain that while releasing the ski might reduce the chances of sustaining an ACL injury, it doesn't prevent them from other potential injuries from the fall. “There could be concussion, fracture, all of these other things that can happen in a fall situation that aren't ACL injury. So we wanted to look at this a step earlier—how do we prevent falls?”

To engage with this research question, the biomotion team investigated the effect of boot modifications on biomechanical balance—first in the SPRI Biomotion Lab (Phase 1) and then on Vail Ski Mountain (Phase 2). The team wrote two papers entitled “The Effect of Canting on Knee Movements in Recreational Alpine Skiers” and “Effects of Common Ski Boot Adjustments on Balance in Recreational Alpine Skiers,” which explained the initial results from the studies, demonstrating that simple modifications like heel lifts and lateral canting can significantly improve balance and knee positioning. Wilson presented the papers at the International Society of Skiing Safety (ISSS) meeting at Squaw Valley in April 2019.

Continuing this multi-phase study, the team has begun initial piloting for Phase 3. For the next part of the study, the team will test 30-50 intermediate to advanced skiers on the mountain using wearable sensors. The goal in this testing phase is to collect more data on how these ski boot modifications help correct misalignment—or, improve balance—for skiers when they are in motion. From there, the team will be able to quantify alignment so that individuals can fine tune their equipment.

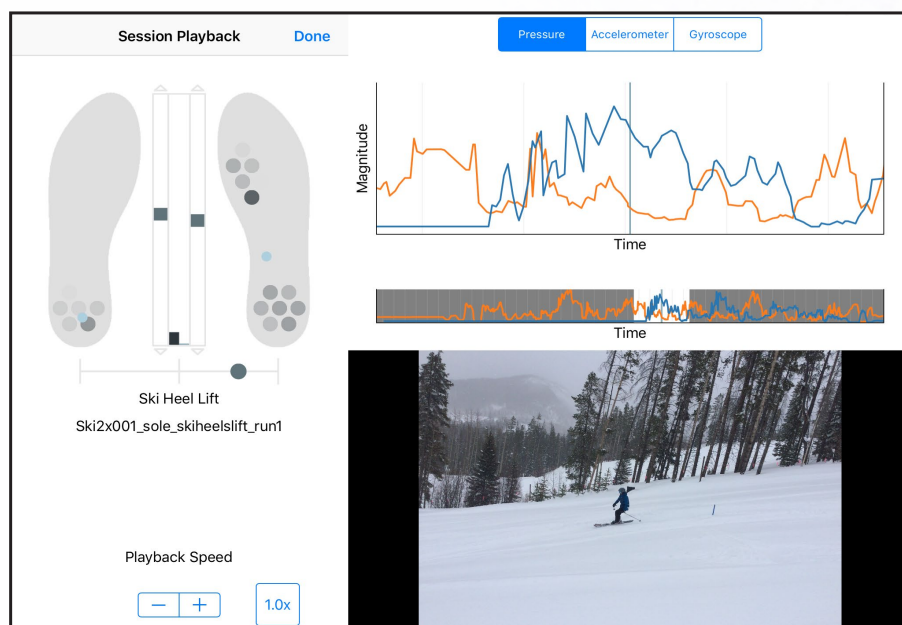
Wilson explained: “For so long, ski boots and footwear in general have been an out-of-the-box, not quite one-size-fits-all situation—you walk into the boot shop with your foot length, width and flex number and they pull boots that match that criteria. Those are personalized numbers—and if we can put a number on alignment and be able to customize that experience, a lot in the way you can customize running shoes, we'd want to do something like that. In adding this additional fit parameter, you can figure out what your body likes and then be able to apply that to your equipment. And what you like doesn't just mean comfort; it's in terms of actual injury prevention, what puts you in the most functional position to move and react dynamically.”

In looking at skiing through this new lens, the Biomotion team has begun to shift the focus on injury prevention from preventing an injury after the skier has already fallen to preventing the fall from happening in the first place. In changing the way skiers equip themselves to have better control on the hill—thus preventing balance-related falls from occurring—the team has the opportunity to truly and positively impact skiing safety.

The biomotion team has begun planning Phase 4 of this study.

AT TOP THE BIOMOTION TEAM SETS UP THE COURSE FOR ON-MOUNTAIN TESTING (PHASE 2).

AT BOTTOM, AN EXAMPLE OF RESULTS FROM A HEEL LIFT MODIFICATION.





Sarah Wilson in competition in Chile, 2012



Sarah Wilson

MEETING AT THE INTERSECTION OF SCIENCE AND SKIING

Research Engineer Sarah Wilson Finds her Niche at SPRI

When Sarah Wilson graduated from college with a math major and minors in physics and computer science, she knew she liked math and science, but, as she put frankly, “I really had no idea what I wanted to do with my life.”

In reflecting on her interests, Sarah realized, “the one thing that I always loved was skiing.” In college, she competed in big mountain freeride extreme skiing competitions. And while she found tremendous joy in her sport, Sarah realized that potential injuries were clouding her experience.



Sarah Wilson works with a research subject in the SPRI Biomotion Lab

“THERE’S A BIG DIFFERENCE BETWEEN BEING ABLE TO *PERFORM* AT A HIGH LEVEL AND BEING ABLE TO *UNDERSTAND WHAT IT TAKES TO PERFORM* AT A HIGH LEVEL.”

“I watched all of my friends get hurt. I started to develop knee pain and simultaneously my coaches were giving me movement advice that just didn’t make any sense for my body.” That’s when the scientist in Sarah emerged: “The nerdy side of me was wondering, how is this affecting the loads on my joints? What is actually happening when I try to move that way and my body doesn’t want to? Why does my knee hurt when I do this particular movement?” This line of thinking helped Sarah understand that it was time for her to get out of the competition world and go back to grad school to study biomechanical engineering.

Shortly after graduating from the Colorado School of Mines, Sarah joined SPRI as a research engineer, a unique opportunity that diverged from her expected path of staying in academia or going into device design. “When this opportunity turned up at SPRI, I was like, oh, I can go live in Vail or I can go do device design in a big city in the Midwest? For a former ski bum, there was no question!”

A few months into her tenure at SPRI, the question of ski equipment modification (see previous story) was posed to the biomotion team. As a former competitive skier and PSIA Level 3 Certified ski instructor, Sarah was uniquely poised to tackle this research question in a way that another biomechanical engineer might not pursue it. “Teaching skiing at the highest level gave me a really solid technical understanding of the sport. There’s a big difference between being able to perform at a high level and being able to understand what it takes to perform at a high level.” She continued: “There’s a reason that Olympians still have coaches, and it’s because they need someone who can look at their movement and make sense of the biomechanics and how to make that movement more efficient.” This combination of technical and biomechanical expertise helped Sarah spearhead this impactful research study.

In addition to her research work at SPRI, Sarah serves as an Ambassador for the If/Then Initiative*, an opportunity that fortuitously emerged when a SPRI benefactor toured the Biomotion Lab at SPRI. If/Then is an initiative focused on empowering women in science, technology, engineering and math (STEM) and inspiring young girls to pursue their passion in STEM. As an Ambassador, Sarah is one of over 100 current women STEM innovators selected to share her story and serve as a role model for young girls.

As Sarah explained, “Science is so often portrayed as really nerdy and masculine, like you have to be the only girl on the team, the token female or a tomboy. The goal of If/Then is to show that no matter what you’re interested in, there is a science field behind it.” The initiative’s tagline is a powerful one: “*IF* you support a woman in STEM, *THEN* she can change the world.” Sarah shared her personal tagline: “If you support a woman in Biomechanics, then she can bring out the athlete in all of us.”

As Sarah explained, “With anything, there’s data behind it that’s just itching to be examined. No matter where you look in the world, whatever excites you, there’s science behind it.”

From big mountain freeride skier to research engineer, Sarah has found a way to unite skiing and science in the Biomotion lab, just steps away from Vail Ski Resort.

*If/Then is an initiative of Lyda Hill Philanthropies.



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