Building Better Implants

How a researcher at the University of Pennsylvania works with surgeons to help improve patient care.

When bones snap, or our bodies break down, doctors and surgeons can usually be relied on to fix them. With screws, implants, stitches, and a bit of healing, patients can make a full recovery.

Surgery has advanced over the years, becoming less invasive and more accessible with each new insight. These advances happen in labs like Biedermann Lab at the University of Pennsylvania in Philadelphia. There, a team of researchers led by Dr. Michael Hast put a magnifying glass to the practices of orthopedic surgery, working directly with doctors to help them provide better care and quality of life for their patients.

Dr. Hast is passionate about the change that he helps create that results in better quality care for patients in the operating room. “That’s what get’s me going, I get a kick out of talking to surgeons about how they’re treating patients and if I’m impacting that in any way that’s positive it’s pretty cool to see.”

Before anything can happen in the operating room, however, Hast spends his time working in the lab with surgeons from the Hospital of the University of Pennsylvania where they stress test common practices and find ways to improve.

The entrance to Dr. Hast’s lab—named Biedermann Lab after the family that provided its initial funding—is an unassuming brown door at the end of a narrow hallway with a black wall-mounted telephone hanging next to it, serving as a doorbell.

After the phone rings for a moment the door opens and a man stands in the doorway, moving his hand in a gesture of invitation.

This is Dr. Michael Hast. He has an easygoing smile and a relaxed attitude as he steps back from the threshold, leaving the door open. The room through the doorway is a small reception area with dark wood paneled floors, plain black furniture, and crisp white walls. He is the only one here this morning, as he mentions later, “we’re in more of a paper writing phase in our research cycle,” so lab work is less urgent.

When prompted about the working relationship between the Biedermann family and the lab that bears their name, Dr. Hast explains that their involvement for the most part is the gift of funding that built the lab in the first place. “We are more than happy to continue to work with them closely but the understanding is that we can technically do anything we want with that money.”

Dr. Hast walks past a door leading off the main hallway where a row of gray cubicles, empty at this time of the day, show off the work stations of the rest of the lab’s team. “We opened our doors with the idea that it would be this open source kind of lab. Theoretically anyone can come and collaborate with us.

“We wanted to have some kind of vetting—almost like Shark Tank but with less money and way nerdier.” To screen for these potential projects Dr. Hast works with a steering committee, which includes a representative from the Biedermann family, to decide which projects they want to pursue.

“Initially when we had less business,” Dr. Hast goes on, “we accepted a wider range of topics but now we’ve gotten to the point where we can be a little more selective and work in a cohesive theme.” As it stands now, Dr. Hast and his team work exclusively in the field of orthopedics research.

Dr. Hast saw Biedermann Lab and orthopedics research in general fall into his lap in a series of coincidences. “Dumb luck is an amazing thing,” he laughs.

Dr. Hast graduated with a degree in Mechanical Engineering from Penn State in 2004, without a concrete idea of what would be next. He found a job at Stryker Orthopaedics in Hoboken New Jersey, because he happened to be living there at the time, and began his journey into the world of orthopedics by helping to design implants that treat skeletal injuries.

After a year working in the private sector, Dr. Hast returned to Penn State to get his PhD in Mechanical Engineering, and six years later found himself accepting a job as the lab manager for Dr. Louis Soslowsky at the University of Pennsylvania. “Dr. Soslowsky is a world renowned researcher in Orthopedics, and he became a mentor for me,” says Dr. Hast. “I was a little more on the experienced end since I had a PhD, so I could do more than a typical lab manager.”

As dumb luck would have it, Dr. Hast found himself at Penn when the funding for Biedermann Lab came in. “I had some experience in construction management as a mechanical engineer, and when [Biedermann Lab] was getting started it was being built from the ground up. It was literally just a concrete slab. So Louis said [he thought I could] help design this lab. I was able to help with the blueprints, and what kind of equipment we would need.” When the job posting as the director of the newly constructed lab went up, Dr. Hast says, grinning, “I would say that I maybe had a hand up on the competition as far as the application pool was concerned.” Hast had designed the space, after all.

Past the neat and ordered offices, a set of metal double doors lead into the research area where all the lab work happens.

The room closest to the entrance is cluttered with power tools and bits of fake plastic bone. Dr. Hast calls out to “watch the cameras, they’re delicate,” as he passes through a forest of motion-capture equipment all pointed at a large machine with a heavy metal bar pointing towards the floor that operates like a giant hammer, adding weight to samples placed underneath.

Dr. Hast explains it is used to test the breaking point of bone samples, both real and plaster, under different conditions and fitted with various implants. The cameras are set up so that Dr. Hast and his team can understand how an implant and the bone around it might break through injury to a patient.

Another set of metal doors separates the main testing area from the more surgically clean implant and dissection prep rooms. When working on a project, these rooms see heavy use in a rapid period of testing and research. “We buy cadaveric specimens, all the implants that we need, we schedule surgeons to come in and do mock surgeries and they break all the ‘stuff’ basically,” Dr. Hast says. By cadaveric specimens and stuff, he means dead bodies and their bones, though he is quick to clarify.

No full bodies—the lab normally uses donor arms and legs in their work. For the moment, the space is severed-limb-free. However, when work does happen in the cadaver area, the team prefers to use pairs of donor limbs to control for different procedures in testing.

Surgeons drafted from the University Hospital break these samples to simulate injuries, and then mend them with different surgical implants so that Dr. Hast’s team can test for the difference between multiple surgical options.

The work that Dr. Hast and his team recently finished culminated in a paper published in the Journal of Orthopedic Trauma exploring two different methods of healing something called a lisfranc fracture.

The injury doesn’t involve any broken bones; it is a tear in a part of the foot called the lisfranc ligament. When this tear happens, bones in the foot fall out of place. The traditional way of treating such an injury is to put a screw through those bones to force them into position while the ligament heals.

The paper that Dr. Hast put out explored the difference between using two types of screws, fully threaded solid cortical (FSC) and partially threaded cannulated cancellous (PCC) bone screws, to see if there would be any real difference from the point of view of a patient.

Though they have complicated names, Dr. Hast says that the main difference is that PCC screws are hollow and FSC screws are solid.

The advantage to a hollow screw is that it can be guided along a wire to ensure that the doctor performing the surgery can get the angle right the first time, “because if you get the angle wrong you’ve just put a very large hole in a very small bone, and it won’t grow back.”

More experienced surgeons don’t usually need the assistance, but for those who only see a lisfranc fracture on rare occasions, hollow screws can mean the difference between performing the surgery themselves or forcing the patient to relocate to another hospital.

The project started through a collaboration with a surgeon at the University Hospital. “This senior surgeon asked this younger guy who started this study, ‘how do you fix a Lisfranc Fracture?’ and he said you used the hollow threaded screws. The senior surgeon said there was no way that would hold.

“So spite would be a strong word for starting a research program but it was almost out of spite.” Dr. Hast laughs, “He was convinced that there was no real difference between the screws.”

In the end, Dr. Hast's team found that no strength was sacrificed when using the hollow PCC bone screws, so he imagines that "that guy is definitely using those hollow screws now. He's doing it with comfort in the OR."

This is the kind of impact that Dr. Hast likes to see. The thing that excites him the most, he says, is running into surgeons at conferences where they question him about his work. "They want to know more," he says, "if they're skeptical about it they'll want to talk to us."

Though Dr. Hast never enters the operating room himself, he knows that the lab work he does has the potential to make surgery less invasive and ultimately more effective for those who need it.