AMAZING RECOVERIES.

Dr. Ralf Schneider of the High Performance Computing Center Stuttgart is improving bone fracture treatment and shortening recovery time.

You never want your doctor taking guesses with your health. But when it comes to treating bone fractures with implants, guesswork is part of the process.

"You have two patients where everything is exactly the same and one implant will fail and the other won't," says Ralf Schneider from the High Performance Computing Center Stuttgart (HLRS). "Why?"

Dr. Schneider is working to answer this very question — and put some certainty into a very uncertain science.

Bone implants are a common method for treating fractures of the hip, in particular. They allow patients to maintain mobility and avoid the severe complications that can come from bed rest. While an ideal solution, hip fracture implants are plagued by a consistent failure rate.

Doctors select an implant for their patients from among several types. And thus far, there hasn't been much science behind that choice.

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They choose "based on their experience in the moment," says Schneider, and then wait to see if it will hold or be among those that fail.

The implant process is unpredictable because bone composition varies from person to person.

Thus, bones react to "loading" — the process by which they "remodel" or heal themselves — differently. That variance is the reason an implant might work for one person but not another.

Schneider knew if doctors could predict how specific patients' bone would remodel, they could better select and position an implant. To do that, they need to see the bone's microstructure and determine its stiffness.

Along with his research colleagues, Schneider is using HLRS's Cray supercomputer to conduct micromechanical simulations of bone tissue. "You have to calculate the local strain within the bone in the correct way," says Schneider. "If you don't have the right elasticity, you'll formulate the strain incorrectly, which will lead to an incorrect estimation of bone remodeling" and an incorrect calculation of the risk of implant failure.

Getting the correct calculations starts with correct material data — meaning bone tissue. It's impractical to get a sample from every patient, so Schneider's goal is to conduct bone tissue simulations for a range of ages and genders and compile a representative database.

"You'll get an idea of what bone elasticities for people in particular ranges look like," he says. "So when you have a patient with no bone tissue sample you can compare his bone density with the samples you already have and you can say, 'Okay, he's most likely to have this stiffness so I'll use this stiffness parameter, then I can calculate the strains and bone remodeling correctly.'"

Schneider calls the planned database a "decision support system." And while these micromechanical simulations aren't large, resolving each tissue sample will require 120,000 individual simulations. Schneider says: "I want to help surgeons with this wonderful simulation, and I couldn't do it without supercomputing. On a workstation I would be calculating for years. With HPC I do it in a day. It's a perfect tool for it."

HIGH PERFORMANCE COMPUTING CENTER STUTTGART

The High Performance Computing Center Stuttgart (HLRS) supports researchers from science and industry with high-performance computing platforms, technologies and services. Their Cray® XC™ system "Hazel Hen" is the fastest supercomputer in the European Union and one of the most powerful in the world.

SYSTEM DETAILS

- Cray® XC™ supercomputer
- 7.42 PF peak performance
- 41 cabinets
- 7,712 compute nodes
- 185,088 compute cores
- 964 TB memory