How to help heal an injured joint

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Knee patients need patience: injuries to these joints take weeks to heal. Fraunhofer researchers have now developed a system that documents the healing process in detail. This motivates patients and at the same time helps doctors to fine-tune the course of treatment.

There's nothing like the sheer delight of sun and snow on a skiing trip. But a momentary lapse of concentration can have nasty consequences. Taking a tumble on the slopes often causes injuries – most commonly to the knee. Weeks can go by before knees regain their full function, and patients are obliged to re-learn how to walk. The time it takes for the knee to heal is directly related to how well it reacts to the chosen treatment. But how is an orthopedic doctor to evaluate the healing process? And how are patients to know what progress they are making? Currently, doctors can only perform limited function tests, whilst patients are obliged to rely on their own subjective feelings.

Now researchers from the Fraunhofer Institute for Manufacturing Engineering and Automation IPA in Stuttgart have developed a system for gathering exact data on knee mobility. It shows patients as well as medical staff how the joint is doing. "It not only lets sufferers see how their healing process is coming along; it also means doctors can tell straight away whether they need to adapt the treatment," says Dipl.-Ing. Bernhard Kleiner of Fraunhofer IPA. "This can give patients a psychological boost." They might not feel they are getting any better, but the system highlights every little improvement in knee mobility. "And that's very motivating," says Kleiner.

This is how the novel approach for monitoring the treatment works: Special sensors are placed in a kind of bracket that is integrated into the bandage. These register the knee's range of movement over a period of time to determine exactly how patients are moving their knee. A new piece of software evaluates these data and presents them in an easy-to-understand format. It sounds pretty simple but it was a tough challenge for the engineers, because such angular measurement systems have only ever been used in industry up to now. The central question was how to place the sensors onto the human body without inconveniencing the patient. The answer, researchers found, lay in using lightweight materials and miniaturizing the sensors, which fall into two categories: angular measurement systems that are based on magnetic principles; and acceleration and rate-of-rotation sensors.

Depending on the injury and treatment, the system not only records the joint's range of movement but can also determine to what degree it rotates and what forces are acting upon it. The sensors observe movements and store data non-stop. This allows doctors to observe how the knee's range of movement changes over time, so they can recognize trends and, where necessary, adjust the treatment. What is more, the various fittings for the sensor systems have been designed by the researchers not to restrict freedom of movement in any way, meaning patients do not even notice that their joint is being monitored.

"We would like to apply the measurement of human kinematics to other parts of the body in future," says Kleiner, and the Fraunhofer researchers have already set their sights on the shoulder and the hips. However, these joints are even more demanding because the system will have to measure their movement about all three axes. To achieve this, engineers are coupling 3-D sensor systems with appropriate software. Visitors to the MEDTEC Europe trade show (March 22-24, 2011, Hall 6, Booth 6211) will have a chance to see the experts demonstrating how mobile joint monitoring works.

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