

RESEARCH NEWS

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Risk of infection with implants

Fraunhofer IFAM develops twofold infection protection for implants

A hybrid implant coating made from antibacterial silver and an antibiotic will protect patients from infection in the future. The antibiotic is tailored to the patient's unique requirements for even better protection. The AntiSelectInfekt project came about in collaboration with a research team from Charité-Universitätsmedizin Berlin.

Anyone who now receives an artificial knee, shoulder or hip joint at the hospital can expect the best-possible treatment and cutting-edge medicine. But implantation is not without its risks. On average, 1 to 2 percent of all patients will develop an infection following the operation. If the level of discomfort is so severe that another surgery is necessary, an infection can be expected in up to 4 percent of all cases ¹. Even if the individual risk is in the lower percentage range, it affects many patients due to the frequency of the surgery. In view of demographic developments, the number of prosthesis operations will also increase steadily.

If the antibiotics administered do not help, it could be a long and painful process. And if worst comes to worst, the implant will have to be replaced.

This new approach promises to significantly reduce the risk of infection. A hybrid coating consisting of antibacterial silver and an antibiotic that is tailored to the patient's requirements or more precise to the bacteria is applied to the implant. The idea was developed four years ago at the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM in Bremen. Kai Borcharding, Head of Medical Technology and Life Sciences at Fraunhofer IFAM, says: "Surface treatment is one of the areas our institute specializes in. Applying this expertise to medicine was a natural choice."

Joint project with Charité

Fraunhofer researchers further developed, tested and implemented this idea through the AntiSelectInfekt project in collaboration with researchers of the Julius Wolff Institute and the BIH Center for Regenerative Therapies (BCRT) of Charité in Berlin. The results are promising. "The preclinical studies have demonstrated that the hybrid implant coating effectively reduces the rate of infection," explains Prof. Britt Wildemann, who is in charge of the studies on effectiveness and biocompatibility in Berlin and is now Head of Experimental Trauma Surgery at Jena University Hospital.

Editorial Notes

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The idea of coating implants is not necessarily new. The ability of silver and antibiotics to combat infections associated with implants has long been studied. What is new, however, is the approach of combining the two and thus vastly improving active protection against bacteria. But the benefits do not end there. Researchers have developed a process that allows them to use an antibiotic tailored to the patient's requirements. The special coating technology developed by Fraunhofer IFAM also regulates release of the antimicrobial substances: while the antibiotic is released in full once the implant is in place, the silver particles take effect gradually close to the surface over a longer period of time, thus providing lasting protection that continues into the healing phase.

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Made in Bremen: coating technology with laser

The coating process is based on tried-and-true technologies further developed specifically for the project. "The first step is to apply a structure to the surface of the titanium implant using a laser. This creates a porous layer," explains Borcherdig. Tiny pores that are mere micrometers in size and invisible to the naked eye appear on the titanium surface. These pores are amphora-shaped, meaning they are narrower above and wider below. In the second step, researchers use the process of physical vapor deposition to apply a layer containing silver particles.

These amphora-shaped pores can be filled during the surgery. Just before implantation, the surgeon immerses the sterile implant with silver coating in a solution containing the antibiotic. "We have seen in preclinical studies that the entire process is very simple and only takes a few minutes," says Prof. Wildemann. Once the implant has been implanted, whether it is a hip, knee or shoulder joint, the antibiotic begins releasing into the surrounding tissue, promptly killing off any bacteria that could cause an infection. The effect of the silver coating is delayed and lasts much longer. The silver ions remain active for several weeks and offer protection from infection during the healing phase.

Numerous lab tests

This success would not have been possible without numerous experiments along the way. Biocompatibility and osseointegration, which refers to the anchoring of an implant through the formation of new bone, were studied both in lab tests with human bone cells and in the animal model. "One of the challenges during the development phase was ensuring the concentration of antibiotic was high enough to kill bacteria, but not so high that it would damage the growing bone cells," explains Borcherdig.

In this context, Fraunhofer IFAM expert Borcherdig refers to another benefit. The pores applied to the titanium surface with the laser treatment ensure better bone adherence, as Prof. Wildemann confirms: "Our study has shown that surface modification increases bone contact: 89 percent contact with implants featuring the hybrid coating, compared to just 52 percent bone contact in the control group. We were also able to prove that cells grow into the amphora-shaped pores and thus anchor the implant much more effectively."

The project has already met with great interest among implant manufacturers and providers of coating services, particularly because no new implants need to be developed for the process. Even products that are already available can be coated. Discussions with manufacturers are being intensified in the final stage of the project to ensure the technology can be used for patients in the near future.

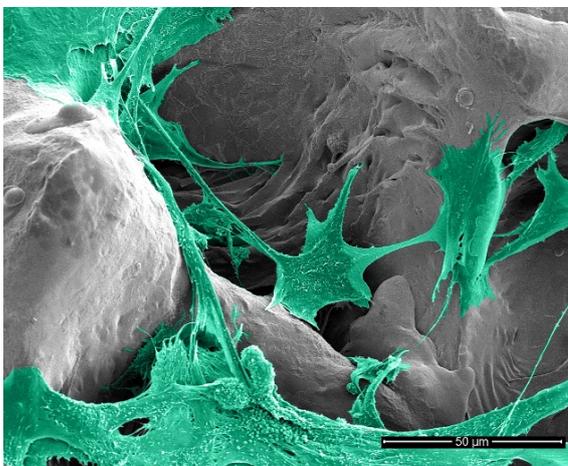
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¹ Izakovicova P., et al. 2019, DOI: 10.1302/2058-5241.4.180092



Picture 1: Hip stem demonstrator with hybrid coating along the shaft.

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Picture 2: Electron microscope image of osteoblast-like cells (MG-63) on the hybrid coating.

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