3D PRINTING

REVOLUTION IN ORTHOPAEDICS

Implants, like clothes, are produced in only a few sizes and usually correspond to the most common shapes. It is our body, i.e. the broken bone or damaged joint, that, with the help of surgeons, has to 'adapt' to them. Personalised implants made with the use of 3D printing are an enticing alternative. They are created as a result of close cooperation between doctors, engineers, technicians, and physicists. The process allows the bone structure and joint geometry to be perfectly reproduced. Although today such solutions are primarily used for young patients and people with severe bone deformities, in the near future they could become a hospital standard.

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‘As recently as two hundred years ago, a broken bone in an upper or lower limb meant, if not death, then certainly amputation of the damaged limb. As far as we are aware, the first fracture fixations were performed around one hundred and twenty years ago. At that time, they were made using wood, metal, or bone’, says Ryszard Tomaszewski, PhD, DSc, Associate Professor at the University of Silesia, Head of the Department of Paediatric Orthopaedics and Traumatology of the Medical University of Silesia and an employee of the Faculty of Science and Technology of the University of Silesia in Katowice, who treats patients with personalised implants.

According to the scientist, there has been enourmus progress in the field of medicine.

On the one hand, the materials have changed. Wood and bones were replaced by metal and then by biodegradable materials. Then they also became bioactive, i.e. they could carry, for example, pharmaceutical substances to speed up tissue regeneration after surgery. Nowadays, there are already rumours about the fourth generation of such materials, which are supposed to be biomimetic and simulate human bones.

On the other hand, progress has been made in the techniques used as well. In traditional implants, the surgeon orders a finished piece and then cuts the patient’s bone during surgery to fit the shape of the implant.

The use of 3D printing and cooperation with engineers, technicians, and physicists allows for the implant to be adjusted for the particular body.

‘Currently, the most common solutions are joint endoprostheses, spinal implants, and materials used in traumatology for internal fracture fixation’, says the orthopaedic surgeon.

To prepare such an implant, first a CT scan of the damaged bone is taken, while in the case of a soft tissue tumour an MRI scan is also taken. Then, the image is converted to a format that allows for the final step, which is the printing of bone and implant models.

‘We present these to patients in preparation for surgery. This is an important step allowing patients to understand the next steps we need to take and so that they know what the benefits of this modern method are’, says Ryszard Tomaszewski.

The printing of surgical trials and implants makes it possible, first and foremost, to reduce the duration of surgery and the number of intra- and postoperative complications.

Currently, those implants are produced from natural and synthetic polymers, ceramics, metal (mainly titanium in this case), and composites of two or more materials. They are biodegradable and bioactive, can be sterilised, should not cause inflammation, and must have strictly defined mechanical properties. Is it a perfect method? Not yet. Scientists and doctors are still facing several challenges.

As Ryszard Tomaszewski explains, mainly one type of tissue is printed. Meanwhile, the human body is a complex system of many different tissues working together. Another problem is the lack of implant growth, which is particularly troublesome in young patients.

‘Today, special motors are used in implants to imitate tissue growth. However, I hope that in the near future, such technological solutions will be used as to make the implant grow with the patient’, says the orthopaedist.

Another issue is the toxicity of certain metal ions, which can be released, for example, when the implant reacts with tissue and cause metallosis.

The cost of such a treatment is also worth mentioning. As with clothing, tailor-made implants are simply more expensive because they require more specialists to be involved in the process and more investment to be spent on research to develop the materials used. However, from a healthcare perspective, it is a good investment. We are facing the consequences of an ageing population. More and more people are struggling with bone-related cancers, osteoporosis, and age-related bone and joint damage. Modern implants not only translate into improved patient well-being and comfort but also fewer post-operative complications and associated costs.

‘We have no complexes. We have been working with engineers in preparing precisely such implants for our patients for a long time. I am convinced that over time they will become cheaper and thus more accessible to everyone for whom they simply translate into a better quality of life’, concludes Ryszard Tomaszewski.

Małgorzata Kłoskowicz, PhD

Ryszard Tomaszewski, PhD, DSc, Associate Professor
Institute of Biomedical Engineering
Faculty of Science and Technology, University of Silesia
Department of Orthopedics and Traumatology, Medical University of Silesia
ryszard.tomaszewski@us.edu.pl