Doctors implant first customised 3-D printed mandible

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Belgian researchers have developed and produced the first patient-specific, 3-D printed titanium implant. For the first time in the history of implantology, a customised implant has replaced a complete mandible. It restored form, function and aesthetic aspects of a natural mandible in a significantly shorter period compared with classical treatments.

The Functional Morphology research group at the University of Hasselt’s BIOMED research institute recently presented the first customised 3-D printed mandible, which was implanted in a patient in June 2011. The procedure was conducted on an 83-year-old woman who suffered from serious osteomyelitis, which had affected almost the entire mandible.

Given the severe and rapidly progressive infection in this senior patient’s lower jaw-bone, treatment options were rather limited. The classical treatment, namely removing the damaged bone, would have resulted in a small mandible without any support and function. Researchers faced the challenge of restoring vital functions, such as breathing, speech, chewing and sensation. The decision to reconstruct the entire mandible with a customised 3-D printed implant was made to spare the senior patient a long surgery and shorten the subsequent stay in hospital. It was the first time that a complete mandible was replaced.

"The introduction of printed implants can be compared to man’s first venture on the moon: a cautious but firm step," said Prof Jules Poukens of BIOMED.

The artificial jaw weighs approximately 107 grams, which is almost as heavy as a natural mandible. The implant is designed to allow the direct insertion of dental bars or bridge implants at a later stage and therefore provides the perfect foundation for dental restoration. Owing to perfect fit, the surgery was completed in four hours, which is only a quarter of the time needed with the classical method. This spared the patient additional adjustment surgeries and speeded up recovery. According to Poukens, the patient regained normal function with adequate speech, swallowing and unrestricted movement within one day after surgery.

Planned and designed by doctors and engineers from various institutions in Belgium and the Netherlands, the implant was produced by LayerWise, a company experienced in metal Additive Manufacturing (AM) technology, which is a specific form of 3-D printing used to create implants layer by layer. A high-precision laser selectively heats metal powder particles to quickly melt and attach them to the previous layer. The titanium model was coated with bioceramic afterwards. AM is used to print functional implant shapes that would otherwise require multiple metal working steps or that cannot be produced any other way.

Metal AM is generally gaining importance in medical implantology. The technique is increasingly being adopted in dentistry and in other medical fields. Many companies already use printers able to build 3-D models for the production of prototypes of new products because they allow the most complex geometries to be produced.

Researchers agree that 3-D implants are an excellent addition to current treatment options. "As illustrated by the lower jaw reconstruction, patient-specific implants can potentially be applied on a much wider scale than transplantation of human bone structures and soft tissue," said Dr Peter Mercelis, Managing Director of LayerWise.

The revolutionary jaw implant was granted the 2012 AM Award by the Additive Manufacturing Network in Belgium.