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Abstract

A patient-matched additively manufactured implant for treatment of thumb amputations: biomechanical analysis and cadaver study

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Thumb amputations accounts for 60 % loss in hand functionality [1]. Passive silicone vacuum prosthesis and autologous transplantation are the most adopted solutions: however, silicone prostheses lack in stability and surgical treatment is not always well accepted by patients. Osseointegrated prostheses were demonstrated to improve stability restore osseoperception, and increase the time of prosthesis use [2]. As thumb amputations may differ in stump size, a standard size implant cannot address the specificity of each patient, while a patient matched solution can meet surgeon requirements by adapting the geometrical features of implant.

In the current work a first additively manufactured patient-matched osseointegrated implant for the treatment of thumb amputees is presented. The implant is realized in Ti6Al4V ELI medical grade powder by using Laser Powder Bed Fusion (LPBF) technology.

A finite element model (FEM) for the analysis of the mechanical strength of the implant was carried out. The FEM was validated by means of experimental tests according ASTM F543. Finally, considerations on performance of the prototype were carried out by means of insertion tests in Sawbones and axial pull-out force assessment. Once the design was confirmed, a cadaver test was performed to evaluate the entire procedure. CT images were collected, a preoperative planning was designed in accordance with surgeons and the proper patient-matched implant was realized in LPBF technology. The cadaver test positively assessed the entire process and confirmed a good overlapping between preoperative planning of the device and postoperative results.

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