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Abstract

3D-printed force sensor adapter for liposuction cannulas: Design, fabrication and in-situ validation

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In aesthetic surgery, shape-altering procedures are increasingly being performed on the human body at the request of patients or out of medical necessity to improve their well-being. Liposuction is the most frequently performed aesthetic procedure [1]. The process and the medical devices required for it are constantly being further developed. Additive manufacturing (AM) technologies, sensors and data are playing an increasingly important role in this [2].

The increasing integration of sensors in medical devices means that these devices, as well as the process and the user themselves, can be partially mapped using data [3]. This data can be statistical, process-related, patient-related and surgical data. By analysing this data, it is possible to gain insights for optimisation, e.g. whether the devices are working optimally or the user is working correctly or not. For instance, 3D-printed adapters can be utilised to expeditiously and efficiently integrate sensors into handles or suction cannulas to directly measure tensile and compressive forces during liposuction. Data analyses can then provide information on the correct execution of liposuction or the condition of human fat tissue, for example. Additive manufacturing of the corresponding adapter designs can be carried out using various AM processes such as material extrusion (MEX), material jetting (MJT) or VAT photopolymerization (VAT). Prototypes can be produced, tested and optimised in a matter of hours. This dramatically reduces development cycles and costs.

In our investigations, we designed, printed and evaluated different AM designs for the integration of a pressure sensor into a liposuction cannula for abdominal liposuction. Using a combination of MEX and MJT, a modular adapter was developed that enables the seamless integration of a force sensor into the cannula and maintains functionality under negative pressure of -0.5 bar. Various 3D-printed prototypes were iteratively tested in a short period of time. The development of the final prototype medical device solution was thus reduced from several weeks to just a few days. The optimised sensor-supported cannula, incorporating 3D-printed components, was successfully tested in real liposuction trials and rapidly transitioned to a production-ready version. Forces between 0.5 and 18 N were recorded using this solution. The 3D-printed design can be further optimised and ergonomically adapted to the specific needs of the user.

AUTHOR'S STATEMENT

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