Transactions on Additive Manufacturing Meets Medicine
Trans. AMMM, 2025, Vol. 7, No 1, Suppl. 1, Article ID 2079, 1 Page

Abstract

Construction of a test rig to quantify the cutting characteristics of additively manufactured phantom samples

L. Peuckert[1,2*], F. Seidensticker[1,2], T. M. Buzug[1,2] and Th. Friedrich[2]

[1] *Institute of Medical Engineering, University of Lübeck, Lübeck, Germany*
[2] *Fraunhofer Research Institution for Individualized and Cell-Based Medical Engineering IMTE, Lübeck, Germany*
[*] *Corresponding author, email: lea.peuckert@imte.fraunhofer.de*

In the field of additive manufacturing, there are currently numerous innovative projects for creating organ phantoms or synthetic tissue. Among other things, these phantoms can be used for the realistic training of surgeons [1]. To date, mainly subjective assessments from surgeons [2] or tests of the mechanical properties have been used to evaluate additively manufactured phantoms.

This research involves constructing a test device to analyse the quantitative cutting properties of samples for the simulation of surgical procedures. To achieve this, a state-of-the-art universal testing machine was expanded with a scalpel holder and a device for clamping a thin tissue or phantom sample. This enables the measurement of the force progression via a load cell during the cutting process, or when first piercing the tissue. The holder was engineered for easy installation and removal without compromising the reproducibility of the measurements in the testing machine.

The scalpel holder was designed to position the blade reproducibly and securely, ensuring linear motion during cutting. The scalpel blade is centered in relation to the clamping heads, so that the influence of torque on the measurements can be avoided. The holder allows for the sample to be inserted at a small angle, so that the blade length can penetrate almost completely into the material when cutting, instead of just using the tip of the blade. Both holders are designed to fit precisely between the clamping heads of the testing machine, to ensure that they are always clamped in the same position. As the test stand is an extension for the testing machine, the cutting movement is fully automated at a set velocity.

Various materials, including 3D printed samples of Stratasys Agilus30™ Clear, were examined to demonstrate the functionality of the test rig whereby samples of the same materials showed similar cutting force profiles.

The resulting testing device enables the recording of the cutting force along the cut and therefore quantifying the cutting characteristics of different materials. This gives a new insight into the understanding of the cutting process in the individual sample and enables e.g. comparing the force-path diagrams of 3D printed samples to biological tissue in the future. The 3D printed sample can then be adapted to simulate the biological material more accurately if necessary.

AUTHOR'S STATEMENT

Authors state no conflict of interest. Acknowledgments: Parts of this work have been carried out as part of an internship at Fraunhofer IMTE and were published in the *Student Conference Proceedings 2024*.

REFERENCES

[1] H. Riedle, *Haptische, generische Modelle weicher anatomischer Strukturen für die chirurgische Simulation*, FAU University Press, 2020
[2] P. Weinstock, R. Rehder, S.P. Prabhu, P.W. Forbes, C.J. Roussin and A.R. Cohen, *Creation of a novel simulator for minimally invasive neurosurgery: fusion of 3D printing and special effects*, in Journal of neurosurgery. Pediatrics, 20(1), 2017, pp. 1-9.

DOI: 10.18416/AMMM.2025.25062079