Transactions on Additive Manufacturing Meets Medicine
Trans. AMMM, 2023, Vol. 5, No 1, Suppl. 1, Article ID 1137, 1 Page

Infinite Science Publishing

Abstract

3D printed brain artery phantoms: current status and future perspectives

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3D-printed vascular phantoms are a crucial element in the additive reproduction of human anatomy and have already revolutionized the approach to research, education, and treatment planning in numerous medical domains [1]. Especially, 3D-printed cerebral artery phantoms play a distinct role in this context [1,2,3]. This is primarily due to the high level of anatomical detail required, often necessitating the precise replication of vascular structures with diameters less than 500 micrometers. This places significant demands on the available scanners, expertise in image-based post-processing, CAD design, and, naturally, the 3D printing infrastructure. Additionally, 3D-printed cerebral artery phantoms offer substantial potential in training aspiring neuro-interventionalists and enhancing treatment planning, which can substantially improve patient care. This potential extends to the rapidly growing market of neurovascular medical device industry.

This study specifically examines and compares technical aspects involved in the production of 3D-printed cerebral artery phantoms. The status in the global comparison already presents a diverse landscape, given that both imaging and manufacturing methods often vary regionally. Common among these methods is the fact that structural features and the choice of printing materials are always tailored to the specific application, with concessions made in non-essential features of the 3D-printed phantom.

The ideal reproduction of a cerebral artery phantom, encompassing realistic elasticity properties, spatial precision, and physiological surface characteristics, remains a subject of ongoing research. Initial strides in this direction should be accomplished using water-soluble resin and traditional silicone molding [3]. Further advancements are likely with the advent of high-resolution silicone printers or the latest generation of PolyJet printers. However, the emergence of bioprinting technologies creates an impression that either this technique or a combination of traditional additive manufacturing and bioprinting will eventually emerge as the optimal solution for 3D printing cerebral artery phantoms.

Author's statement

Conflict of interest: Authors state no conflict of interest.

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DOI: 10.18416/AMMM.2023.23091137