

3D Models of Arterial Stenosis and Aneurysms for the Study of Drug Distribution

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INTRODUCTION

Vascular pathologies, such as arterial stenosis and aneurysms, pose significant risks to patients. Their development varies greatly among individuals, and finding a universally effective treatment has proven challenging. Moreover, the targeted delivery of medications for patients with these vascular conditions remains inadequately explored. The objective of this study was to investigate whether 3D realistic models of arterial stenosis and aneurysms could be utilized to predict the distribution of potential drug carriers.

MATERIALS AND METHODS

The foundation for our 3D models was derived from CT scans of patients with arterial stenosis at the bifurcation of the internal carotid artery and an aneurysm of the middle cerebral artery. Using silicone and 3D printing with fused deposition modeling, we created models of arterial stenosis, while models of arterial aneurysms were directly printed using stereolithography. To verify the accuracy of the models, we performed CT scans followed by 3D reconstruction and data registration. Subsequently, we integrated the models into a flow system, using a glycerin-water mixture to simulate blood behavior. By observing micro-particle aggregation, representing potential drug carriers, we analyzed flow characteristics in the models.

RESULTS AND DISCUSSION

Both 3D printing technologies yielded highly precise vascular models, closely resembling the original CT data. The average distance between corresponding parts of the stenosis models ranged from 0.3 to 0.5 mm, while for the aneurysm models, it ranged from 0.2 to 0.3 mm. Micro-particle aggregation predominantly occurred in regions with significantly reduced flow velocity, such as at the vascular bifurcation in the stenosis and at the distal end of the aneurysm.

CONCLUSIONS

3D printing can provide exceptionally accurate vascular models of arterial stenosis and aneurysms. These models hold promise for predicting the distribution of potential drug carriers, offering valuable insights for targeted therapeutic interventions.

ETHICAL STATEMENTS

The study was conducted in accordance with the Declaration of Helsinki and approved by the local Ethics Committee of Masaryk Hospital / Krajská zdravotní, a.s. (Reference No. 261/17) on June 20th, 2018. Informed consent was obtained from all subjects involved in the study.

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