Aksaray University Journal of Medicine Sciences
Aksaray Üniversitesi Tıp Bilimleri Dergisi

asujms 2025; 5(1): 39-40

Letter to the Editor

The Synergy of 3D Printing and Artificial Intelligence in Cardiology: A Glimpse into the Future

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To the Editor,

The intersection of three dimensional (3D) printing and artificial intelligence (AI) has paved the way for revolutionary advancements in the field of cardiology (1, 2). This brief communication offers an overview of the current and potential future applications of this powerful synergy, showcasing its transformative impact on cardiovascular care (1, 3).

In the present, 3D printing in cardiology is primarily employed for the creation of patient-specific anatomical models (1, 2). These models serve as invaluable tools for preoperative planning, education, and enhanced communication with patients and their families (2, 3). AI, on the other hand, is playing a pivotal role in data analysis, aiding in the interpretation of medical images, and assisting in early diagnosis (3).

The fusion of these technologies holds immense promise for the future of cardiology. Through machine learning algorithms, AI can be used to automate and expedite the segmentation of cardiac structures from medical images, enabling the rapid generation of patient-specific 3D-printed models (3, 4). These models, while currently employed for surgical planning, are poised to become instrumental in the development of personalized cardiac devices, such as stents and prosthetics, offering an unparalleled level of customization for improved patient outcomes (4, 5).

Moreover, AI-driven predictive modeling can assist in forecasting patient-specific cardiovascular risks, helping physicians tailor treatment plans and interventions. The integration of AI with 3D printing technology is set to enable real-time adjustments to devices during procedures, based on the patient's immediate needs (5, 6).

Educational institutions and medical training programs are already benefiting from this synergy, as it provides a lifelike platform for medical students and practitioners to hone their skills. The 3D printing of heart models, incorporating AI-generated scenarios, offers a dynamic training ground, enhancing understanding and procedural expertise (6, 7).
While the marriage of 3D printing and AI in cardiology shows great promise, it is not without challenges. Issues of data security, standardization, and regulatory frameworks must be addressed. However, the potential benefits, including more precise surgical planning, reduced procedure times, and improved patient outcomes, make these challenges worth tackling (7, 8).

Here are a few examples of how AI is being used together with 3D printing in cardiology:

1. Automated Segmentation of Cardiac Structures

AI algorithms are used to automatically segment cardiac structures from medical imaging data, such as MRI or CT scans. This data is then converted into a 3D model of the heart, which is printed using 3D printing technology (3, 4). The printed model provides a detailed representation of the patient's heart, helping cardiologists plan surgeries and interventions with greater precision. This integration speeds up the creation of patient-specific models, reduces the time needed for manual segmentation, and enhances the accuracy of the models, leading to better surgical outcomes (1, 3).

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Recieved: 23.08.2024
Accepted: 08.09.2024

2. Personalized Cardiac Device Development

AI is employed to analyze a patient's unique cardiac anatomy and determine the optimal shape and size for a personalized cardiac device, such as a stent, valve, or prosthetic. The customized design is then 3D printed, ensuring a perfect fit for the patient's heart structure (4, 5). This approach ensures that the implanted devices are tailored specifically to the patient's needs, improving their functionality and reducing the risk of complications, such as device migration or improper fitting (1-8).

3. Real-Time Intraoperative Adjustments

During cardiac surgeries, AI algorithms analyze real-time data from imaging devices and sensors to assess the patient's heart condition. This information can be used to make real-time adjustments to 3D-printed surgical guides or implants.[5, 6] For example, if a patient's anatomy changes during surgery, a new guide or implant can be rapidly printed to adapt to the new measurements. This capability allows surgeons to make precise, real-time decisions during operations, enhancing surgical accuracy and patient outcomes (1-8).

CONCLUSION

In conclusion, the convergence of 3D printing and AI represents a dynamic and transformative force in the field of cardiology. By amalgamating the precision of patient-specific anatomical models with the analytical power of AI, the future of cardiovascular care promises to be highly personalized, efficient, and effective. As technology continues to evolve, we anticipate that this synergy will further redefine the landscape of cardiovascular medicine, ultimately leading to improved patient outcomes and enhanced quality of care. [1-8]

Declarations

Sources of Funding: None declared
Acknowledgements: None declared

REFERENCES

1. Göçer H, Durukan AB, Tunç O, Naseri N, Ercan E. A Novel Method to Adjust Saphenous Vein Graft Lengths Using 3D Printing Models The Heart Surgery Forum 2020;23: 2019-2765.
2. Göçer H, Durukan AB, Tunç O, Naseri N, Ercan E. Evaluation of 3D printed carotid anatomical models in planning carotid artery stenting. Turkish Journal of Thoracic and Cardiovascular Surgery 2020; 28: 294-300.
3. Göçer H, Durukan AB. The use of artificial intelligence in interventional cardiology Turkish Journal of Thoracic and Cardiovascular Surgery 2023;31: 420-421.
4. Panchal V, Kumar P, Garg A, Kalra MK. Artificial intelligence in cardiac CT and MR angiography: Current state and future directions. AJR Am J Roentgenol 2020;214:1276-1286.
5. Wang Y, Bai W, Chen X, Zhang J, Liu J, Sun Y. Artificial intelligence in CT angiography: clinical applications and future prospects. Quant Imaging Med Surg 2022;10: 909-922.
6. Rodriguez A, Rodriguez-Granillo GA, Rodriguez- Palomares, JF. Deep learning for analysis of coronary angiography. J Cardiovasc Comput Tomogr 2020;15: 23-30.
7. Makaryus JN, Makaryus AN, Johnson M, Ruggiero NJ. The role of artificial intelligence in enhancing coronary angiography and percutaneous coronary intervention. Curr Cardiol Rep 2020;2: 1-10.
8. Kaku B, Komuro K, Shoda M. Current status and future prospects of AI in coronary angiography. Circ J 2021;85: 383-890.