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Review Article

A Review on Novelty in Medical Technology: 3D Printing

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ABSTRACT

3D printing is latest technology in these days and this review is based of some recent developments and applications of the 3D printing in the medical field. Depends of how and why 3D printing is transforming medical practice, education, and research is given at the beginning of the discussion. The use of 3D printing in medicine also comes with some challenges. We then demonstrate the use and applications of the state of the art 3D printing using recent instances of advancements in the field, recommending if when more advancements and can be made in 3D printing in future.

INTRODUCTION

3D printing, also known as additive manufacturing, has made a transformative impact across various industries, with healthcare being one of the most significant sectors benefiting from this technology. In the medical field, 3D printing has enabled advancements in areas like surgical planning, prosthetics, implants, and even drug development. By allowing precise, patient-specific designs, 3D printing enhances treatment outcomes, accelerates innovation, and offers more personalized care.

Key Areas Where 3D Printing is making an Impact in Healthcare

1. Prosthetics and Orthotics


One of the most prominent applications of 3D printing in healthcare is the creation of custom prosthetic limbs and orthotics. Traditional prosthetics are often expensive, uncomfortable, and may not perfectly match the patient's unique anatomy. 3D printing allows for the rapid production of lightweight, custom-fitted prostheses, improving both comfort and functionality. Additionally, the use of 3D printing reduces costs and makes prosthetics more accessible to a wider range of patients

2. Surgical Planning and Simulations

Surgeons are increasingly using 3D-printed models based on patient-specific medical scans (like CT or MRI scans) to prepare for

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complex surgeries. These physical models help doctors visualize and plan the procedure in advance, which can reduce risks and improve outcomes, particularly in high-stakes or uncommon surgeries. Surgeons can also practice on 3D models before operating on real patients, leading to more efficient and effective procedures.

3. Customized Implants

3D printing allows for the creation of customized implants that fit a patient's anatomy precisely, unlike standard, off-the-shelf implants. This is particularly important for joint replacements, dental implants, or cranial implants, where a tailored fit can significantly enhance functionality and recovery time. The ability to create implants with complex geometries or materials that are not possible with traditional manufacturing is a major advantage.

4. Bio-printing and Tissue Engineering

One of the most exciting frontiers of 3D printing in medicine is **bio-printing**, where living cells, biomaterials, and growth factors are used to "print" tissues or even organs. Although this technology is still in its early stages, it holds the potential to revolutionize organ transplantation by enabling the creation of lab-grown tissues and organs that could be used for transplants or as models for drug testing. Researchers are also exploring the use of 3D printing for creating skin grafts, blood vessels, and other complex tissues.

5. Drug Development and Personalized Medicine

3D printing can also be applied in pharmaceutical development, where researchers are creating patient-specific doses or drug formulations. For example, the ability to 3D print medications that are tailored to a patient's needs, such as controlled-release tablets or multi-drug combinations, could

greatly improve treatment efficacy. This personalized approach may be particularly beneficial for patients with rare diseases or those who require specific drug dosages.

6. Medical Devices and Tools

3D printing is also being used to design and produce custom medical tools and devices, such as surgical instruments, scaffolds for tissue growth, and training models. For instance, a surgeon may need a specialized tool for a certain procedure, and 3D printing can quickly produce a prototype or a final tool at a fraction of the cost and time compared to traditional manufacturing methods.

7. Medical Education and Training

Medical schools and hospitals are increasingly using 3D-printed models for educational purposes. These models allow students and trainees to engage with realistic representations of human anatomy, enhancing their understanding of complex structures and systems. 3D printing can also be used to create replicas of rare or complex conditions, giving students and doctors the opportunity to practice on lifelike models before performing real procedures.

Benefits of 3D Printing in Healthcare

- **Customization:** The ability to create patient-specific models, implants, and prosthetics ensures better fit, function, and comfort.
- **Cost-Effectiveness:** 3D printing can reduce the cost of manufacturing medical devices and prosthetics by eliminating the need for expensive molds or mass production techniques.
- **Speed:** Complex models, implants, or tools can be produced quickly, allowing for faster treatment and fewer delays.
- **Innovation:** 3D printing facilitates innovation in medical device design, drug delivery systems, and surgical techniques, offering solutions that were previously not possible.



Challenges and Considerations

Despite its many benefits, the use of 3D printing in medicine also comes with challenges:

- **Regulation and Standards:** The medical industry is heavily regulated, and ensuring that 3D-printed devices and implants meet safety standards is a crucial concern.
- **Material Limitations:** While there is a wide variety of materials used in 3D printing, the availability of suitable materials for medical applications (e.g., bio-compatibility for implants or printing tissue) is still a limiting factor.
- **Cost of Equipment and Expertise:** While 3D printing can be cost-effective for certain applications, the initial investment in specialized 3D printers and the expertise required to operate them can be high.

The Future of 3D Printing in Medicine

The future of 3D printing in healthcare looks promising. As technology continues to evolve, we can expect more breakthroughs in bio-printing, organ creation, and personalized medicine. Additionally, improvements in 3D printing materials—such as bioinks and synthetic tissues—will expand the potential applications even further. With ongoing research and development, 3D printing could redefine the way medical professionals diagnose, treat, and manage diseases, leading to more effective, personalized, and cost-efficient healthcare solutions for patients around the world.

SUMMARY AND CONCLUSION

In summary, 3D printing is a revolutionary technology with immense potential in the medical field, providing new opportunities for improved patient care, innovation, and efficiency across a wide range of applications. 3D printing is rapidly transforming the medical field, offering innovative solutions that are enhancing patient care, improving surgical outcomes, and enabling the creation of personalized treatments and devices.

From customized prosthetics and implants to advanced surgical planning tools and the potential for bio-printing living tissues, the impact of 3D printing on healthcare is profound. By enabling precise, cost-effective, and faster solutions, 3D printing not only improves the quality of care but also opens the door to new possibilities in medicine that were once considered unimaginable. However, while the benefits are clear, challenges remain, particularly in terms of regulation, material limitations, and ensuring patient safety. As the technology continues to evolve, it will be crucial for the medical industry to address these obstacles while continuing to push the boundaries of what is possible. In the future, 3D printing holds the potential to revolutionize areas such as organ transplantation, drug development, and personalized medicine, making healthcare more tailored and accessible. With continued research, innovation, and collaboration between the medical and tech industries, 3D printing will undoubtedly play a central role in shaping the future of medicine, ultimately improving the lives of countless patients around the world.

REFERENCES

1. A.I. Committee, ASTM International Committee F42 - Additive Manufacturing Technologies, ASTM F2792-12 Standard Terminology for Additive Manufacturing Technologies, American Society for Testing and Materials, West Conshohocken, PA, 2009.
2. Sidambe, A.T., 2014. Biocompatibility of advanced manufactured titanium implants — A review. *Materials*, 7(12), pp.8168-8188.
3. Gu, Q., Hao, J., Lu, Y., Wang, L., Wallace, G.G. and Zhou, Q., 2015. Threedimensional bio-printing. *Science China. Life Sciences*, 58(5), p.411.
4. Shafiee, A. and Atala, A., 2016. Printing technologies for medical applications. *Trends in molecular medicine*, 22(3), pp.254-265.



5. Elahinia, M.H., Hashemi, M., Tabesh, M. and Bhaduri, S.B., 2012. Manufacturing and processing of NiTi implants: a review. *Progress in materials science*, 57(5), pp.911-946.
6. Golab, A., Smektala, T., Krolikowski, M., et al . (2018) Percutaneous Nephrolithotomy Using an Individual 3-Dimensionally Printed Surgical Guide. *Urologia Internationalis*, 100, 485-487. <https://doi.org/10.1159/000446291>
7. Mcallister, P., Watson, M. and Burke, E. (2018) A Cost-Effective, In-House, Positioning and Cutting Guide System for Orthognathic Surgery. *Journal of Maxillofacial and Oral Surgery* , 17, 112-114. <https://doi.org/10.1007/s12663-017-1067-y>
8. Lee, J.W. and Cho, D.W. (2015) 3D Printing Technology over a Drug Delivery for Tissue Engineering. *Current Pharmaceutical Design*, 21, 1606-1617. <https://doi.org/10.2174/1381612821666150115125324>
9. Zhu, M., Huang, T., et al . (2017) Progress in 3D Printing of Biomaterials. *Shanghai University of Science and Technology*, 39, 473-483, 489.
10. Pan, S., Zhong, Y., Shan, Y., et al . (2019) Selection of the Optimum 3D-Printed Pore and the Surface Modification Techniques for Tissue Engineering Tracheal Scaffold in Vivo Reconstruction. *Journal of Biomedical Materials Research Part A*, 107, 360-370. <https://doi.org/10.1002/jbm.a.36536>
11. Isaacson, A., Swioklo, S. and Connon, C.J. (2018) 3D Bioprinting of a Corneal Stroma Equivalent. *Experimental Eye Research*, 173, 188-193. <https://doi.org/10.1016/j.exer.2018.05.010>
12. Kim, B.S., Lee, J.S., Gao, G., et al . (2017) Direct 3D Cell-Printing of Human Skin with Functional Transwell System. *Biofabrication*, 9, Article ID: 025034. <https://doi.org/10.1088/1758-5090/aa71c8>
13. Zhang, Y.S., Yue, K., Aleman, J., et al . (2017) 3D Bioprinting for Tissue and Organ Fabrication. *Annals of Biomedical Engineering* , 45, 148-163. <https://doi.org/10.1007/s10439-016-1612-8>
14. Muwaffak, Z., Goyanes, A., Clark, V., et al . (2017) Patient-Specific 3D Scanned and 3D Printed Antimicrobial Polycaprolactone Wound Dressings. *International Journal of Pharmaceutics* , 527, 161-170. <https://doi.org/10.1016/j.ijpharm.2017.04.077>
15. Shi, G.Q., Luo, G.X., Chen, X.W., et al . (2018) 3D Printing Polyoxymethylene Siloxane Biomimetic Silver Nanocomposites and Their Properties. *Medical Journal of Chinese People 's Liberation Army* , 43, 840-848.
16. Wang, K.K., Yang, K., Zhao, J., et al . (2018) Rapid Detection of Hepatitis B Virus Nucleic Acid by Fluorescence Quantitative PCR Based on Microfluidic Chip. *Journal of Analytical Science* , 34, 450-454.
17. Stratasys. 3D printing vs. CNC machining: comparing two rapid prototyping alternatives. 2017. Available from: https://www.stratasys.com/-/media/files/explore/white-papers/3d-printing-vs-cnc/wp_fdm_3dpsvcnc_0621a.pdf. Accessed February 22, 2021.
18. Ventola CL. Medical Applications for 3D Printing: Current and Projected Uses. *P T* 2014;39(10):704–171. PMID:25336867.
19. Hoy MB. 3D printing: making things at the library. *Med Ref Serv Q* 2013;32(1):94–9. doi:10.1080/02763869.2013.749139, PMID:23394 423.



20. Kirby B, Kenkel JM, Zhang AY, Amirlak B, Suszynski TM. Three-dimensional (3D) synthetic printing for the manufacture of non-biodegradable models, tools and implants used in surgery: a review of current methods. *J Med Eng Technol* 2021;45(1):14–21. doi:10.1080/03091902.2020.1838643, PMID:33215944.
21. Gülcan O, Günaydın K, Tamer A. The State of the Art of Material Jetting- A Critical Review. *Polymers (Basel)* 2021;13(16):2829. doi:10.3390/polym13162829, PMID:34451366.
22. ISO/ASTM 52900:2015(en). Additive manufacturing – general Principles-Terminology. 2018 March 26. Available from: <https://www.iso.org/obp/ui/#iso:std:iso-astm:52900:ed-1:v1:en>.
23. Murr Lawrence E. Frontiers of 3D printing/additive manufacturing: from human organs to aircraft fabrication. *J Mater Sci Technol* 2016;32(10):987e95. <https://doi.org/10.1016/j.jmst.2016.08.011>.
24. Kumar M. Advances in welding technologies for process development. (No Title) 2019:77. <https://doi.org/10.1201/9781351234825>.
25. Horn Timothy J, Ola LA Harrysson. Overview of current additive manufacturing technologies and selected applications. *Sci Prog* 2012;95(3):255e82. <https://doi.org/10.3184/003685012x13420984463047>.
26. Lee Hyub, et al. Lasers in additive manufacturing: A review. *Int J Prec Eng Manufact Green Technol* 2017;4:307e22. <https://doi.org/10.1007/s40684-017-0037-7>.
27. Horvath Joan, Cameron Rich. Mastering 3D printing. Berkeley,CA: Apress; 2014. <https://doi.org/10.1007/978-1-4842-5842-2>.
28. Khatri Pinak, Shah Mansi K, Namrata Vora. Formulation strategies for solid oral dosage form using 3D printing technology: A mini-review. *J Drug Deliv Sci Technol* 2018;46:148e55. <https://doi.org/10.1016/j.jddst.2018.05.009>.
29. Katstra WE, Palazzolo RD, Rowe CW, Giritlioglu B, Teung P, Cima MJ. Oral dosage forms fabricated by Three-Dimensional Printing. *J Contr Release* 2000;66(1):1e9. [https://doi.org/10.1016/S0168-3659\(99\)00225-4](https://doi.org/10.1016/S0168-3659(99)00225-4).
30. Cui M, Pan H, Fang D, Qiao S, Wang S, Pan W. Fabrication of high drug loading levetiracetam tablets using semi-solid extrusion 3D printing. *J Drug Deliv Sci Technol* 2020;57:101683. <https://doi.org/10.1016/j.jddst.2020.101683>
31. Bartolo, Jorge Paulo, editors. Stereolithography: materials, processes and applications. Springer Science & Business Media; 2011. <https://doi.org/10.1007/978-0-387-92904-0>

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