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EDITORIAL

The robotic frontiers of endodontic care

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In the healthcare field, digital technology is transforming dentistry, particularly in the field of endodontics. Recently, transformative technologies such as 3D printing, real-time navigation, and artificial intelligence (AI) have been introduced, and they have set a few examples that reshaped the way dental care is delivered [1,2]. This statement has proven to be true for diagnostic methodologies and decision-making strategies, as well as the performance of dental procedures.

The rapid advancements in AI have led to a variety of applications in endodontic diagnosis, ranging across various degrees of automation [3]. Such advancements are particularly beneficial for facilitating quick disease screening and supporting naïve dental practitioners. Robotics have emerged as a game changer with the potential to execute definite and repetitive tasks. Robotics originated in the automotive industry and were pioneered in neurosurgery in the late 1980s [4]. In the 1970s, NASA required remote yet precise surgical interventions for medical emergencies and astronauts, which led to the development of surgical robotics [5]. More than thirty years later, this frontier modality came into use, and the first FDA-approved medical robotic "da Vinci" model was introduced in 2000 [6].

In 2017, the FDA approved dental robotics for surgical osteotomy preparation and implant insertion in dentistry [6]. This was fronted by the robotic model "Yomi", which was the prime innovation of "Neocis" [4,7]. The success gained with robotic-assisted implantology has further pushed the boundaries for other modified applications.

Moreover, the dynamic environment of dental education and training has fostered the next-generation "SIMROID" model, where robotic mechanics and AI are combined in tasks in a confined and tiny environment, such as a root canal, which presents many challenges. Several early trials, including those of Dong et al., were linked to the hot topic of endodontic-targeted robotic-assisted drilling [8]. Herein, the term "microrobotics" was used to describe the miniature robotic system assisted by the advancement of smart orientation adjustment, built-in sensors, and a smart haptic feedback system. A microrobot-based endodontic experimental model was proposed to automate tasks routinely performed in the field of endodontics, such as probing, access drilling, and root canal cleaning. Nanorobotics has recently received some attention due to its potential since it is constructed in nanoscale sizes [9].

Nonetheless, the integration of robotics is accompanied by a spectrum of pros, cons, and immense potential. One of the most significant advantages of incorporating robotics into endodontics is the unparalleled precision it offers. Endodontic procedures, such as root canal treatments, require a high level of accuracy to ensure optimal results. Robotics could reduce the margin of error with its ability to execute minute and controlled movements. This approach is crucial for less experienced operators. Recent evidence has proven the accuracy of robotic-assisted drilling in the application of fiber post-removal [10]. The precise and efficient drilling technique that was assisted by robotics was significantly less invasive than free-hand drilling, with the least amount of tooth structure lost, performed at a significantly rapid performance of ten seconds. Furthermore, robotics in the field of endodontics can carry out repetitive tasks tirelessly, minimizing the risk of fatigue-induced errors that human practitioners might encounter during prolonged procedures. This approach not only contributes to ensuring consistency in treatment outcomes but also allows dentists to focus on tasks that require a profound human touch.

In terms of patient experience, robotic interventions often translate to less invasive procedures. This not only enhances patient satisfaction but also expands for individuals who may have been hesitant to undergo certain treatments due to fear or anxiety. Tele-endodontics, an emerging field that combines telecommunications and endodontics, can be significantly enhanced by robotics [11]. Remote-controlled robotic systems could enable experienced endodontists to perform predefined procedures on patients located in remote areas, thereby expanding access to specialized dental care globally.

While the promises of robotic dentistry are evident, it is crucial to acknowledge the challenges that come with this technological paradigm shift. One of the primary concerns is the significant initial cost associated with acquiring and maintaining robotic systems. Small to medium-sized dental practices would find it difficult to invest in robotics soon, as such practices have not yet been proven to be cost-effective. Moreover, the integration of robotics requires practitioners to undergo specialized training to operate and manage these systems effectively. This transition may be met with resistance from established dental professionals who are accustomed to traditional methodologies.

The learning curve, therefore, becomes a potential obstacle in the widespread adoption of robotic technology in dentistry. There is also ethical consideration of the potential depersonalization of patient-dentist relationships. There is a risk of patients feeling disconnected from the human aspect of their dental care. Keeping a balance between technological advancement and maintaining compassion and empathy in

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healthcare is a constant challenge. In addition, dentistry in general and endodontics in particular often face challenging environments that demand high intellectual abilities.

Looking ahead, the potential of robotics in endodontics is vast and transformative. The ability of robotics (supported by the advancement in AI algorithms) to process and analyze vast amounts of data can lead to personalized treatment plans tailored to individual needs. Notably, the recruitment of robotics facilitates automated and semiautomated dental procedures and advances minimally invasive dentistry. Finding the right balance between innovative technology and maintaining the core values of dental care is crucial to incorporating robotics into endodontics. While the precision and efficiency of robotics hold significant promise, it is crucial to address the challenges encountered. A collaborative effort is needed between dental professionals, technology developers, and regulatory bodies to ensure better patient health outcomes.

Disclosure statement

No potential conflict of interest was reported by the author.

References

1. Fouad EM, Abdelbaky M. Dynamic navigation: how far it would go in endodontics?. J Dent. 2022;121:103992. https://doi.org/10.1016/j.jdent.2022.103992
2. Zhao D, Xie W, Li T, Wang A, Wu L, Kang W, et al. New-designed 3D printed surgical guide promotes the accuracy of endodontic microsurgery: a study of 14 upper anterior teeth. Sci Rep. 2023;13(1):15512. https://doi.org/10.1038/s41598-023-42767-x
3. Mohan KR, Fenn SM. Artificial Intelligence and Its Theranostic Applications in Dentistry. Cureus. 2023;15(5). http://doi.org/10.7759/cureus.38711
4. van Riet TC, Sem KT, Ho JP, Spijker R, Kober J, de Lange J. Robot technology in dentistry, part one of a systematic review: literature characteristics. Dent Mater. 2021;37(8):1217-1226. http://doi.org/10.1016/j.dental.2021.06.001
5. Takács Á, Jordán S, Nagy DÁ, Tar JK, Rudas IJ, Haidegger T. Surgical robotics—Born in space. IEEE 10th Jubilee International Symposium on Applied Computational Intelligence and Informatics. 2015. (pp. 547-551). http://doi.org/10.1109/SACI.2015.7208264
6. Wu Y, Wang F, Fan S, Chow JK. Robotics in dental implantology. Oral Maxillofac Surg Clin North Am. 2019;31(3):513-518. http://doi.org/10.1016/j.coms.2019.03.013
7. Bhat B, Bhandary S, Naik R, Shetty D. Robotics in dentistry: Fiction or reality. J Dent Res. 2017;4(3):67-68. http://doi.org/10.4103/JDRR.JDRR_55_17
8. Dong J, Hong S, Hesselgren G, Dds PD. WIP: a study on the development of endodontic microrobot. Proceedings of the 2006 IJME-INTERTECH Conference. 2006. (pp. 20104-110). https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=0ac79a7a5bdc37c80720cf86974c870bc0029333
9. Sachdeva S, Mani A, Mani SA, Vora HR, Gholap SS, Sodhi JK. Nano-robotics: The future of health and dental care. IP Int J Perio Implant. 2021;6:E6-E10. https://doi.org/10.18231/j.ijpi.2021.002
10. Dale J. Removal of Endodontic Fiber Posts Using Robot-Assisted Haptic Guidance: A Novel Approach. MUSC Theses and Dissertations. 2022.700. https://medica-musc.researchcommons.org/cgi/viewcontent.cgi?article=1700&context=theses
11. Teja KV, Vasundhara KA, Sriram G. Insights on Applying Teledentistry Principles in Managing the Emergency Endodontic Conditions During the COVID-19 Pandemic. 1st ed. Switzerland: Springer Cham; 2022. p. 247-253. http://doi.org/10.1007/978-3-031-05049-7_15

https://doi.org/10.61577/ohmr.2024.100005