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VIEWPOINT

Revolutionizing dentistry: the integration of artificial intelligence and robotics

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Technology is rapidly transforming traditional practices in modern healthcare. One area that stands out is the convergence of artificial intelligence (AI) and robotics, revolutionizing dentistry. This powerful combination enhances precision, efficiency, and patient outcomes in oral health care while reducing potential errors.

AI, with its ability to analyze large amounts of data and identify intricate patterns, has found a place in dentistry. Its applications range from diagnostic tools and treatment planning to personalized medicine and patient management.[1] By utilizing advanced imaging techniques, AI assists in the early detection of oral diseases,[2] enabling proactive intervention and improving prognosis. The integration of AI into orthodontics and endodontics has radically transformed the field of dental care. In orthodontics, AI and machine learning systems support orthodontists in making informed decisions, particularly regarding tooth extraction. AI-driven custom orthodontic treatments minimize subjectivity and improve decision-making processes by utilizing neural networks to predict the extraction outcomes. AI is used throughout orthodontic procedures, from diagnosis to personalized treatment planning, utilizing 3D scans and virtual models to assess abnormalities, produce aligners, and optimize tooth removal strategies.[3] Similarly, in endodontics, AI enhances root canal therapy by enabling precise anatomical analysis, lesion detection, fracture identification, stem cell viability prediction, and assessment of treatment efficacy.[4] The contributions of AI in both orthodontics and endodontics have resulted in increased efficiency, accuracy, and improved patient outcomes, showcasing significant advancements in dental healthcare.

AI also plays a critical role in posttreatment patient monitoring, ensuring timely intervention, and improving recovery. Through continuous data analysis and feedback, AI facilitates long-term oral health management, empowering patients and practitioners with proactive insights into sustained well-being. By integrating AI, dental experience is enhanced by combining cutting-edge technology with personalized care that redefines standards in dental health and treatment protocols. Furthermore, AI algorithms streamline administrative processes, optimize scheduling, and enhance patient experience, thereby improving the overall operational efficiency.[5]

The capabilities of robotics in dentistry have complemented those of AI, unlocking new frontiers in precision and minimally invasive procedures.[6] Robotics provide unparalleled dexterity and control during surgery, resulting in superior outcomes and quicker recovery times for patients. These technological marvels not only enhance the skill set of dental professionals, but also expand access to care in remote or underserved areas. Advancements in technology and computer science have pushed the integration of robotics into navigational surgery in various medical fields. This progress is now being extended to dentistry, where innovative technologies are revolutionizing traditional dental procedures. Robotics-assisted dentistry, employing nanomaterials, nanorobots, and advanced diagnostic tools, is evolving to address the complex procedures necessary for oral healthcare maintenance and lesion removal. These advanced systems are reshaping conventional practices in dentistry, particularly implant therapy, challenging existing paradigms, and expanding the capabilities of practitioners.[7]

One notable development in robot-assisted dentistry is the creation of micro robots (MR), designed to enhance the precision and efficiency of endodontic treatments, specifically root canal therapy. These advanced robots autonomously perform tasks such as drilling, cleaning, shaping, and filling the root canal system under the supervision of cutting-edge computer-assisted technologies. By integrating various components, such as micro position controllers, sensors, and automated tools, the MR ensures error-free procedures, reduces discomfort for dentists, and enhances treatment outcomes with unparalleled accuracy.[8]

Furthermore, nanomaterials and nanorobots play a crucial role in enabling the creation of nanorobots for various dental applications such as tooth repair, drug delivery, orthodontic adjustments, and cavity treatments. These minuscule robots offer swift and precise dental care interventions, illustrating their potential to revolutionize traditional dental practices. Additionally, robotic applications in oral and maxillofacial surgery enhance surgical precision by allowing surgeons to program robots for specific tasks, such as bone surgeries and plate positioning.[9] As technology continues to advance, the integration of robotics into dentistry promises to reshape the field, offering new possibilities for enhanced patient care and treatment outcomes.

The fusion of robotics with AI algorithms holds promise for a future in which complex dental procedures are conducted with unprecedented accuracy and safety. Although the potential benefits of AI and robotics in dentistry are immense, their integration is not devoid of challenges. Ensuring

data security, maintaining patient privacy, and addressing ethical concerns surrounding autonomy and decision making are crucial considerations in this rapidly evolving landscape. With appropriate regulations and ethical guidelines in place, the dental community can harness the full potential of these technologies, while upholding the highest standards of patient care and professional integrity.

As we stand on the cusp of a new era in oral healthcare, characterized by the symbiotic relationship between human expertise and technological prowess, it is imperative for stakeholders to embrace innovation responsibly.[10] Collaborative efforts among researchers, clinicians, technologists, and policymakers will be vital in harnessing the transformative power of AI and robotics to chart a course towards a future where dental treatments are not only effective but also personalized, efficient, and accessible to all.

The integration of AI and robotics in dentistry heralds a paradigm shift in the delivery and reception of oral healthcare services. By leveraging these cutting-edge technologies thoughtfully and ethically, the dental community can elevate standards of care, expand treatment options, and improve patient outcomes, as well as redefine the future of dentistry.

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CONFLICT OF INTEREST

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