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3D Printing in Dentistry – Discovering New Possibilities

Tamer M. Hamdy [1,*]

[1] Restorative and Dental Materials Department, Oral and Dental Research Institute, National Research Centre (NRC), Giza, Dokki, 12622, Egypt
* Corresponding author e-mail: dr_tamer_hamdy@yahoo.com

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Abstract: 3D printing is often regarded as a groundbreaking technology that is set to transform the manufacturing landscape. Its applications span across various fields, including aerospace, defense, art, and design, but it is gaining particular traction in the realm of surgery. The technology is especially relevant in dentistry, where advancements in 3D imaging and modeling technologies, such as cone beam computed tomography and intraoral scanning, are making a significant impact. Coupled with the established use of CAD CAM technologies in the dental field, 3D printing is poised to play an increasingly vital role. Some of its applications include creating drill guides for dental implants, producing physical models for prosthodontics, orthodontics, and surgical procedures, manufacturing dental, craniomaxillofacial, and orthopedic implants, as well as fabricating copings and frameworks for dental restorations. This paper explores the various types of 3D printing technologies available and their diverse applications in dentistry and maxillofacial surgery.

Keywords: 3D Printing; digital dentistry; dental material

The profession has embraced digital manufacturing technologies, transforming much of the laboratory work that was once done by artisans into digital processes. Now, only the final touches of restorations are applied by hand. CAD CAM technology has become a standard in dental laboratories and is increasingly being integrated into dental surgeries. In the past, scanning and the creation of digitally manufactured restorations depended on centralized facilities, but many laboratories now possess their own scanners and milling units. In dental practices, intraoral and CBCT scanners are becoming increasingly prevalent.

As a result, dentists and dental technicians are becoming familiar with handling large amounts of digital data. 3D printing serves as another output option for dental CAD software, allowing for the creation of complex components and objects from various materials. It is particularly beneficial for unique, custom structures with intricate designs, especially when 3D scan data is readily available.

In the field of dentistry, 3D printing has a wide range of applications and holds significant potential for enabling innovative treatments and manufacturing methods for dental restorations. While national regulatory bodies have yet to establish guidelines for the use of 3D printing in surgery or dentistry, there will eventually be a need for regulators to address this technology and set appropriate standards.

Despite 3D printing technologies being accessible for over a decade, it is advancements in scanner technology, computer-aided design software, and increased computational power that have made the practical use of this technology feasible. Additionally, growing commercial and public interest has heightened awareness and improved access to necessary resources.

With the advent of milling technology, a wide array of new materials became accessible for creating restorations; likewise, new generations of dental restorative materials for 3D printing are continuously being developed and introduced. Considering

the various applications of 3D printing in dentistry, along with the profession's extensive experience with scanning and milling technology, it can be argued that dentists and dental technologists possess more experience with these 3D manufacturing technologies than any other field. While CAD software remains primarily in the hands of those who are well-trained and tech-savvy, this will not deter newer generations of operators, as the software is constantly evolving to become more intuitive and user-friendly. Significant future advancements that could enhance our use of this technology, beyond the clear advantages of lower costs, faster production times, and more efficient, less invasive treatments for patients, include the ability to 3D print with ceramic materials featuring digital coloration and staining, minimizing the post-processing required for metal components, and incorporating machining/milling of 3D printed metal parts into the overall metal printing process.

The gradual integration of digital technologies in dentistry has gained significant traction, leading the authors to believe that we have moved well beyond the early adoption phase. We now have a real opportunity for the widespread use of 3D printing technology in orthodontics, dental laboratories, and surgical practices. There is immense potential for further advancements; while much attention is given to individual pieces of equipment, the crucial factor lies in how well these tools integrate with planning and design software. This integration is essential for creating a seamless, efficient workflow, which will ultimately influence the acceptance and implementation of these transformative technologies. With the advent of this new technology comes a wealth of opportunities. The challenge we face is to view 3D printing not merely as a new tool for traditional practices, but as a means to foster creativity, develop innovative materials, and establish more predictable, less invasive, and cost-effective procedures for our patients. We must also be cautious not to fall into the trap of assuming that digital solutions are inherently superior. Research is essential to establish standards and ensure that the rapidly emerging equipment in our laboratories and surgeries performs at least as effectively as existing conventional 'analog' methods.