Futuristic Dentistry: Intelligence Augmentation rather than Artificial Intelligence should be the Future Realm of Dentistry

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Digitization is an emerging trend in the current transformation of the dental industry. With technological innovations taking place at an extraordinary rate, the world saw the birth of two novelties—artificial intelligence (AI) and intelligence augmentation (IA). It needs to be seen that the unique creativity of the human does not fade away or take a backseat in any way. The two watchwords, AI and IA have frequently been interchangeably used. But the difference should be properly stated. AI is used when you are mentioning a wider concept of machines that can complete tasks that humans would label as intelligent or smart. IA is employed when technology is used to support and complement human cognitive functions. IA places humans central to the system and decision-making, whereas AI places technology at the core. Moreover, IA systems can overcome the limitations imposed by system boundaries on AI systems.[1]

The first technology to improve efficiency in the dentistry sector was implemented in 1092. Starting this year, the barber surgeons arose. Subsequent technological developments, including the invention of amalgam as a material for tooth restoration and dentures to replace missing teeth, which were made of ivory, hippopotamus or human bone, or metal in the mid-19th century, a major advancement in caries treatment, the usage of dental drills became a key revolution in speeding up removal of decayed tissue.

Today the use of technologies in dentistry can be seen in every arena like computer-assisted design and computer-assisted manufacture (CAD/CAM) and intraoral cameras—both laboratory and clinician-controlled. The technologies are used in caries diagnosis, in computer-aided implant dentistry, including the design and fabrication of surgical guides; in digital radiography (intraoral and extraoral), including cone-beam computed tomography; in electric and surgical/implant handpieces, lasers, occlusion, and temporomandibular joint analysis and diagnosis; in photography (extraoral and intraoral); in practice and patient record management, including digital patient education; and in shade matching. With all these digital dentistry progressions dentists, researchers and inventors worldwide are further stimulated to continuously seek new technologies or advancements that can be used to elevate the profession to its optimal state.

Artificial intelligence (AI) and IA have numerous applications in the dental sector, and as technology evolves, more applications will continue to digitize the industry. Some of the most common applications[2,3] include the following:

- Dental project management software: Project management software isn't anything new and has been around for decades. However, AI and automation have changed how the dental

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industry uses these systems. Instead of relying on separate software for appointment booking, marketing, billing, and electronic health records, platforms like Adit, CareStack, Denticon, and Curve Hero provide an all-in-one solution.

- Smart toothbrushes: These provide real-time feedback *via* a companion app warning you if you are applying too much pressure, where you are brushing and even coach the user as to how to brush properly. And there are several such devices on the market from companies like Colgate and Oral-B.
- Augmented reality (AR): Image Navigation's DentSim simulator pairs AR with a mannequin on which students can perform procedures while receiving immediate feedback as their movements are tracked. This helps them identify faster where they should improve and develop their skills in the process.
- Virtual reality (VR): Nobel Biocare held the first dental surgery filmed through VR and allowed observers to virtually assist the whole procedure from the surgeon's perspective. In comparison, the first VR-recorded surgery was performed at the Royal London Hospital in 2016. Using augmented virtual reality can be very useful for complex procedures requiring careful planning and high precision, like oral surgery or implant installation.
- Computer-assisted design (CAD)/computer-assisted manufacture (CAM): CAD and CAM, including three-dimensional (3D) printing, are already revolutionizing the dental sector. With CAD/CAM technology, a computer image of a patient's prepared crown just manufactured the crown right in the office, 3D printers are also

able to produce orthodontic models, surgical guides, aligners, retainers and more dental equipment faster and more precisely; tasks that would take longer with traditional methods.[4]

- Intraoral cameras: MouthWatch, Dürr Dental, and Carestream Dental are some of the many companies to have launched intraoral cameras on the market. The latter promises revolutionary cameras, which are real "patient conversation starters." The cameras' unique liquid lens technology works like the human eye to ensure effortless image capture to deliver clear, detailed images. This allows you to spot potential problems earlier, feel more confident during operations, and perform dental procedures more accurately.

- Regenerative dentistry: The field of regenerative dentistry has paved the way for developments that can lead to self-healing teeth and biological therapy for damaged teeth. Previously, researchers from the University of Nottingham and Harvard University developed dental fillings that allow teeth to heal themselves. researchers at Karolinska Institute in 2020 were able to map the differentiation pathways of the cells that make up human teeth. They also discovered new cell types and cell layers in teeth that can impact tooth sensitivity.[5]

- Clustered regularly interspaced short palindromic repeats (CRISPR) and gene editing technology: Chinese researchers are conducting studies with the technology to isolate and switch off oral cancer-associated genes. Other researchers are using CRISPR to alter the functioning of bacteria responsible for plaque formation. Gene editing has expanded to include genome-wide screening for both loss and augmentation of function.[6]

- Robotic dentistry: Robotic-assisted dental technologies enable minimally invasive procedures and help dentists perform flapless techniques, thus avoiding unnecessary incisions and streamlining the recovery process for patients. Robotic systems that are currently being used offer precise guidance during surgery through haptic robotic technology. They prevent drill deviation or over-drilling past preplanned depths and ensure the surgeon avoids critical anatomy such as nerves or sinus cavities.

Dentistry has advanced in leaps and bounds from its beginnings to the present day, and mastering the proper use of technologies reduces the pressure on the dentist in office and patient management. If you know these technologies are on their way to becoming a regular part of dental practices worldwide, you can begin making preparations and thinking of ways to implement this new tech into your practice, improving the quality of your patient care.

Progressing in collaboration with intelligent machines and modern technologies, dentistry seems to have an optimistic future ahead.

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