Editorial

Future perspectives: Teleprosthodontics in the era of metaverse dentistry

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A R T I C L E   I N F O

1. Introduction

The COVID-19 pandemic reshaped global healthcare delivery, creating both challenges and opportunities for healthcare professionals worldwide. In particular, it accelerated the adoption of telemedicine and telehealth practices across various medical disciplines, including dentistry. As part of the broader trend of teledentistry, teleprosthodontics emerged as a viable means of providing remote care for patients requiring prosthetic rehabilitation. Prosthodontics, a field focused on restoring and replacing missing or damaged teeth through crowns, dentures and bridges, traditionally relies on in-person visits for consultations, impressions and insertion procedures. However, the need for social distancing during the pandemic forced practitioners to rethink the way they deliver care. Teleprosthodontics, which combines digital technologies such as intraoral scanning, 3D printing and virtual consultations, allowed for the continuation of care while minimizing patient and healthcare worker exposure to COVID-19.

In the post-pandemic world, teleprosthodontics presents a unique opportunity to enhance the accessibility, efficiency and cost-effectiveness of Prosthodontic care. The use of digital technologies in Prosthodontics has gained momentum, and the pandemic has only expedited its integration into routine clinical practice.

This paper explores the development, applications, challenges and future directions of teleprosthodontics in the post-pandemic era. It aims to provide an in-depth understanding of how teleprosthodontics can revolutionize care delivery, especially for underserved populations, while highlighting the technological innovations that underpin this transformation.

2. Discussion

2.1. The evolution of teleprosthodontics

Teleprosthodontics, as a branch of teledentistry, is the remote provision of prosthetic care facilitated by digital technologies. Historically, Prosthodontics relied heavily direct patient interaction. This included the need for in-person consultations, physical impressions and the hands-on insertion of dental prostheses.[1–4] In many cases, this process could be time-consuming, requiring multiple visits to the dental clinic. As the field evolved, digital technologies began to play a more prominent role, enabling more efficient and precise treatments. The emergence of intraoral scanners, computer-aided design (CAD), and computer-aided manufacturing (CAM) systems significantly transformed the practice of Prosthodontics by reducing the time required for prosthetic fabrication and improving the accuracy of restorations.

The COVID-19 pandemic, however, acted as a catalyst for the rapid implementation of teleprosthodontics. Social distancing measures and lockdowns severely restricted

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patient access to healthcare facilities. This forced many practitioners to explore alternative ways to deliver care remotely. Teleprosthodontics became an effective solution to meet the ongoing need for prosthetic services during this period. While the concept of teledentistry had been explored before, the pandemic pushed it to the forefront of dental care delivery. With the adoption of digital impressions, virtual consultations, and remote follow-ups, Prosthodontists were able to continue providing essential services while adhering to pandemic-related restrictions.[5–7]

2.2. Technological foundations of teleprosthodontics

The successful implementation of teleprosthodontics depends on a variety of digital tools and technologies. The most critical of these technologies include: Figure 1

2.2.1. Intraoral scanners

Traditional impressions using trays and impression materials are being replaced by intraoral scanners. These devices capture highly detailed digital impressions of the patient's oral cavity, which can be transmitted to Prosthodontists or laboratories in real time. Intraoral scanners reduce patient discomfort and improve the accuracy of the impressions, which is especially important for complex prosthetic designs. The digital data collected can be sent directly to the laboratory, where the design of crowns, bridges, or dentures can begin without the need for physical molds.

2.2.2. Cloud-based platforms

Teleprosthodontics relies heavily on cloud-based platforms for the storage, sharing, and management of patient data. These platforms allow for the secure transmission of 3D models, digital impressions, and treatment plans between the patient, Prosthodontists and laboratory technicians. Secure cloud platforms ensure that patient data is protected and comply with regulatory standards such as HIPAA (Health Insurance Portability and Accountability Act) in the United States, which mandates strict guidelines for patient confidentiality and security.

2.2.3. CAD/CAM systems

Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM) systems have revolutionized Prosthodontic practices by enabling precise design and fabrication of dental prostheses. CAD software allows Prosthodontists to digitally design crowns, dentures and bridges, while CAM systems help automate the fabrication of these prostheses. By integrating CAD/CAM with digital impressions, teleprosthodontics ensures that restorations are both accurate and efficient, reducing the need for multiple patient visits.

2.2.4. Teledentistry platforms

Various telecommunication platforms such as Doxy.me and DentalMonitoring have been developed to facilitate remote consultations and follow-ups. These platforms enable patients to communicate directly with their Prosthodontists through video calls, text messaging and the sharing of images or videos of their prostheses. Teledentistry applications also allow Prosthodontists to assess the condition of the prosthesis, monitor any potential issues and provide guidance on maintenance or adjustments.

These technological tools have made it possible for Prosthodontists to offer remote consultations, diagnostics and even treatment planning, which have proven to be effective alternatives to in-person visits during the pandemic.[8,9]
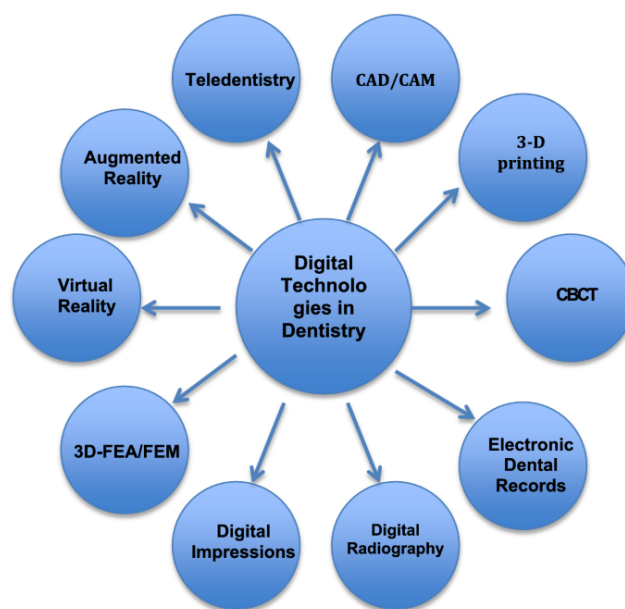

Figure 1: Technological foundations of teleprosthodontics

2.3. Advantages of teleprosthodontics

The integration of teleprosthodontics into clinical practice offers several advantages, not only for patients but also for healthcare providers:[8–11]

2.3.1. Improved accessibility

One of the most significant advantages of teleprosthodontics is its ability to provide care to patients in remote or underserved areas. For patients who live in rural regions or have limited mobility, teleprosthodontics removes geographical barriers to care. Virtual consultations allow patients to access specialist Prosthodontic services without the need to travel long distances, which can be especially beneficial for elderly patients or individuals with physical disabilities.

2.3.2. Continuity of care

Teleprosthodontics ensures that patients continue to receive care even when in-person visits are not possible. Virtual follow-ups allow Prosthodontists to monitor the progress of treatment, assess the condition of prosthetic devices, and provide timely adjustments or repairs. This continuity of care is essential for patients with complex needs who require regular monitoring and maintenance of their prostheses.

2.3.3. Cost-effectiveness

By reducing the need for multiple in-person visits, teleprosthodontics helps lower healthcare costs for both patients and providers. Virtual consultations eliminate travel expenses and lost work time for patients, while healthcare providers can optimize their schedules by conducting remote appointments. Additionally, the use of digital workflows for prosthesis design and fabrication reduces the time and labor required to produce high-quality restorations.

2.3.4. Patient engagement and satisfaction

Teleprosthodontics enhances patient satisfaction by offering greater convenience and flexibility. Patients no longer need to take time off work or make extensive travel arrangements for consultations or follow-up appointments. Moreover, many teleprosthodontics platforms offer features such as appointment reminders, treatment tracking and virtual education, which keep patients engaged in their treatment and informed about their care.

2.3.5. Collaboration and efficiency

Teleprosthodontics fosters greater collaboration between practitioners, laboratories, and specialists. Prosthodontists, general dentists, and lab technicians can all access the same digital models and treatment plans, making it easier to coordinate care and share insights. This improved communication streamlines the process of designing, fabricating, and adjusting prostheses, leading to faster treatment timelines and fewer errors.

2.4. Challenges and limitations of teleprosthodontics

Despite the many benefits, teleprosthodontics faces several challenges and limitations that need to be addressed for it to become a permanent fixture in Prosthodontic care:

2.4.1. Technical limitations

While digital impressions and remote consultations are effective, some aspects of Prosthodontic care still require in-person visits. Complex cases that involve intricate fitting or adjustments of prostheses may not be fully manageable through remote means. Furthermore, the quality of the digital impressions and scans depends heavily on the equipment used and low-quality images or scans can compromise the accuracy of the treatment.

2.4.2. Regulatory and legal issues

Teleprosthodontics must navigate the regulatory frameworks governing healthcare delivery, including licensing, data protection and reimbursement policies. Telehealth regulations vary by region, and Prosthodontists may face challenges related to patient privacy, insurance coverage, and cross-border consultations. For example, some regions may not reimburse teleconsultations or digital treatment planning, making it difficult for practitioners to offer these services sustainably.

2.4.3. Digital divide

Access to teleprosthodontics is limited by the availability of digital infrastructure. Patients who lack access to high-speed internet or digital devices may struggle to benefit from teleprosthodontic services. This "digital divide" presents a significant barrier to equitable healthcare delivery, particularly for older adults or those in rural areas with limited technological access.

2.4.4. Patient adaptation and digital literacy

Not all patients are comfortable with digital technologies, and some may find it challenging to engage with teleprosthodontic platforms. Older adults, who often constitute a significant portion of the Prosthodontic patient population, may lack the digital literacy required to navigate telemedicine systems or use intraoral scanning devices. Patient education and support are crucial to ensure the success of teleprosthodontics.

3. Conclusion

Teleprosthodontics has the potential to reshape the way Prosthodontic care is delivered, providing increased accessibility, cost-efficiency and patient satisfaction. While the COVID-19 pandemic accelerated the adoption of teleprosthodontics, its applications extend far beyond crisis management. Digital technologies such as intraoral scanners, cloud-based platforms, and CAD/CAM systems have already shown significant promise in improving the precision and speed of prosthetic care. The advantages of teleprosthodontics, including improved accessibility, continuity of care, and cost-effectiveness, are clear, particularly for underserved populations. [12]

However, there are several challenges to overcome, including technological limitations, regulatory hurdles and the digital divide that may restrict access for certain patients. For teleprosthodontics to thrive in the post-pandemic world, it is essential to address these barriers through improved infrastructure, policy reforms and patient education. As technology continues to evolve, the integration of artificial intelligence, augmented reality and virtual reality into Prosthodontics holds the potential to further revolutionize the field. With the right support, teleprosthodontics could be the future of prosthetic care, improving outcomes for

patients while reducing costs and increasing efficiency.

4. Conflict of Interest

None.

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