



NEW PERSPECTIVE ARTICLE:

Teledentistry's Evolution Post-COVID-19:
Moving from Crisis Response to Long-Term Solutions
La evolución de la teledetección después del COVID-19:
el paso de la respuesta a la crisis a las soluciones a largo plazo

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ABSTRACT: Telehealth, the use of telecommunications technology and electronic information to aid in healthcare delivery, has revolutionized patient care. Health communities have already approved telemedicine for treating certain acute and chronic diseases, while teledentistry has emerged as a distinct field within the broader scope of telemedicine. Numerous trials have demonstrated the value of teledentistry in reducing dental expenses and expanding dental care access to remote and rural areas. With technological advancements, teledentistry holds the potential to further enhance dental services and patient care. The COVID-19 pandemic has brought healthcare to the forefront of public concern. The need for close face-to-face contact with patients largely led to the suspension of dentistry services. However, the increased use of cell phones and related software packages integrated into "teledentistry" has facilitated easier clinical data exchange between patients and clinicians. This technology proved invaluable for dentists managing dental emergencies during lockdowns, providing an innovative means to resume dental practice. As a result, integrating teledentistry into routine dental practice as a complement to the existing dental system is advisable. It has the potential to revolutionize dental care for the better by expanding access to care and decreasing expenses. Given these circumstances, this review discusses the value and implications of teledentistry, highlighting its potential as a game-changing solution for the dental industry.

KEYWORDS: COVID-19; Telemedicine; Dental care; Technology.



RESUMEN: La tele salud, el uso de la tecnología de telecomunicaciones e información electrónica para ayudar en la prestación de atención médica, ha revolucionado la atención al paciente. Las comunidades sanitarias ya han aprobado la telemedicina para el tratamiento de ciertas enfermedades agudas y crónicas, mientras que la teledentología ha surgido como un campo distinto dentro del alcance más amplio de la telemedicina. Numerosos ensayos han demostrado el valor de la teledentología en la reducción de los gastos dentales y la ampliación del acceso a la atención dental en las zonas remotas y rurales. Con los avances tecnológicos, la teledentología tiene el potencial de mejorar aún más los servicios dentales y la atención al paciente. La pandemia de COVID-19 ha puesto a la atención de la salud en el primer plano de la preocupación pública. La necesidad de un contacto cercano cara a cara con los pacientes condujo en gran medida a la suspensión de los servicios odontológicos. Sin embargo, el aumento del uso de teléfonos celulares y paquetes de software relacionados integrados en la "teledentistry" ha facilitado el intercambio de datos clínicos entre pacientes y médicos. Esta tecnología resultó inestimable para los dentistas que gestionan emergencias dentales durante los bloqueos, proporcionando un medio innovador para reanudar la práctica dental. Por consiguiente, es aconsejable integrar la teledentología en la práctica dental de rutina como complemento del sistema dental existente. Tiene el potencial de revolucionar la atención dental para el mejor, ampliando el acceso a la atención y disminuyendo los gastos. Dadas estas circunstancias, esta revisión discute el valor y las implicaciones de la teledentología, destacando su potencial como una solución que cambia el juego para la industria dental.

PALABRAS CLAVE: COVID-19; Telemedicina; Atención dental; Tecnología.

INTRODUCTION

In the previous decade, tele-technology has received increased attention in the medical and dental industries, with the promise of a simple, rapid, and secure means to share and deliver health information (1, 2). Telemedicine has been widely used in academic medical centers, as well as both rural and community hospitals. It has also been used to provide consultations, connecting developing countries' hospitals to those of developed countries. The rapid progress in telecommunication and digital advances poses the possibility of a remote path in medical care providence (3). There are multiple ways of using telemedicine, like chatting, video calls, audio calls, and mobile health applications. Teledentistry, the young son of telemedicine, has become one of the most utilized modalities for patients, especially after the

emergence of the COVID-19 pandemic. Therefore, this review aims to highlight the current value and applications of teleconsultation in the dental field.

METHODOLOGY

The authors searched the PubMed and Google Scholar databases for articles evaluating the importance and implications of teledentistry before and during the COVID-19 pandemic. The articles in the English language were the only ones included. Moreover, we searched the bibliographies of the collected studies to identify additional relevant papers.

TELEMEDICINE

Telehealth is described as the use of telecommunications technology and electronic

information to assist in the delivery of health care, which may or may not include remote clinical services (4). Telemedicine differs from audio-only telephone contacts or other methods of remote patient monitoring or data collection in that it requires both auditory and visual components. Telemedicine can be provided either in real-time as live, two-way audio-visual interactions between patients and providers or via sharing recorded data, messages, and images with the doctor later. Moreover, patient remote monitoring in which the patient's vital data is sent to the health care provider (5).

In the past, the use of telemedicine focused primarily on urgent care issues, particularly acute respiratory infections (6). However, in the evolution of telemedicine, it is becoming more broadly used for a variety of applications, including specialty care for chronic disease management, screening of specific diseases, or monitoring of some chronic diseases (7). Telemedicine is increasingly being used to manage chronic illnesses such as diabetes (8), mental health difficulties, heart failure, nutrition, chronic obstructive pulmonary illness (9) and obesity. Telemedicine encounters are well-suited for urinary tract infections or upper respiratory infections, as well as evaluation of dermatologic conditions and management of depression and chronic anxiety (10).

Many examples can be mentioned; in patients with chronic heart failure, telemonitoring is used to predict and prevent acute decompensation episodes in heart failure patients by tracking symptoms that require optimization of therapy like an increased dose of diuretics. Although in systematic reviews and meta-analyses, the use of telemedicine showed benefits for individuals suffering from heart failure (11), in randomized trials, the use of telemedicine alone for monitoring patients with heart failure has not consistently shown benefits for a reduction in hospitalization and mortality (12). However, when used in the context of a broader disease management

program, the addition of telemedicine is likely to be of benefit.

Questionnaires have been one of the most successful adjunctive telemedicine tools for reaching many patients in a short time. Moreover, it can overcome the language barrier between physicians and candidates. Also, it can overcome bias and is more subjective. Using questionnaires was to assess health scores or risk stratification and some disease grading (13).

TELEDENTISTRY: TERMINOLOGY AND APPLICATIONS IN THE DENTAL FIELD

The term "teledentistry" was first introduced by Cook in 1997. He described it as the practice of video-conferencing technologies used to diagnose and give guidance regarding treatment over a distance. The birth of teledentistry can be traced back to a United States (US) army military project known as the Total Dental Access Project (TDA) in 1994 (14). The TDA project enabled the US military dentists to consult various dental specialists concerning their patients. The project aimed to improve dental services for patients' interests (15). Moreover, it was proved that teledentistry is valuable in reducing dental expenses and can extend dental care to remote and rural areas (16). With the advancement of technology, there is more that teledentistry could offer to improve dental service and patient care.

Teledentistry can be considered as one of the specific fields of telemedicine concerned with dentistry. It is based on the interchange of images and clinical data across remote distances (17). Several researchers have proven that teledentistry can be used for treatment planning and as an alternative for specialists' consultation, particularly in rural areas where deficit specialization is present (18). With the use of teledentistry, quality improvement research addressing oral health care in elderly individuals in rural Queensland, repor-

ted enhanced health care plans and reduced the need to consult an oral health care system (19). Nowadays, the acceptance of teledentistry is increasing in advanced countries. However, introducing teledentistry in developing countries is still questionable (17, 20).

Although dental care is primarily based on procedures and examinations, scientists have demonstrated that teledentistry can be effective in a variety of dental fields. Teledentistry is a useful tool for diagnosing, following up (monitoring), and treating oral lesions (21). In situations where patient transport is difficult or expensive, it could aid in the diagnosis and preoperative evaluation of third molar impaction cases (22). Based on photographs of endodontically accessible teeth, it might be utilized to locate root canal orifices and identify periapical lesions, enabling immediate assistance (23). General dentists can use teledentistry to arrange orthodontic treatments while orthodontic specialists observe them from afar. This has proven to be a viable means of reducing the severity of malocclusions in children when an orthodontic referral is not possible (24). It also cuts down on unnecessary orthodontic referrals and gives general dentists immediate access to specialist guidance (25). In prosthetic or oral rehabilitation, video conferencing can help with diagnosis and treatment planning (26). Perio surgeons can use video chat to supervise follow-up and suture removal after perio surgery. Teledentistry is also useful for screening dental caries in children (27) (Figure 1).

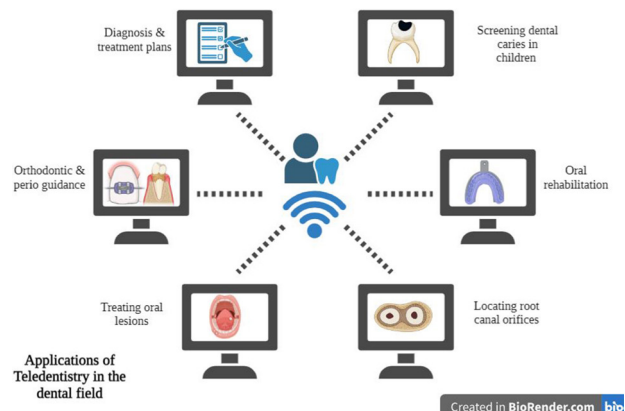


Figure 1. A diagram showing some of the applications of teledentistry in the dental field.

ROLE OF TELEDENTISTRY IN PREVENTION OF COVID-19 DISSEMINATION

The pandemic of COVID-19 has posed unique obstacles for healthcare providers. A quarantine was established in many nations during the epidemic, prohibiting free movement even for emergencies. It was advised to avoid going to hospitals, dental offices, or other medical institutions because they could spread the virus (28). Many dental offices were closed during the quarantine to reduce the spread of infection because most dental treatments include the formation of microorganism-contaminated aerosols and droplets, and the dental setting has been proven to be a substantial source of transmission (29). As a result, the dentist is more likely to become sick from his or her patients and pass the infection on to their family. In the minds of the dentists, this created a sensation of terror and worry (30). To address this, teledentistry provi-

ded solutions which allow virtual consultations and follow-ups instead of physical contact and face-to-face clinical examinations. The internet is now playing a crucial role in establishing a robust connection between dentists and patients, thanks to high-speed mobile data. It is now feasible to perform teledentistry using smartphones, laptops, and various video conferencing software tools. This was particularly useful during the pandemic to reduce the likelihood of COVID-19 dissipation, allowing patients to attend the dental clinic only when necessary (31).

During the COVID-19 pandemic, teledentistry tools were crucial for triaging patients before receiving them for urgent dental services in educational institutions, hospitals, and private clinics (32). Several studies demonstrated the importance of teledentistry in the care of urgent cases and patient follow-up. In a recent pilot study, telemonitoring appeared to be a promising tool in the remote monitoring of urgent dental/oral pathological issues and for follow-

up either after surgical operations or for chronic conditions, notably in terms of lowering expenses, waiting times, limiting human interaction, and minimizing the danger of COVID-19 spreading (33). This is in line with other studies that have suggested reducing face-to-face dental appointments to reduce the risk of infection and illness transfer from person to person, especially SARS-COV-2 (34). Moreover, during the COVID-19 pandemic, Brazilian researchers demonstrated the use of WhatsApp and telemedicine in the differential diagnosis of oral lesions (35). Additionally, telecommunication played a significant role in the management of symptoms related to oral and maxillofacial pathology (36, 37, 38, 39), orthodontic issues (40), pedodontics problems (41, 42), as well as emergency and non-emergency cases of prosthodontics during the pandemic (43). However, teledentistry was not a suitable treatment option for cancer patients, but it enhanced their general health by maintaining oral health of the oral cancer patients (44, 45) (Table. 1).

Table 1. Examples of teleconsultation role in prevention of COVID-19 dissemination.

Author & year of publication	Country	Study design	Target participants	Application	Main result
Giudice <i>et al.</i> (33)	Italy	Pilot Study	G1: Patients with urgent pathological condition G2: Patients in follow-up	WhatsApp, Messenger	Teledentistry reduced the risk of COVID by enabling patient monitoring with minimal human contact.
Machado <i>et al.</i> (35)	Brazil	Case report	Patient with urgent pathological condition	WhatsApp, Messenger	Teledentistry reduced the risk of COVID by enabling patient monitoring with minimal human contact.
Alsafwani <i>et al.</i> (36)	USA	Retrospective	Patients with pain secondary to pathological conditions or previous treatment	Zoom video Communications	Teledentistry played a significant role in the management of symptoms related to oral medicine, with various benefits over in-person visits during the pandemic.
Barca <i>et al.</i> (37)	Italy	Pilot study	G1: Patients with urgent pathological condition G2: Patients in follow-up	WhatsApp, Messenger or Telegram	Teledentistry improved accessibility to oncological and non-management activities, as well as reduced the risk of COVID by enabling patient monitoring with minimal human contact.
Meurer <i>et al.</i> (38)	Brazil	Editorial letter	Patients with pathological conditions.	Telephone & video calls	Teledentistry was useful to provide clinical and supportive care to patients with oral diseases during the pandemic.
Muniz <i>et al.</i> (39)	Brazil	Case report	Patient with oral burn	WhatsApp, Messenger	Teledentistry was an effective way for oral diagnosis and treatment.
Crawford & Taylor, (40)	UK	Pilot study	Patients with orthodontic issues.	NHS England's Attend Anywhere platform	Teledentistry was not the solution to deliver a full service as orthodontic treatment demands practical treatment, however, it played a significant role in some emergency cases.
Brecher <i>et al.</i> (41)	USA	Comparative study	Children with orthodontic or urgent pathological conditions	Teleconsultation	Teledentistry was used to manage almost half of emergency situations in pediatric dentistry.
Wallace <i>et al.</i> (42)	UK	Pilot study	Children with pathological conditions, particularly caries	'BigWord' telephone interpreting service	Teledentistry had an effective role in pediatric dentistry, improved safety and provided convenience for both parents and children during the outbreak.
Aldhuwayhi <i>et al.</i> (43)	KSA	Minireview	Elderly patients with partial or complete denture	WhatsApp, Messenger, Instagram, Skype	Teledentistry was essential for management of all prosthodontic non-emergency and emergencies during the pandemic.
Kochhar <i>et al.</i> (44)	India	Pilot study	Patients in follow-up after oral cancer therapy	Telephone & video calls	Teledentistry was an effective way for maintaining oral health of the oral cancer patients and in turn their quality of life.
Rajendran <i>et al.</i> (45)	Malaysia	Pilot study	Patients with oral potentially malignant disorders (OPMD)	MeMoSA@2.0	Although Teledentistry may not be appropriate for many patients and does not replace emergency care, it can improve their overall health.

TELEDENTISTRY AND COVID-19 RESEARCH

Several studies demonstrated the importance of telehealth in the research field to learn more about the pandemic, either by exploring a potential risk factor or investigating the presence of new dental and oral symptoms.

Kamel *et al.*, 2021 (46) study conducted on 308 participants demonstrated the effect of the oral health status of recovered COVID-19 patients on the severity of their symptoms. This was assessed via a detailed questionnaire designed by experts in the dental and medical fields. The first section of the questionnaire remotely evaluated the oral

health status of the participants, while the second section was for COVID-19 severity assessment. The researchers created an oral health score by which the participants were categorized according to their answers into three groups: poor, fair, and good oral health. The interpretation of COVID-19 severity classified patients according to their symptoms into mild and severe cases. The authors estimated a cut-off value that showed high sensitivity and specificity, suggesting the usage of this detailed questionnaire in evaluating oral health on a larger scale for COVID-19 severity prediction.

AbuBakr *et al.*, 2021 (47) study proved that mild and moderate cases of COVID-19 infection are coupled with oral symptoms. They designed a questionnaire survey which was conducted on 665 Egyptian patients with confirmed COVID-19 infections based on the polymerase chain reaction (PCR) test. The recovered participants reported the oral manifestations they suffered from while being infected with COVID-19. This survey was one of the first published trials to highlight the oral manifestations of COVID-19.

ACCEPTANCE OF TELEDENTISTRY

DENTISTS' ACCEPTANCE OF TELEDENTISTRY

Numerous studies on the perceptions, effectiveness, and applications of teledentistry have been undertaken in a variety of nations. Estai *et al.*, 2016 (48) investigated Australian dentists' attitudes towards the use of teledentistry and found that a majority of 80% felt that utilizing teledentistry has positive outcomes for both dentists and patients. Palmer *et al.*, 2005 (49) found similar results in a Canadian survey, with the majority of orthodontists supporting the use of digital and electronic technologies in dental practice. A significant majority of respondents in a recent questionnaire-based study conducted in Saudi Arabia believed that teledentistry would enhance dental practice by improving contact with peers, counseling, and

referral of new patients (50). Furthermore, an observational study based on an electronic survey sent to dental professionals all over the world found that the general influence of teledentistry on dental professionals was good, with a sufficient desire to implement this modality into their clinical practice (51).

However, dentists' reluctance to accept teledentistry might be related to the fact that they may be resistant to learning new skills. They may be technically illiterate, fearful of giving an incorrect diagnosis, and anxious about rising expenditures and expenses. Infrastructure restrictions may include insufficient internet access, a paucity of hardware, a lack of training, and a lack of technical support and knowledge. Other obstacles to teledentistry's acceptance by dentists include organizational incompatibility with the healthcare system, inadequate financial payback, poor guidelines, incoordination between the remote and core centers, and excessive setup costs (52). Other limitations include a two-dimensional display of lesions and the difficulty of performing tests such as auscultation and palpation (53).

To overcome these obstacles, dentists must be thoroughly trained and educated about this method, which will boost teledentistry's adoption. After this pandemic, not only should the dental school curriculum be updated on infection control measures (54) but teledentistry should also be taught as a method for infection transmission prevention. In addition, proper funding, payment, and authentication of teledentistry will be necessary within the healthcare systems.

PATIENTS' ACCEPTANCE OF TELEDENTISTRY

Any module's success hinges on patient acceptance. Patients may fear that their difficulties are not being communicated properly to their dentists due to a lack of face-to-face communication. Patients' acceptance of teledentistry will rise

in lockstep with the overall acceptance of telemedicine, which is growing by the day. Teledentistry is progressively gaining favor among consumers and healthcare practitioners, according to numerous polls (52, 55).

PITFALLS OF TELEDENTISTRY

Even while teledentistry is a benefit to dentists in these challenging times, nothing compares to the precision of a professionally executed patient diagnosis. The several fundamental steps of diagnosis, the most significant of which are palpation and percussion, cannot be performed in teledentistry. Only preventive and diagnostic procedures benefit from teledentistry. If a patient needs treatment, he must come to the clinic for restorations, extractions, and endodontic treatments. Clinical photography is used to make a diagnosis, which may change depending on face-to-face conversation (56, 57). The precise representation on intraoral pictures or video recordings may differ from what is actually present.

The expensive cost of telemedicine equipment is an obstacle. Another stumbling block is the payment of the teledental oral healthcare practitioner. The topic of "who pays the teledentistry service provider?" remains unanswered. There are currently no protections in place to ensure the security and effectiveness of information and its transmission, posing a high risk of unauthorized access. As a result, to prevent the aforementioned issues, well-defined requirements protocols are required. Access to the internet could be a significant challenge. If internet access is lost when providing teledentistry services or transmitting data, for example, the consultation session may be canceled, or a misdiagnosis may occur.

Both the service seeker and the service provider must have some computer skills for teledentistry to work. As a result, people in

locations where teledentistry will be used must be trained. This training will require both money and time. Furthermore, because the majority of teledentistry-based teaching programs are in English, they must be translated into many languages to be used globally (58).

CONCLUSION

With today's technological breakthroughs in dentistry, dental professionals may soon be able to connect to virtual dental health clinics, ushering in a new era of dentistry. When long-term dental treatment is unavailable, such as in rural locations or during pandemics, teledentistry could be used. The preliminary findings are quite promising. However, various obstacles must be resolved before teledentistry may reach its full potential. More research is needed, especially on the best modalities and their costs and advantages.

Finally, in the near future, would teledentistry improve and gain more implications with the development of higher technology in visual and audio services? And would it be acceptable in different patients' cultures? Or teledentistry will return to the pre-COVID-19 era.

AUTHOR CONTRIBUTION STATEMENT

Conceptualization and design: A.H.M.K., A.B. and N.A.

Literature review: A.H.M.K.; A.B., G.A. and N.A.

Methodology and validation: A.H.M.K., A.B., G.A. and N.A.

Formal analysis: A.H.M.K., A.B. and N.A.

Investigation and data collection: A.H.M.K., A.B., G.A. and N.A.

Data analysis and interpretation: A.H.M.K., A.B., G.A. and N.A.

Writing-original draft preparation: A.H.M.K., A.B., G.A. and N.A.

Writing-review & editing: A.H.M.K., A.B., G.A. and N.A.

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