

# Teledentistry: A Need of the Hour

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## ABSTRACT

Almost two-thirds of the Indian population lives in rural areas and is unable to get good oral health care services due to various barriers like poverty, lack of transportation, lack of education and awareness, etc. An amalgamation of telecommunication and dentistry is known as 'Teledentistry', which involves switch-over the clinical information in remote areas for diagnosis, consultation, health education, and treatment planning. Due to the enormous growth of technological capabilities, teledentistry possesses the potential to fundamentally change the current practice and the face of dental care. It also has an immense perspective to overcome the disparities in oral healthcare between rural and urban populations. This review focuses on the wide range of use of teledentistry in all the specialities in dentistry, and also focuses on the future perspective of teledentistry and its need in Indian scenario.

**Key words:** Teledentistry, Telemedicine, Telecommunication, Public health, India

## INTRODUCTION

According to the 2012 World Health Organization (WHO) fact sheet on oral health, "Oral health is essential to general health and quality of life. It is a state of being free from mouth and facial pain, oral and throat cancer, oral infection and sores, periodontal (gum) disease, tooth decay, tooth loss, and other diseases and disorders that limit an individual's capacity in biting, chewing, smiling, speaking, and psychosocial wellbeing".<sup>[1]</sup> Oral diseases are a burden for developing countries such as India, especially among the rural masses.<sup>[2]</sup> Prevalence of oral diseases is very high in

India with dental caries (50%, 52.5%, 61.4%, 79.2%, and 84.7% in 5, 12, 15, 35–44, and 65–74 years old, respectively) and periodontal diseases (55.4%, 89.2%, and 79.4% in 12, 35–44, and 65–74 years old, respectively) as the two most common oral diseases.<sup>[3]</sup> It is also well documented that there is an association of oral health with various systemic conditions such as diabetes, cardiovascular disorders, pregnancy, and its impact on the quality of life.<sup>[4,5]</sup>

Technology plays a significant role in our lives. In today's world, its next to impossible to imagine a life without the use of technology. Remarkable progress in telecommunication technology has had and will continue to have an enormous impact on oral health care services. In particular, digital technology that integrates transmission, switching, processing, and retrieval of information provide opportunities to deliver various types of health care modalities irrespective of the distance between the care-provider and care-receiver. Teledentistry is a relatively new field that combines telecommunication technology and dental care. Due to the enormous growth of technological capabilities, teledentistry possesses the potential to fundamentally change the current practice and the face of dental care.<sup>[6]</sup> 'Teledentistry' allows a whole new way of providing specialist advice. Through the use of telecommunication and computer technologies, it is now possible to provide interactive access to specialist opinions that are not limited by the constraints of either distance, space, time, or any other barriers.

## NEED FOR TELEDENTISTRY IN INDIA

In India, the dentist population ratio is 1: 8,000 in urban areas and 1: 50,000 in rural areas, which is much lower than the ideal ratio suggested by WHO. For the majority of the population that resides in a rural area, the only source of health care is primary health centres where the majority of the professionals are the medical practitioners. Also, dental professionals are less accessible to the population as compared to the medical ones in rural areas. The reasons for this lack of oral health care are the main barriers like poverty, geographical location, inadequate financial coverage for the dental treatments, social and cultural barrier, lack of workforce, lack of transportation, lack of knowledge and awareness of oral health, etc. In a country like India where the 2/3rd population lives in rural areas and unable to get good oral health services, teledentistry is a boon without any doubt. [7,8]

## HISTORY OF TELEDENTISTRY

Teledentistry had emerged from Telemedicine, being defined as the use of Information and Communication Technologies (ICT) for the exchange of data and health information and to provide health services in situations where there is a need to overcome geographical, temporal, social and cultural barriers. [9] The origin of the use of teledentistry lies in telemedicine, which was firstly used in the 1970s in NASA. [10] The term “teledentistry” was first used in 1997 when Cook defined it as “the practice of using video-conferencing technologies to diagnose and to provide advice about the treatment over a distance”. [11] In this scenario, the National Health System reported concern about the dental assistance of patients living in remote and isolated regions, declaring that Teledentistry is a support alternative for dentists who works in these regions, [12] presenting itself as a more accessible way to provide services to the population in distant. [13]

## TYPES OF TELEDENTISTRY

Currently, there are two basic types of teledentistry:

- **Two-way interactive technology:** This is the commonly used type of teledentistry in which by the use of video-conferencing or basic telecommunication patients can consult with their dentist in real-time at different locations with advanced telecommunication technologies and internet connections. This technology also assists general dentists to consults with their peer dentist for any special case, then plan the treatment accordingly. [8]
- **Store and forward type of teledentistry:** In this method, all information assembled and stored then relocates the information onward to consulting practitioners from different locations. The stored data includes all relevant information including the patient’s history, photographs, x-rays, MRI scans, etc. [8]

## ADVANTAGES OF TELEDENTISTRY

The scope and advantages of teledentistry are as follows:

- **Access to care for underserved and undertreated population:** In a country like India, Teledentistry is extremely beneficial to the elderly, poor, underprivileged people. As a result, the majority of this group of patients can avoid hospital-based treatment entirely and need for expensive transport, with the added advantage of reduced patient’s anxiety and the chance of hospital-acquired diseases. [14]
- **Cost-effective:** The initial setup cost of teledentistry equipment is high, but this is a one-time investment, and the cost is negligible later on. The cost effectiveness of teledentistry is greatest in the remote communities as the need for expensive transport can be avoided. [14] Mobile phones with various internet-based applications can prove to be the simplest means of communication

with virtually no extra cost. Recently, there have been many mobile applications coming up for the common man for their general and dental health, which they can access round the clock without an extra expense.

- **Less time consuming:** As the travel time for the patient is greatly reduced, and accessibility of specialist is almost within a few minutes, there is a substantial reduction in time. [15] All images can be reviewed within a few minutes of received and patients can be contacted within a few hours of image review and can be invited to undergo an oral mucosal examination later if required. [16]
- **Enhanced communication:** Teledentistry involves sending clinical images or audio files to a colleague to compare opinions and peer consultation which can often lead to better prognosis. [16] It also enhances communication between the dentist and laboratory personnel. Enhanced communication leads to early, correct, and swift management of oral pathologies, thus improving patient's quality of life.
- **Early diagnosis:** Teledentistry may help in early diagnosis, and also in preventive treatment as well, for example, early diagnosis and proper management of precancerous lesions help to prevent a benign lesion to turn into a malignant one. Besides, carious lesions can be detected at an early stage by this method and proper treatment can be planned accordingly for the patient. [17]
- **E-prescription:** With the help of teledentistry, the patient can receive medicinal treatment without even traveling to a specialist in far areas. However, the patient should be asked regarding drug allergies and other health problems. In case, the patient is not recovering, he/she should visit the specialist personally. [17]
- **Aid in training dental personnel at the remote site:** It is seen that there is a

scarcity of specialists in remote areas. For this, sometimes it is needed to train the dental team at the remote site, thus leading to enhanced training of dental personnel. [17]

- **Storage of data:** Information regarding patient detail can be stored in computers and mobile phones for record purposes and this data, if required can be further transferred to a specialist for diagnosis and treatment planning. These can be accessed anytime, and their records can be sent for a second opinion from specialists. This further saves the time of the specialist and the patient. It can also help in solving criminal cases with the help of forensic dentistry. Stored data can also be used in various retrospective studies, cohort studies, and surveys. [17]

## USES OF TELEDENTISTRY IN VARIOUS DENTAL SPECIALITIES

### Oral pathology, medicine, diagnosis, and radiology

- Oral lesions can be electronically photographed and clinical data can be stored in a textual file. The diagnosis could be further improved with the use of a comprehensive electronic patient history containing previous medical records, drug history, family history. [18] Therefore, in cases of orofacial disorders such as oral cancer, temporomandibular joint disorder, oral mucosal diseases, salivary gland disorders, orofacial pain disorders, and infective orofacial lesions the role of remote consultation can be of great help. Aziz and Ziccardi et al. reported that simple smartphones can provide fast and easy access to electronically mailed digital images. [19]
- OralCDx is a method for screening oral lesions that involve a brush biopsy and computerized analysis of the histologic slide, allowing for screening of patients for premalignant or malignant lesions. These tools help to consult an expert or specialist through the available telecommunications channels. [20]

- Digital radiology including Intraoral periapical radiographs, panoramic radiographs, cone-beam computed tomography (CBCT), CT, and magnetic resonance imaging can be transferred to a specialist through the internet for consultation. [20] Images can also be transferred to the specialist for peer consultations and second opinions from remote areas, thus saving a lot of time and obtaining an accurate diagnosis.
- Dental insurance authorization, maintenance of records, retrieval of records, and for forensic purposes and continuing education are the other potential application of teledentistry.

#### **Oral and maxillofacial surgery**

- Impacted teeth can be evaluated by interpreting a radiograph and taking proper history including the age of the patient, signs, and symptoms.
- Guidance in placements of dental implants.
- Prescribing medications for oro-facial infections and abscesses can also be done with the help of simple telecommunication or video conferencing. [18] Duka et al. (2009) investigated the practical usability of telemedicine for the treatment of impacted third molars and concluded that diagnostic assessment of impacted or semi-impacted third molars assisted by the telemedicine approach was equal to the real-time assessment of clinical diagnosis. [21]

#### **Periodontology**

- Patient's education and motivation.
- Teledentistry could be an extremely effective audio-visual aid to deliver oral hygiene instructions including brushing techniques, flossing technique, use of interdental cleaning aids, chemical plaque control methods, etc.
- Evaluation of dental implants for peri-implantitis through the obtained radiographs.
- Increase the awareness regarding the relationship between periodontitis and systemic health and how poor oral

hygiene can lead to several systemic disorders such as cardiovascular disease, respiratory diseases, diabetes mellitus, cerebrovascular complications, pregnancy-related complications can be beautifully explained to the patients in distance, saving their time, number of appointment and transportation.

#### **Orthodontics**

- Minor emergencies such as rubber ligature displacement, irritation due to the orthodontic appliance can be solved by telecommunication in the field of orthodontics, thus limiting visits to the dental office. [14]
- Peer teleconsultants, if required, may also participate from a distance in the creation of a plan and program of orthodontic management, using a digital patient model. [15] Berndt et al (2008) had shown in his study that Interceptive orthodontic treatments provided by sufficiently prepared general dentists and supervised remotely by orthodontic specialists through teledentistry are a viable approach for decreasing the severity of malocclusions in underprivileged children when referral to an orthodontist is not possible. [22]

#### **Pedodontics and preventive dentistry**

- Prevention and early detection of caries.
- The method of teledentistry has been demonstrated as an excellent alternative in children afraid of dentists, reducing their fear and anxiety compared to clinical examination in real-time. [18] Kopycka-Kedzierawski and Billings et al (2013) had successfully demonstrated that Teledentistry examinations were comparable to clinical examinations when screening for early childhood caries in preschool children. [23]
- Home application of fluoride can be shown through teledentistry.
- Traumatic injuries to the teeth, which are very common in children, can be primarily managed with the help of telecommunication from the distant, thus reducing the time gap between injury and primary care, which



ultimately increases the chance of the survival of a traumatized tooth, especially in situations like avulsion.

- The effects of nutrition on oral health can be explained audio-visually to the parents.
- Diet counselling which is the first and foremost treatment modality for Early Childhood Caries, can be done from distant.

### Endodontics

- Detection of caries, interpretation of periapical lesions through the obtained radiographs, prescribing medications for abscesses, preparation of crowns using Computer-aided design and computer-aided manufacturing (CAD-CAM) systems are a few of the major use of teledentistry in the field of endodontics. Baker et al. have demonstrated that there is no statistically significant difference in the interpretation of periapical lesions between the images viewed locally (using a viewBox) and images transmitted through a video-conferencing system.<sup>[17]</sup>

### Prosthodontics

- Occasionally, communication is required between the dentist and the laboratory technicians for the fabrication of prostheses. In such cases, colored images of the patients' teeth can be sent for shade selection, size, shape, and contours of the prosthesis to be fabricated.<sup>[3]</sup>
- CAD-CAM systems are gaining precedence in the manufacturing of individual dental crowns, dental inlays, and onlays, over traditional hand modeling and casting of prosthetic reconstructions.
- Digital impressions are replacing conventional impression techniques where the jaws are scanned and sent as a computer file to the dental laboratory for fabrication of the various prosthesis.
- Post-insertion instructions, temporary changes in chewing habits, and speech can be explained through

telecommunication, thus benefitting the patient by saving their time and cost of transportation.<sup>[24]</sup>

### Forensic dentistry

- Since the digitization of data is required in teledentistry, the data are stored and can be used retrospectively. It can thus help in solving criminal cases related to forensic dentistry. Stored data can also be used in various retrospective studies, cohort studies, and surveys.

### TOOLS USED IN TELEDENTISTRY

**A plain old telephone system (POTS)** is a frequently used tool for telecommunication. The cost of using this method is low and affordable. Two methods of POTS are real-time method and store and forward method. By the real-time method, we can relocate information without any delay whereas by stored and forward method there is a need to allow the storage of data on the local database then forwarded whenever required. The POTS is very reliable and runs through Telephone Company at the low speed.<sup>[8]</sup> **ISDN (Integrated services digital network)**, is a set of communication standard network which transmits information in the form of voice, video, data, and other network services over the traditional circuits of the public switched telephone network. This method of information broadcast increases trustworthiness and accessibility in teledentistry. Although building an ISDN network worldwide is quite difficult. **Worldwide web-based teledentistry** is also an important tool in transferring the information and unlike ISDN it is available in most cities and cost-effective also. Apart from the tools used in telecommunication, a good instructor is needed with well-organized education, teaching experience, and computer knowledge to work in teledentistry. All educational courses should be guided by a sound instructor with experience in online communication.<sup>[8]</sup>

**MODEL OF TELEDENTISTRY**

James Friction et al (2009) has proposed a basic model for teledentistry (Figure- 1) [25]

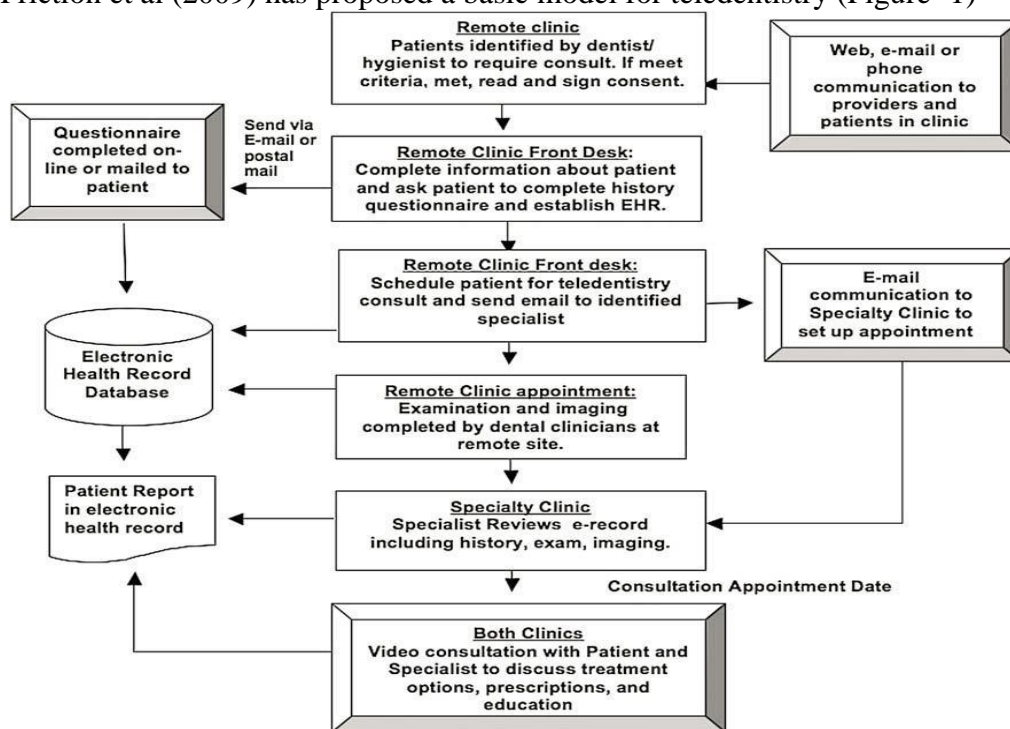


Fig 1: Model of teledentistry

**EVIDENCE ON APPLICATIONS OF TELEDENTISTRY IN VARIOUS DENTAL SPECIALIZATIONS (Table: 1)**

Table 1: Studies on applications of teledentistry in various dental specializations

Specialization	Author	Purpose of study	Conclusion
Oral medicine [26]	Torres-Pereira et al. (2013)	To evaluate the applicability of Telediagnosis in oral medicine through the transmission of clinical digital images by e-mail	Use of information technology can increase the accuracy of consultations in oral medicine. As expected, the participation of two remote experts increased the possibility of correct diagnosis
Oral medicine [27]	Almeida Castro et al. (2014)	To determine whether a teledentistry system is a valid tool to screen for the presence of dental caries	Teledentistry appears to be a reliable alternative to the traditional oral examination for dental caries assessment
Pedodontics [28]	Purohit et al. (2016)	To assess the reliability of video-graphic method as a tool to screen the dental caries among school children	Teledentistry may be used as an alternative screening tool for assessment of dental caries and is viable for remote consultation and treatment planning
Periodontics [29]	Rocca et al. (1999)	To evaluate the removal of sutures 150 miles away under the telesupervision of the periodontist	Patients felt that they have received better care and dentists were also comfortable in making decisions
Orthodontics [30]	Favero et al. (2009)	To codify a distance communication method based on teleassistance	The possibility of sharing videos and images is particularly useful in the orthodontic field, as minor emergencies can be solved easily at home, reassuring patient and parents on one hand, and limiting visits to the dental office to cases of real need
Endodontics [31]	Brullmann et al. (2011)	Remote recognition of root canal orifices was tested on endodontically accessed teeth acquired with an intra-oral camera	Recognition of root canals by experienced dentists can help younger colleagues in the detection of root canal orifices
Prosthodontics [32]	Ignatius et al. (2010)	To investigate whether videoconferencing could be used for diagnosis and for making treatment plans for patients requiring prosthetic or oral rehabilitation treatment	Video consultation in dentistry has the potential to increase the total number of dental specialist services in sparsely populated areas
Oral and Maxillofacial Surgery [33]	Miladinović et al. (2013)	To assess the possibility of using telemedicine methods in the pathology for patients with suspected odontogenic infection	The method of telemedicine provides us with a tool to make a correct clinical diagnosis of odontogenic infections equally well as in real time, as well as to suggest adequate treatments

## LIMITATIONS OF TELEDENTISTRY

[17]

- **Treatment requires a visit to the clinic:** Teledentistry may only help in preventive and diagnostic procedures. For most of the dental treatments, the patient needs to visit the specialist.
- **Technique sensitive and time-consuming:** It can be time-consuming for both the specialist and patient, as the process of procuring digital photographs of an oral lesion, transferring photos to a device connected to the internet and forwarding the picture as an attachment to get a diagnosis requires expertise and knowledge of technical details. Technical snag and poor network can lead to delays in teleconsultations.
- **Initial investment:** Though it is a one-time investment, the initial cost of equipment is high. For instance, to capture high-quality images, a special intraoral camera or digital camera is required, and high-speed internet is also required which increases the cost.
- **Virtual examination:** Diagnosis is based on clinical photography that may change on face-to-face communication. [9] The accurate display on intraoral photographs or video recording may be different than what is present actually. Additional diagnostic aids such as percussion and palpation cannot be performed.
- **Decreased accuracy:** Specialists cannot perform hands-on examination. A patient has to rely on the examination performed by the dental team at the remote site, thus making the diagnosis less accurate. [2]
- **Legal issues:** Telemedicine and teledentistry also raise a concern about the confidentiality of medical and dental information. Therefore, informed consent should be taken from the patient and the patient should be made aware of the inherent risk of improper diagnosis or treatment due to the failure of technology. [12] Technical problems

occurring during data transmission may cause misdiagnosis or medical error. Issues of responsibility and malpractice also need to be considered. [7] The licensure of teledentistry practice largely depends upon the country's definition of teledentistry. [13]

- **Language barrier:** Most of the teledentistry-based education programs are in English, and rural people, especially in India, are not well versed with this language. The web may be a worldwide tool, but future goals should include consideration of more multilingual programs. [7]

## POSSIBLE REASONS FOR SLOW ADOPTION OF TELEDENTISTRY BY ORAL HEALTHCARE PROFESSIONS [34]

- Lack of infrastructure planning and development
- Telecommunications regulations
- Reimbursement for telemedicine services, due to absent or inconsistent policies
- Licensure and credentialing, based on conflicting interests concerning ensuring the quality of care, regulating professional activities and implementing health policies that can vary by state or country
- Medical malpractice liability due to uncertainties associated with the legal status of telemedicine within and between states
- Confidentiality issue due to possible increased risk of unauthorized access to patient information compared with hard copy records
- Fear that telemedicine will only increase the current workload of healthcare workers, especially in a transitional phase
- Fear that telemedicine is market-driven, instead of being user-driven, with the danger of market-driven abandonment of products and technologies.

- Rapid technological advances are resulting in fear of technological obsolescence.
- Lack of attention to knowledge and skills of users
- Lack of standardization

## CONCLUSION

Hence, we have reviewed the definitions, history, evidence, and use of teledentistry in clinical oral health care and education. In rural areas, where there is a shortage of specialists, the lack of comprehensive and sophisticated health care is a problem. The use of teledentistry as a way to enhance access to oral health services in areas with inadequate availability of general and specialty dental care. Teledentistry can emerge as a practical solution in emergency aid, initial consultation, and expert opinion, especially for rural parts of India. Setting aside the issues associated with using a teledentistry system and despite the limitations described, this review demonstrates that using teledentistry in the management of patients with oral diseases can work successfully. Dentistry, in a synergistic combination with telecommunications technology and therefore, the Internet, has yielded a comparatively new and exciting field that has endless potential. More studies are needed to be carried out showing the effectiveness of this technology though. However, with few drawbacks and constant efforts to combat them, teledentistry has a very promising future and a long way to go.

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