Teledentistry: A cornerstone of Dental practice- A Review

Dr. K. Srinivasan¹ and Dr. S. Chitra²

¹. SENIOR LECTURER, DEPARTMENT OF PEDODONTICS AND PREVENTIVE DENTISTRY, ADHIPARASAKTHI DENTAL COLLEGE AND HOSPITAL, MELMURUVATHUR (T.N STATE).
². ASSOCIATE PROFESSOR, DEPARTMENT OF ANAESTHESIA, CHRISTIAN MEDICAL COLLEGE, VELLORE (T.N STATE).

Abstract:

Our duty, as Doctors, is to offer to our patients the best possible solutions at the moment. However, there are moments when we are ready and willing to offer the best, but because of the circumstances, we are unable to do that. Perhaps the most important adverse treatment consequences result from wrong diagnosis and wrong and improperly conducted treatment.

The purpose of this article is to highlight the various aspects on Teledentistry and also describes the possibility of effectuating consultation with our remote colleagues, also illustrates as to how Teledentistry can be an effective solution for Dentists and their patients.

Teledentistry is newly introduced technology in the field of Dentistry. Until now, Telemedicine has been successfully used in many Medical specialties but not so widely used or accepted in Dentistry (Teledentistry).

Teledentistry is a synergistic combination of telecommunications technology; Internet and Dental practice which shows promising potential to be a highly effective mechanism for enhancing diagnosis and related treatment.

Nevertheless, Teledentistry may be quiet useful as a practical and potentially cost-effective means to screen a large number of children and adolescence for the signs and symptoms of oral disease. The developing field of Teledentistry has the potential for benefiting Dental care by enhancing early remote diagnosis, timely treatment of oral diseases, improved utilization of Dental services and access to care.

Teledentistry provides new opportunities for Dental education by providing an easy access to primary care professionals for efficient consultation, thus helping in conducting effective postgraduate education and continuing Dental education programmes.

Key Words: Oral Health Care, Teledentistry, Tele communication, Telehealth, Telemedicine, Video conferencing.

Introduction

Oral health is an integral part of general health. Nowadays Dental care is being transformed by opportunities provided by technology and telecommunication. Technologic innovations in the field of Dentistry have been extensive in recent years. Most important advances have been made in the use of computers, Telecommunication technology, Digital diagnostic imaging services, devices and software for analysis and follow-up.

Nowadays, it is hard to imagine a Dental clinic without computerized patient registry, electronic invoicing, digital radiography, intraoral cameras, digital cameras, and better equipped centre’s have 3D computerized systems for prosthetic Dental reconstruction and 3D cone beam computerized tomography systems for precise intra tissue imaging, measurements, and navigation in operative Oral and Maxillofacial Surgery.¹

Internet is the basis of modern systems of Teledentistry, being up-to-date and fast, and able to transport large amounts of data.¹

Teledentistry is a relatively new field that combines telecommunication technology and Dental care. It provides new opportunities for education and delivery of care that offer much potential and challenges.¹

Cook in 1997 defined “Teledentistry” as “The practice of using video-conferencing technologies to diagnose and provide advice about treatment over a distance.”⁵

According to Norris C. Telemedicine is defined as the Utilize of information and telecommunications technology to transfer Medical information for diagnosis, therapy, and education ¹.
Telehealth to indicate care beyond that provided in Medical encounters (e.g., health education, health-related Web sites, etc.).

The entire process of networking, sharing digital information, distant consultations, workup and analysis is built up with a segment of science of telemedicine concerned with dentistry called as Teledentistry. Tele” is a Greek word meaning “distance” and “mederi” is a Latin word meaning “to heal.”

**History of Teledentistry**

Telemedicine began in 1924, with the concept of a Physician seeing his patient over the radio using a television screen. Telemedicine programs first started in 1950. The initial concept of Teledentistry developed as part of the blueprint for Dental informatics, a new domain combining Computer and Information science, Engineering and Technology in all areas of Oral health.

Teledentistry was put into practice in US army in 1994 by doing Dental consultations on person located more than 100 miles apart. Since then, various institutes and organizations have practiced Teledentistry with varying degree of success.

**FORMS OF TELEDENTISTRY:**

Teledentistry can take two forms: (1) Real-time consultation and (2) Store and forward.

Real-time consultation Interactive videoconferencing may be conducted via POTS (Plain Old Telephone Service), satellite, ISDN, Internet or Intranet. Interactive video-conferencing includes both a live interactive videoconference with a proper camera setup where the patient’s information can be transmitted; and supportive information (such as the patient’s medical history, radiographs, etc) that can be sent before or at the same time (for example, via fax) as the video conference. The advantage of this type of education system is that the user can receive an immediate feedback.

Store and forward, on the other hand, involves the exchange of clinical information and static images collected and stored in the telecommunication equipment. In store and forward, the dental practitioner collects all the required clinical information and digital intraoral and extraoral images and radiographs (or scanned, originally no digital images) and forwards them for consultation and treatment planning via established networks and/or the Internet and treatment is provided in a far time, targeted, and cost-effectivemanner.

**TELEDENTAL EQUIPMENT**

Teledentistry sites require some or all of the following basic equipment. The exact equipment required will depend on the nature of the site being outfitted. Hub sites will be different from remote sites – hub sites will only require videoconferencing equipment, whereas remote sites will require digital Dental diagnostic equipment along with videoconferencing equipment. Moreover, mobile sites may require different transmission equipment than fixed sites (e.g., satellite dishes and modems). The nature of the telecommunication equipment will depend on the type of telecommunication service utilized by each site.

Further, the Teledental equipment does not include the equipment or supplies needed to outfit a traditional dental unit with traditional dental (which will be necessary in the remote sites).

One other note, there are a variety of manufacturers and models. Thus, there are a variety of choices for each individual piece of equipment.

a) Videoconferencing System
b) Intraoral Wand Digital Camera
c) Digital Radiographic Equipment
d) Laser Caries Detection Device (KaVo DIAGNO dent)
e) Computer

**SCOPE OF TELEDENTISTRY IN INDIA**

India has opened up to Telemmedicine to address various issues which are being faced by the healthcare delivery system, like inadequate health infrastructure and clinical services, paucity of qualified doctors, the almost non-availability of specialist care, the late discovery of the ailment, the delay in the delivery of the treatment due to the greater time which is required for the transport of the patients to urban healthcare facilities and the provision of healthcare by inexperienced primary healthcare service providers.

In 1999, the Department of Information Technology, the Ministry of Communications and Information Technology (Government of India) launched a pilot project which was entitled, ‘Development of Telemedicine
Technology’, with the objective of reinforcing the national healthcare delivery system. The key specifications of the project included:

- To identify the appropriate technological tools and services which are required to implement Telemedicine technology at the three premier hospitals in the northern parts of India, namely, All India Institute of Medical Sciences (AIIMS), New Delhi, the Post Graduate Institute of Medical Education and Research (PGIMER) at Chandigarh and the Sanjay Gandhi Post Graduate Institute of Medical Sciences (SGPGIMS) at Lucknow (Uttar Pradesh).
- To develop and carry out system integration to enable telemedicine technology and for establishing telemedicine services (Teleconsultation and Telediagnostic services for the specialties of Radiology, Cardiology and Pathology and Teleeducation) at three tertiary level hospitals.
- To train clinicians in the use of Telemedicine technology.

In India, where a majority of population lives in rural areas and where healthcare facilities are insufficient, Teledentistry can have a significant contribution in bridging the gap between the demand and the supply.

APPLICATIONS:

Telemedicine has been applied in different Medical fields. Many of the applications of Telemedicine have been studied in various clinical trials and implemented in daily clinical practice. Such applications include Teleradiology, Telepsychiatry, Telesurgery, Telecytopathology, Teledermatology and Teledentistry as well as other Telemedicine applications in different medical specialties.

1. **TELEMEDICINE IN ORAL MEDICINE**

An effective distant access to oral lesions and benefits of use of e-mail services and a Store-And-Forward image system. Specialist in oral medicine analyzes independently the obtained images and clinical information. They make the diagnosis (usually one or two) and electronically return the results. Torres-Pereira et al. have shown an effective distant access to oral lesions and benefits of use of e-mail services and a Store-And-Forward image system.

2. **TELERADIOLOGY**

Teleradiology systems allow direct digital or digitized film images to be transmitted to distant locations, where they can be viewed and downloaded to hard copy for reading and interpretation. Two basic types of digital Dental systems are commercially available to acquire images without the need to scan conventional films. One is a direct digital system with electronic sensors using charge-coupled devices (CCDs) or complementing metal oxide semiconductors as image receptors. The other is an indirect digital system using storage phosphor plates as image receptors. The storage phosphor system has also been referred to as computed radiography. Post processing of the electronic images is possible with virtually all of these systems, which allows the practitioner to enhance, magnify, and measure the images as well as vary the contrast and density after acquisition.

3. **TELEPATHOLOGY**

Very few Teleconsultations is being used in the field of Pathology. Dr. Ace Allen of Dartmouth-Hitchcock Medical Centre (USA) in 1999 reported that in 1998 Dr. Vincent Mienoil, Section Chief of Anatomic Pathology at Dartmouth-Hitchcock Medical Centre started experimenting with their “Homegrown” web-based, store and forward Telepathology system.

4. **PERIODONTICS:**

US Army in July 1994 tested Teledentistry at Fort Gordon, Georgia. In this study, the patient records and images were transmitted from the dental clinic Fort McPherson over to Fort Gordon, Georgia, a distance of 120 miles. Fifteen periodontal patients were referred to Fort Gordon for surgery. One week after their surgery, each patient reported to Fort McPherson for suture removal and intra-oral imaging. At the time of suture removal, color still images were obtained of the surgical sites and these images were transmitted to Fort Gordon for
examination by the Periodontist who performed the surgery. The results of this study showed that 14 of the 15 patients saved the return trip to Fort Gordon. The patients uniformly felt that they had received better care than they normally received and were especially pleased at the elimination of the long trip to Fort Gordon. The dentists were also comfortable in their ability to make proper decisions and diagnosis using the equipment.12

5. TELEMEDICINE IN PEDIATRIC AND PREVENTIVE DENTISTRY

Prevention and early detection of caries are the key factors in the suppression of this mass disease of etiologically insufficiently known nature. It is the need of the hour to develop models for schools and childcare centers in our country to utilize Teledentistry to increase the access to Dental care for the children. Schools and child care centre’s play a vital role in ensuring the optimum oral health of the children through:

- Screening for Dental problems before these become emergencies.13
- Helping children in managing chronic illnesses.
- Connecting children and their families to the needed health and social services. And
- Providing urgent care.

Amável et al. have demonstrated in real conditions that distant diagnosis of Pediatric Dental problems, based on non-invasive imaging, is a valid grounding for an appropriate insight into dental problems and dental treatment preparation (Amável et al., 2009).

Kopycka-Kedzierawski et al. have successfully performed the study of prevalence of dental caries in children using the teledentistry method and dental photographs taken with intraoral cameras and web-based storage of images (Kopycka-Kedzierawski et al., 2008).

6. TELEORTHODONTICS

Orthodontic practice via Teledentistry project is a universally accepted part of modern healthcare as much of hands on care can be done by technicians and general practitioners under the supervision of an orthodontist. Orthodontic tooth movement takes time and this is the main reason why a long term follow-up is required and most of the orthodontists work on a patient in a uniformly spaced interval of time.14

Clinical orthodontics advanced the most in routine use of computerized technology, where instead of traditionally used study Casts, present orthodontics use digital 2D and 3D models and all analyses, Measurements and assessment of relationships are done by using software to process the Images. The two most renowned computerized digitization systems are Orthocad- I, e-models.

7. TELEMEDICINE IN ENDODONTICS

Any faults in differential diagnosis and prognosis of treatment of periapical lesions can be the source of subsequent complications, problems, additional waste of time and money, sometimes being the cause of complete revisions of prosthetic restorations based on poorly treated teeth. Periapical lesions constitute a large portion of Dental Pathology and their treatment is commonly performed by dentists who are not specialists in Endodontic.15

Modern Telemedical systems are an ideal solution for seeking and obtaining timely expert help in that regard. Zivkovic et al.,(2010), have practically demonstrated that with the use of teledentistry methods based on Internet, diagnosis of periapical lesions can be adequately assessed; based on that, a necessary plan can be devised for a proper Endodontic or Oral Surgical management of these lesions.

Teledentistry based on Internet as a medium for distant communication enables its use worldwide, wherever the World Wide Web is present as a wire or wireless connection, reducing the costs of management and increasing the availability of urgent help to all patients

The method is based on the creation of digital information for each of the teeth of interest:

- Sequence of digital extraoral photographs (frontal and bilateral),
- Sequence of digital intraoral photographs (vestibular portion of the alveolar ridge in the area at the level of tooth root, palatal/lingual portion of the alveolar ridge of the target tooth, and dental crown),
- Retro alveolar dental digital x-ray,
- Anamnestic information in the format of text.
8. **TELEMEDICINE IN DENTAL PROSTHETICS DENTAL PROSTHETICS**

   CAD/CAM (computer-aided design and computer aided manufacturing)

   These systems are gaining priority in the manufacturing of individual Dental crowns, dental inlays and onlays, over traditional hand modeling and casting of Prosthetic Reconstructions.16

9. **Tele Oral and Maxillofacial Surgery**

   Use of new technologies in Dental surgery provided better diagnosis, situational analysis, and planning of appropriate treatment solutions. Technologic development has been at its highest level in computerized support in Dental Implants placement, where it is possible to observe the patient in one part of the world, and in the other part make a digital project of complete implant and prosthetic construction and route the direction for navigational technique of dental implantation. One of the first cases was scientifically presented by the Karl Landsteiner Institute for Biotelematics, Vienna (Schicho & Ewers, 2008), consisting of a specially devised Telenavigation server and Telenavigation clients.

   The advances and availability of Smartphone technology have contributed to the feasibility and availability of telemedicine in Oral and Maxillofacial Surgery. Smartphone’s are able to read and display 3D computer reconstructions of head skeleton, giving instantly the necessary information to distant Teleconsultants in Oral and Maxillofacial Surgery. Maxillofacial Surgeons are thus able to monitor the condition of their patients even after very complex interventions, such as osteotomies, removal of Ameloblastic fibromas, and so on (Aziz & Ziccardi, 2009).

10. **TELEDENTISTRY IN ALLIED HEALTH SCIENCES:**

    Dental hygienists and staff are being trained to take the case histories with the local dentist when the patient is treated through Teledentistry service.1, 17

11. **TELEDENTISTRY AND ITS ROLE IN POSTGRADUATE EDUCATION AND DENTAL PRACTICE**

    Teledentistry can serve as a good tool for educating Postgraduate students and for providing continuing updates for the practicing dentists. In interactive video-conferencing, the patient information is evaluated first (with or without the patient’s presence), which allows for the interaction and feedback between the educator and the students.

    The patient cases can be reviewed thoroughly and at the students ‘pace. The cases can be discussed at length after all the clinical data have been collected and transmitted, without the patient being present at the scheduled meeting. This enhances the students enthusiasm and provides new learning opportunities for the dental students and the practicing dentists.17-19

12. **TELEDENTISTRY AND ITS USE IN RURAL AREAS**

    In rural areas, where there is a shortage of specialists, the lack of comprehensive and sophisticated health care is a problem. Teledentistry can increase the accessibility of the specialists to the rural and underserved communities for their Dental needs, besides decreasing the time and the costs which are associated with the specialty consultations.20

    Changing the service delivery method may also positively affect the feasibility of a rural practice. Isolation from peers, specialists, and continuing education opportunities are the negative aspects of a rural practice. Providing Dental care in a salaried arrangement allows one to meet the financial obligations while learning to build the efficiencies which are gained with experience in care delivery without incurring additional debt. It also allows one to sample the experience of living in a rural setting without committing to a permanent relocation.20

**FUTURE PROSPECTIVES OF TELEDENTISTRY**

The advances in telecommunication have rightly enabled the Dental care to promise many exciting changes during the next few a year’s. However, like any revolution, it will not be easy or painless. There are certain issues which require resolution for the success of Teledentistry. These issues include inter-state licensure, jurisdiction and malpractice, as well as technological, security and ethical aspects.16

Various measures that can be employed for the effective implementation of Teledentistry are:
a) The practitioners who are engaged in Teledentistry must have a license in each state in which they practice.

b) Dentists who are engaged in Teledentistry must make every effort to ensure the security of their systems, as well as of any data that they may transmit. For example, data encryption, password protection and user access logs can help in deterring most of the people and in protecting patient confidentiality.

c) The instructors of the Teledentistry education courses need to be well versed with computer knowledge and they should have adequate teaching experience.

Conclusion

It is clear from the above discussion that Teledentistry is the fastest growing segment of dentistry. Teledentistry has shown promise in eliminating the gap between the undeserved patient in rural areas and the specialists. Teledentistry has been fruitful in reaching the masses. Although history has shown growth of Teledentistry since 1994, but the growth curve is exceptionally high since past five years, which is a good sign of our profession.

We have summarized various specialties of dentistry in terms of Tele-health and it can be concluded from here that Teleorthodontics, Periodontics, Teleradiology and Dental care for rural population has shown very good results as much of the hands on care can be rendered by dental hygienist, technicians and general practitioners who are provided hands on course to render treatment under the guidance of specialists.

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