



TELERADIOLOGY IN COVID-19 PANDEMIC - REDEFINING DIGITAL DENTISTRY- A REVIEW

Dental Science

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ABSTRACT

As COVID-19 continues to spread across the world, healthcare personnel are working 24/7 to treat more than 6.42 million confirmed cases across the world and 2.27 lacs cases all over India. As our community professionals continue to treat infected patients, they risk contracting and spreading the virus themselves. Now more than ever, determining how to best protect patients and facility personnel is critical. Fortunately, advancements in medical technology allow some industry professionals to work remotely, joining many Indians in avoiding virus exposure and attempting to "flatten the curve." Not only General Radiologists—who have already been instrumental in the detection and early diagnoses of COVID-19 cases but also Maxillofacial radiologists with proper Knowledge and attitude of Maxillofacial Imaging—can effectively conduct their work from home with the use of Teleradiology (TR). TR provides the same functionality for physicians as their onsite workstations, allowing radiologists to read images and diagnose from the safety of their home. As the fight against COVID-19 continues, there is a growing need to make TR solutions more common mostly in dental emergencies especially in highly sensitive group of Children under age of 10 years and geriatric patients. The demand for diagnostic and image interpretation services in radiology is growing rapidly all over the world. This has highlighted two issues like the lack of adequate staff for providing interpretative coverage and the lack of specialty expertise. To some extent, these problems can be overcome by utilizing robust communication and image transfer systems to draw on the expertise of distantly located radiologists. This process whereby images are transferred to distant locations for the purpose of interpretation and diagnosis is termed TR.

In modern radiology departments in both the academic and private sectors it has become commonplace to select the location of a fully functioning picture and archiving communications system (PACS) workstation based on manpower and workflow considerations rather than proximity to the site of image acquisition. In addition, affordable scaled down TR solutions have allowed referring physicians and radiologists to access imaging from the convenience of their homes and offices. This review summarizes some of the key issues in image acquisition, transmission, and interpretation. These summaries are followed by a discussion of the clinical practice of TR in general as well as during COVID 19 Pandemic to greater extent and also sharing knowledge gained from practical experience that can be useful in helping a TR program meet its full potential.

KEYWORDS

TR, Novel COVID 19, Pandemic PACS.

INTRODUCTION

Telemedicine, also known as telehealth includes all methods where the doctor-patient interaction is not direct but some form of telecommunication is used. TR is a branch of telemedicine in which telecommunication systems are used for the transmission of radiological images from one location to another. TR falls under the telehealth umbrella because radiologists can interpret images and communicate with physicians electronically while working remotely. For example, Android based, cloud-based workstations and mobile applications allow radiologists and physicians to access diagnoses, reports, and images no matter their location via pictorial archiving and communication systems (PACS). Hundreds of scans can be analyzed and reported in few minutes using this technology, surpassing the industry average of 30 minutes per case. This allows both radiologists and physicians to provide proficient and excellent care for the patient while reducing the risk of spreading or contracting COVID-19. The industry has already become a largely digital workforce. Many maxillofacial radiologists have begun to view images at home, dictate notes with voice recognition and sign off on reports electronically especially in acute dental emergencies in childrens and geriatric patients who are very much susceptible for the infection.

The earliest efforts in TR were made back in 1929, when dental x-rays were transmitted with the help of telegraph from one location to a distant location.¹ The need for TR in COVID 19 Pandemic is very important as before clinical examination of patient which altogether increases the risk of contracting infection to dentist from active as well as carrier of the COVID 19 as intraoral examination is done standing very close to patients oral cavity besides the chair. Also dentist gets exposed to upper respiratory tract of patient directly while examination, even after wearing PPE kits. Recent incidents of dentist falling prey and deceased due to COVID 19 infection is reported in many cities in India especially in Mumbai which has highest cases in India. TR

practices in dentistry include interpretation for conventional procedures intra oral and extra oral radiography, computed tomography (CT), cone beam computed tomography (CBCT), ultrasound (US), magnetic resonance imaging (MRI), and nuclear medicine (NM).^{1,2}

The reason for the growth of TR in dentistry is that most parts of rural India do not have good radiological services like orthopantomograph and cone beam computed tomography set ups and personnel. With TR, this gap can be bridged by using the help of more experienced workforces so that difficult cases in specific areas like odontogenic cysts and tumors, fibro-osseous lesions, benign and malignant tumors etc., can be sent to experts for their expert opinion.³ Also teleradiology /medicine/ Teleconsultation has a significant relevance oral health care of children and especially geriatric patients who have limited access to visit dental hospital either ways in any Pandemic or Epidemic as well as in general also as they are dependent on family members because these patients are benefited of avoiding multiple visits to centre or physician or referring dentist and also to radiology centre and inconvenience caused to them.

The aim of this review is to provide information to dentists about TR advantages in dento-maxillofacial radiology as communication media between dental radiologist and other dental specialist using TR system. The Dento-maxillofacial radiology service in India is growing in line with technological developments. However, little research has been addressed the application of TR to dentistry during COVID 19 Pandemic.

APPLICATIONS OF TR IN DENTISTRY

The benefits of TR are: modernization of the radiology center; digitalization of radiological apparatus; the possibility of obtaining text information, radiological images, video or moving images, their

interpretation and sending back to determined destination via Internet; mutual consultations between remote radiologists and other specialists about received information; tele-education of dento-maxillofacial radiologists and other medical staff as an additional opportunity for improvement in medicine, radiology and other fields of medicine; collaborating use of electronic medical records; medical monitoring and alarm connecting patients on home care and emergency centre; transfer of radiological research data; improving health care; reduction and limitation of the growth of costs in radiology; maintaining the quality of radiological services etc.^{4,5} Advantages for patients from TR usage are: the availability of top radiologists for the interpretation of findings; radiological findings are obtained without the travel costs and accommodation in one of health care institutions; absence from work and uncertainty of the patient are minimized because the radiologic findings or other opinions are obtained in a very short notice etc.

Cassius C. Torres-Pereira et. al. 2013 carried a study to evaluate the applicability of teleradiology in oral medicine, through the transmission of clinical digital images by e-mail in 60 consecutive patients who sought oral medicine services at the Federal University of Parana, in southern Brazil. In this study clinical history and oral lesion images were recorded using clinical electronic charts and a digital camera, respectively, and sent by e-mail to two oral medicine consultants. The consultants provided a maximum of two clinical hypotheses for each case, which were compared with biopsy results that served as the gold standard. This confirming it with clinicopathologic diagnosis. They found out that in 51.7%, both oral physicians made the correct diagnosis; in 28.3%, only one consultant made the correct diagnosis; and in 20%, neither consultant made the correct diagnosis. Thus making 80% of cases, were correctly diagnosed by a single consultant. In there study the agreement between the first consultant and the gold standard was substantial ($\kappa=0.669$), and the agreement between the second consultant and the gold standard was fair ($\kappa=0.574$) in a statistical analysis. Thus they concluded that use of information technology can increase the accuracy of consultations in oral medicine as well as the participation of two remote experts increased the possibility of correct diagnosis.⁶

SECURITY AND PRIVACY CONSIDERATIONS

Patient privacy and data security are key issues in any radiology service, so TR is no exception. Digital Imaging and Communications in Medicine (DICOM) also addresses security and privacy issues, and there is continued research on improving the standard and optimizing its performance. Digital watermarking is popular and authentic method to protect images.^{7,8}

IMAGE AND INTERPRETATION QUALITY

When digitizers are used, there is evidence that for the most part digitizers are equivalent in terms of acceptable contrast and low geometric distortion; hence there are circumstances where these solutions are acceptable. Even with digitally acquired images, there is considerable variability in the quality of images between sites, both as a function of the basic imaging procedures and the equipment used, so users need to be alert of these variations and account for them during the interpretation process.^{9,10}

SELECTING A TR SERVICE – IMPORTANT CONSIDERATIONS

Once made the initial decision to use TR, there are some important considerations to keep in mind. The first aspect concerns what exactly you want from a TR service. It includes: final versus preliminary reads (cost and turnaround times would differ); the types of cases to be covered; when you need coverage (eg, 24/7, nights only, weekends only, or only when local radiologists are on vacation); what types of critical (i.e, life-threatening findings on routine studies) findings require an emergency written report and personal notification; and whether reporting requirements differ for emergency versus routine cases.

Once a provider has been decided, the dentomaxillofacial teleradiologists must be licensed and credentialed per federal, state, and local regulations. This is important, not only for legal reasons, but also for billing considerations. Ensuring that they are properly covered with adequate malpractice insurance is also important. As already noted, there are specific guidelines in place for electronic practice of radiology and TR, but these should be reviewed with the provider to ensure for example that they adhere to the DICOM standard, the Health Level Seven standard, and the 1996 Health Insurance Protection and Accountability Act.

On both the provider and referring sides, there should be specific contact people covering such aspects as contracts and billing, information technology, and clinical services, with responsibilities, contact information, and procedures clearly recognized. It is important for the dentomaxillofacial teleradiologist to have the contact information for the radiology technologist(s) at the referring site, since poor quality images are often a problem with TR interpretation. It is also very useful to have periodic onsite visits from the teleradiologist, not only for the personal contact, but also so that they can have a clear picture of the services, technology, staff, and even patient populations at the referring site.

Reimbursement is important consideration, and there are a variety of models being used. A very common model is for the teleradiologist (or TR service) to be paid a set amount per case or per time period, with the amount being set as a function of modality, nature of the study, and urgent versus routine.¹¹

THE PRINCIPLES OF TR¹²

Components required in TR system are as follows:

- 1-Image sending Station
- 2-Transmission networks
- 3-Review station

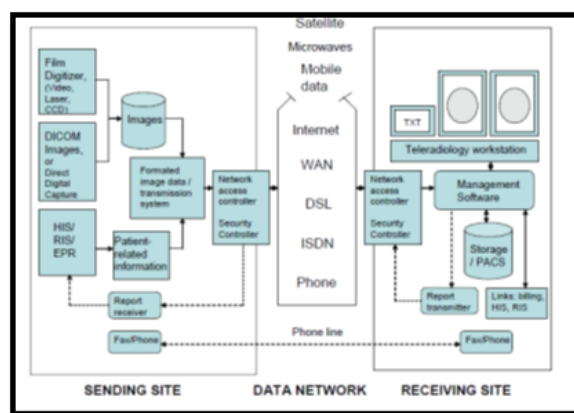


Figure: WORK FLOW OF TR

[CCD- Charged Coupled Device; DICOM- Digital Imaging and Communications in Medicine; HIS- hospital information system; RIS- radiology information system; EPR- Extended Producer Responsibility; WAN -Wide area network; DSL- Digital Subscriber Line; ISDN -integrated services digital network; TXT-PACS- picture archiving and communication system]

METHODS OF TELECONSULTATION

Jampani et. al.¹² also discussed the recent advancement in term Teleconsultation which can be adjuvant and interchangeable with TR. These terms includes Teleconsultation through teledentistry can take place in either of the following ways – “Real-Time Consultation” and “Store-and Forward Method”. Real-Time Consultation involves a video conferencing which dental professionals and their patients, at different locations, may see, hear, and communicate with one another. These can be carried out by various teleconferencing apps like saynamaste.in, FreeConferencecall, googlemeet, IMO, Whatsapp video.

Another Store-and-Forward Method involves the exchange of clinical information and static images collected and stored by the dental practitioner, who forwards them for consultation and treatment planning which is a part of simulation in imageology also called as virtual imaging. The patient is not actually present during the history taking and examination. Dentists can share patient information, radiographs, clinical presentations of oral hard and soft tissues intraoral images, past medical history records and several investigations and other information transportable through multiple providers. This data sharing can be of extreme importance for patients, especially those in need of specialist consultation. A third method has also been described, known as “Remote Monitoring Method”, in which patients are monitored at a distance and can either be hospital-based or home-based. A “Near-Real-Time” consultation has also been mentioned in the literature, which involves low resolution, low frame rate product that looks like jittery television.¹³

CONFIDENTIALITY OF DATA¹⁴

TR services running on the website, at the time of upload imagery contained personal information of patients. Medical records the patient's personal information is transmitted using TR systems must be kept confidential. Therefore, TR users in the service must be trained about the confidentiality of the data security information. It also calls for the protection of data and guarantee data integrity to prevent damage data intentionally or not.

Studies in TR have focused on three main objectives:

- Reduce the amount of memory required to encode imaging radiography
- Increase rate of transmission on the network
- Fix the display of digital imaging and communication in medical.

MEDICO-LEGAL ISSUES

Concerns about the confidentiality of dental information arise from the transfer of medical histories and records as well as from general security issues of electronic information stored in computers. The practitioners of teledentistry should take utmost care to ensure that patient privacy is not compromised by unauthorized entities. However, patients should be made aware that their information is to be transmitted electronically and the possibility exists that the information will be intercepted, despite maximum efforts to maintain security. Concerns also may arise about the proper method of informing patients of the potential transmission of their data. Informed consent in teledentistry should cover everything that exists in a standard, traditional consent form. The patient should be informed of the inherent risk of improper diagnosis and/or treatment due to failure of the technology involved.

LIMITATIONS OF TR

The barriers for successful implementation of TR include: problems with telecommunications, energy problems, high price and unavailability of the Internet and maintaining the manpower. TR should not result in weaker relationships between radiologists and colleagues in other fields. This also includes weak communications with patients but this can be reviewed by telephonic conversation with patient as well as there referring physicians or dentists.

DISCUSSION

Dentomaxillofacial radiology science in India had grown rapidly in recent years. Consulting services of dentomaxillofacial radiology interpretation should be efficient and effective to support diagnostic and treatment plan and ultimate benefit to the patient. There are few obstacles that arise in:

- The use of conventional system for processing and radiographic interpretation causes delay in patient's diagnosis.
- Another obstacles for consultancy services and radiographic interpretation is the distance, the services cannot reach the remote area.
- One of the biggest obstacles is the limited ratio of dentomaxillofacial radiologist compared with the quantity of service needs that exist.

TR is used as a media of communication in the field of dentomaxillofacial radiology especially to provide efficient patient services, by overcoming the issues of limited human resources, time, distance and location. Because of insufficient facilities, there is requirement of alternative techniques in the field for remote communication to supply the need of dentomaxillofacial radiography services to any hospital. To resolve these obstacles, comprehensive system is required. The digitalization of working system facilitates various things: the long distance, time, and human resources which can be resolved by long-distance communication.

TR systems provide services to patients more efficiently, especially for night time inclusive of emergency room or hospital in a remote area with limited dentomaxillofacial radiologist especially in case of implant, trauma and severe life threatening pathologies. Dental imaging can easily be sent not only within the hospital but also outside the hospital and at other locations around the world for expert opinion and correct treatment plan.

The existence of TR systems can resolve the above mentioned obstacles, but there is still less socialization of TR in the field of dentistry. This discussion is throwing light to introduce TR system in the field of dentistry which is expected to be useful and further developed in the field of dentistry.

Development in digital technology leads to the rapid growth of TR.

The electronic transmission of radiographic imaging like panoramic radiograph or cone beam computed tomography from one location to another for interpretation radiograph, consultation and research can be done. TR can increase access to radiograph interpretation which would improve services to patients.^{15,16}

The supporting factor for TR systems is the changing paradigm about processing and use of radiograph imaging. Since the discovery of x-rays by Roentgen, the imaging process is based on the chemical of photograph and physics of imaging. Modern appliance such as the Nuclear Medicine and cone beam Computed Tomographic imaging is displayed and stored digitally using a computer was the beginning of the changing from conventional into digital imaging. The positive impact of the use of digital imaging and TR can also reduce the use of chemical waste unlike in conventional radiograph.

CONCLUSION

TR, Telehealth and Teleconsultation all can be used as communication media between dentomaxillofacial radiologists with other dental specialists, especially in providing services radiograph interpretation. The current health care environment places a high premium on efficiency and increased access to quality care for all patients, and TR represents one very important way that affordable health care will be available to all those that need it. Thus can provide patient services effectively and efficiently, overcoming problem of human resources, time, distance and location.

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