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Review Article

Teledentistry – An oral radiology perspective

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ABSTRACT

Telemedicine is a rapidly evolving field in the present scenario. Teledentistry is considered as a subset of telemedicine that utilizes telecommunication network and for transfer of relevant clinical data and images for dental diagnosis and treatment planning. Tele-oral-radiology is considered as a subspeciality of Teleradiology and is still in an emerging phase in many nations including India. Adoption of Teleradiology practices enable the Teleradiologist to enjoy the freedom of working from any location and alleviates the problem of overnight specialty coverage. Even though teleradiology has numerous advantages it is bound for certain limitations as well. Literature reports have found tele-oral-radiology to be beneficial in aiding general dental practitioners in the diagnosis and interpretation of oral and maxillofacial radiographs. The aim of this paper is to provide a brief about Tele-Oral-Radiology practice.

1. Introduction

The practice of Medicine has evolved to a greater extent in the recent decade because of the advent of technological advancements. Telemedicine can be defined as the application of information grounded technologies and systems to deliver healthcare across geographic distances.[1] Teledentistry is a similar form that involves the exchange of clinical information and images over remote distances to aid in dental discussion and treatment planning. The term "Teledentistry" was first used in the year 1997 by Cook who defined teledentistry as the practice of using video conferencing technologies for diagnosis and treatment recommendations over a distance".[2,3]

Few literatures report teledentistry as the means of use of Web for information regarding the management of specific cases and few other evidences report online continuing education courses as teledentistry. However, it will be more appropriate to refer both the condition as web surfing and distance literacy, rather than teledentistry.[3,4] With the continuous widespread evolution of telemedicine and teledentistry in the recent years, there is a positive response that has been reported among public regarding the use of telemedicine practices. The major advantage of these practices is that specialized medical advice can be sought over telecommunication networks that can serve medically underserved rural areas.[2] The aim of this narrative review is to provide a brief about the practice of tele-oral-radiology in the current scenario.

2. Origin

The original vision of teledentistry originated as part of the design for dental informatics, which was drafted during a 1989 conference financed by the Westinghouse Electronics Systems Group in Baltimore. The early concept of teledentistry was to integrate dental informatics and clinical practice so as to improve the delivery of oral healthcare.[3] In 1994, teledentistry emerged as a subspeciality of telemedicine in the military design of the United States

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Army Project. The main aim behind the project was to enhance patient care, dental education, and communication between clinicians and dental laboratories. Adoption of the military concept teledentistry was found to be beneficial in reducing the total patient care expenses, and facilitated dental care to distant areas.[5] Over a period, with advancing technologies new opportunities for teledentistry have been established to ameliorate the position of patient care and modernize current business models.

3. Methods of Teleconsultation

There are various ways by which teleconsultations can happen in teledentistry. Real Time Consultation and Store - Forward Method are the two common methods.[5,6] Real Time Consultation utilizes videoconference in which dental expert can directly see and communicate with the patient in a different geographic location, while Store and Future method comprises of interchanging the patient related data and clinical photographs for discussion and devising a treatment plan. Sharing of clinical data and information is crucial for specialist opinion.[6] Another method known as Remote Monitoring system is also considered as a modality of teledentistry used to monitor the treatment progression.[7]

Fig. 1: A modern Telemedicine System.[2]

4. Tele Consultation Services in Radiology

Tele Medicine and Dentistry is still in a growing phase in developing nations. However, In the United States, US Army Medical Department Telehealth Network has a large base of covering countries across time zones. It covers various services such as cardiology, dermatology, contagious diseases, neurosurgery, etc.[8] Teleradiology is critical on the battleground and teleradiology systems are especially useful in handling trauma cases by speeding transfer of images from the operating room to the radiologists for case discussions. The teleradiology service is also used to give conservation of the CT scanners used in the theater when it is functionally demanded. The US military medical services uses digital radiology which is connected by a system of electronic health records.[9,10]

The concept of dates back to the late 1920s. According to the definition of teleradiology by American College of Radiology (ACR), it is the electronic transmission of radiographic images from one location to another location for the purposes of radiographic interpretation and/or consultation.[9] Storjohann et al. reported comparable radiological diagnostic accuracy in teleradiology when compared to inhouse diagnosis.[10] Schwartz et al. reported adequate accuracy in mobile phone diagnosis of Chest radiographs.[11]

5. Teleradiology in India

Teleradiology is widely practiced in United States, United Kingdom, and Singapore where the number of scans is being increased and in conditions where there is a shortage of radiologists available during the night hours. In India, Jankharia Imaging in Mumbai is credited as being the first establishment to implement teleradiology in 1996. Siemens presented the first ever public meet of teleradiology at the Annual Congress of the Indian Radiology and Imaging Association in the year 1997.[12]

Lack of timely diagnostic services creates significant difficulties for clinicians during crises especially at unfavorable hours. The Health Care Financing Administration (HCFA) at the United States mandates 24-hour services in all hospitals which is made possible by outsourcing their radiology reporting services to international locations including India. Night reporting outsourcing is generally known as "nighthawking." Rapidity in diagnostic reports is crucial during medical emergencies, it is a major benefit of outsourcing radiology or teleradiology.[13,14] Another important reason for adoption of teleradiology in India, is due to the fact that majority of rural areas in India lack adequate radiological diagnostic services and specialist care. Active adoption of teleradiology practices have made it possible for rural areas to avail the services of trained specialists who are actually located in major urban centers.[12]

6. Tele-Oral-Radiology Practice

Tele-Oral-radiology can be considered as a subset of teledentistry. Choi et al. in their study with the Korean Academy of Oral and Maxillofacial Radiology found dental teleradiology to be useful in general dental practice. Teleradiology was found to be useful among general dental practitioners for diagnosing panoramic radiographs with discriminational opinion of common dental lesions.[15]

According to the findings of Salazar-Fernandez et al., application of tele-radiology in diagnosis and management

of temporomandibular joint disorders have shortened the delay in treatment after diagnosis and reduced the loss of working hours. Tele-radiology opinion has also prevented the unnecessary transfer of patients and reduced the cost expenses upto 60%.[16] A study by Jacobs et al. found comparable accuracy in diagnosis of maxillofacial trauma radiology using telemedicine compared with direct consultation.[17]

7. Work Flow of Tele Radiology

The workflow starts from the acquisition of radiographic data by appropriate imaging modality such as intraoral and extraoral radiography, computed tomography (CT), Cone Beam Computed Tomography (CBCT), ultrasound (US), magnetic resonance imaging (MRI), and nuclear medicine (NM).[18] Employing Cloud storage and PACS have simplified the workflow and remote access to radiographic data.[19] Once the image is acquired it is converted into digital files by a digitizer. If the radiographs were originally on x-ray films, a film scanner CCD is used to turn the films into digital files. However, DICOM files are standardized and user-friendly formats that facilitate easy remote access of the data in teleradiology, with preserving the actual quality. The data is uploaded in the server or sent to the teleradiologist, who then accesses the data and interprets using appropriate viewing software or Reporting Software. A review of teleradiology systems suggests a high-end monitor with a resolution of 1024x1024 pixels as the best for studying cross sectional images. For primary diagnosis, digital radiography resolution should include local storage for images and software that makes it easy to manage and display images and relevant patient data.[20] The teleradiologist creates the report and uploads it to the end-user server which can be readily used by the clinician.

8. Image and Interpretation Quality

Tele radiology involves the interpretation of the radiographic images that are sent to the remote radiologist over tele communication network. Digital accession bias is a serious issue in most teleradiology practices. The primary reason for this is that digitized photos are typically of lower quality, which results in reduced confidence and uncertainty of the reporting radiologist. Discrepancies from the original image quality in terms of low geometric deformation occurs when digitizers are employed in the transmission of radiographic images, which could affect the interpretation of certain structures such as the perception of bone quality. When digitally recorded images are transmitted from one geographic location to the another through network, significant difference in the image quality occurs as the initial imaging method and the software used differs from the equipment or software used for interpretation. Therefore, it is crucial for the reporting teleradiologists to be aware of these variances and account for them during the process of radiographic interpretation.[21,22] DICOM which stands for Digital Imaging and Communications in Medicine is considered as the standard data format for transmission of radiographic data, which was developed by the American College of Radiology (ACR) and the National Electrical Manufacturers Association (NEMA) in the year 1983. DICOM consists of data structures for radiographic images, network-oriented services for image transmission, data interchange, consistency and quality of display and conformance standards for devices and applications.[23] In Oral radiology practice, Cone Beam Computed tomography volumes are transmitted either as compressed or uncompressed DICOM formats.

According to the ACR guidelines, it is the responsibility of the teleradiologist for the timely communication of results, especially critical findings to the end-user. An end-user may be the referring diagnostic centre, hospital or the referring clinician. It is also mandatory for the teleradiologist to be available for relevant consultation and case related discussion with the clinician, even if the case related diagnostic query arises days after interpretation and reporting.[24]

9. Data Security Considerations

Case sequestration and data security are crucial issues in any radiology service. Although security and sequestration have been incorporated into teleradiology practice from the beginning, there is always a scope for enhancement. It is necessary for all Telemedicine providers to be acquainted and abiding 2009 Clinical Health Act (HITECH), Health Insurance Protection and Responsibility Act regulations and updates regarding the meaningful usage of health information technology, electronic health records and technology.[25] The ACR- AAPM- SIIM Electronic Practice Guidelines have also put forth recommendations regarding security and sequestration of data pertaining to medical imaging. There are numerous approaches to ensure security while working with patient data, and there are guidelines and principles that are governed by stringent ethical and legal standards. ISO27799 (Security Management in Health Using ISO/ IEC/ 17799) is the inaugural international standard designed for the security operation of health information, which provides guidance on information coverage via perpetration of ISO17799.[26,27]

Digital watermarking is a method of adding information to a picture as a watermark that can be identified afterwards, and it facilitates detection of any alteration in the radiographic data. It is frequently regarded as an authentication system, and the watermark is typically invisible to the human eye and does not impede the process of radiographic interpretation.[28] However, it is also the duty of the teleradiologist to maintain the confidentiality of the patient related data.

10. Advantages and Disadvantages

Availability of specialized expert care and consultation to all parts of the world irrespective of their geographic accessibility, with no cost for travelling to avail the service is the major advantage of telemedicine practices.[29] Adoption of Teleradiology practices enable the Teleradiologist to enjoy the freedom of working from any location and alleviates the problem of overnight specialty coverage. Setting up of Centralized image distribution centers provide hospitals and emergency departments with quick access to qualified teleradiologists who can provide quality reports for imaging services without substantial increase in the expenses.[24,30] According to Bradley, the adoption of picture archiving and dispatches systems (PACS) have enabled teleradiologists to gain increased remote access to the electronic data of patients.[6]

The compromise in image quality is considered as a drawback of transmitting radiographic images over network, however DICOM transmission have been a successful standard for radiographic data transmission. Other disadvantages include reporting by Ghost radiologists, who are not qualified enough to interpret the data and signing of the reports without adequate reviewing of the radiographic data. Some teleradiology service hubs are focused only on the reports and devalues or undermines the specialty practice and teleradiologists tend to become faceless providers of interpretations without any contact with those entering the reports.[24]

11. Future Perspectives

American College of Radiology has set forth technical guidelines and recommendations with minimal conditions necessary regarding the interpretation of the radiographic data.[31] There can be bias in the software and equipment used such as mobile phones, tablets, computers etc. for radiographic interpretation. The US Food and Drug Administration (FDA) has approved smart phone applications for radiology namely, Resolution MD by Calgary Scientific, Inc Calgary, AB, Canada and Mobile MIM by MIM Software, Cleveland, OH, USA. Although there are various other applications that a teleradiologist can use for reporting.[32] However, there is a scope for developing specific smart phone-based user-friendly oral radiology applications that can aid in tele-oral-radiology services.

12. Conclusion

Teledentistry is actively growing, especially in the post-Covid era, Tele-Oral-Radiology practices can serve as a quick and handy option for general dental practitioners to avail specialized services, and also as an emerging career option for Oral and Maxillofacial Radiologists. However, further research in the field of tele-oral-radiology is recommended to facilitate a widespread technology transfer.

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None.

14. Conflict of Interest

None.

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