

Maxillofacial and Oral Teleradiology: A Scoping Review

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Abstract

Teleradiology is an innovative practice of interpreting radiology images from a distant site and has boomed into a global trend in radiology. It was earlier known as off-site reading where X-ray images were diagnosed by radiologists who were physically based at a distant site. The technique involves standard equipment to capture, view and share images across radiology platforms so that physicians can handle it with ease. However, there are various regulations that are laid down by different countries and radiology associations. The significance of teleradiology in maxillofacial dentistry and oral care is undoubtedly massive and it needs further streamlining to increase global adaption. The present paper discusses the trends in teleradiology and the future scope especially for the maxillofacial radiologists.

Keywords: Teleradiology; Telemedicine; Maxillofacial Imaging; Dental Imaging.

INTRODUCTION

Teleradiology is defined as the exchange of radiological images between geographically different locations for image interpretation, expert consultation and diagnosis. It involves digital sharing of radiographic images. Teleradiology (TR) is a sub specialty of telemedicine.¹ With the advent of smart health technologies, teleradiology services have become exceedingly popular across

nations. TR emerged due to the imbalance between the demand and availability of radiologists across the globe.

Initial evolutionary trends

Teleradiology was earlier known as off-site reading where X-ray images were diagnosed by radiologists who were physically based at a distant site. In 1929 the first dental x-rays were transmitted with telegraph to distant locations.² In the late 1990's, this practice of non-patient facing interpretation became increasingly popular. A 2016 European society of radiology survey reported that 74% of European radiologists practiced teleradiology within their localities and 71% engage in inter-state and international teleradiology services.³ A 2019 survey among American College of Radiology (ACR) members stated that 84% practiced teleradiology within their

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states and 46% provided international teleradiology services.⁴ Countries like the US mandate 24 hours imaging services in all hospitals and so they prefer outsourcing radiology reporting to Australia, Europe, and India etc. English communication, availability of radiologists and cheap labor has made India a prime site for teleradiology reporting services in the recent years.

Classification of Teleradiology

Teleradiology is classified into two types

1. Internal teleradiology/Intramural radiology

This is the practice where radiologists who are registered practitioners conduct an at home reading and interpret images sent to them. The teleradiology service provider and receiver are in the same state or in the same country. The service provider is mostly an individual practitioner or a small group of radiologists who provide such services with a small set up. With the covid pandemic creating new challenges many radiologists have taken up internal teleradiology. A study done in 2020 among US Radiologists, showed increasing radiologists having set up home work stations for radiology reporting. Around 66.7% of radiologists who took part in the study wanted to practice teleradiology even beyond the pandemic. 64.8% were pleased with their teleradiology practices and reported reduced stress levels.⁵ Even academic institutions like the YALE New Haven Hospital have began to incorporate routine teleradiology practice among faculties 6 pm onwards. They interpret emergency imaging studies and provide specialty interpretations

2. External teleradiology/Extramural tele-radiology

This is the practice where a corporate company is in charge of delivering teleradiology services by employing radiologists across the nations. It is also called night hawk services, where after hours coverage beyond the normal OPD time is prevalent. Teleradiology companies have grown substantially over the past few years. Many radiologists prefer internal TR but not many embrace the idea of corporate teleservices due to the concept of commoditization of radiology services. Though commoditization has been widely debated by academic colleagues, it is unarguably a hot business, increased opportunities and remuneration to radiologists. However it is mandatory that such TR companies meet the guidelines of the ACR with certification, state licensure, liability insurance etc. Cheap Indian labor has encouraged the

mushrooming of such companies that provide services to a number of hospitals including remote facilities within and outside the country. A number of images like CT, CBCT, and Ultrasound can be interpreted and timelines can be met precisely. Teleradiology services connect countries with radiologists with those countries which lack radiologists.⁶ Extramural teleradiology requires remote reporting and when done as a full time job, there is no interaction with colleagues of the medical fraternity. These reasons do not seem attractive to many radiologists.

PROCEDURE

In teleradiology the major steps involved are:⁷

- Image acquisition
- Image digitization
- Image compression
- Image transmission
- Image interpretation

Image acquisition and digitization

Initially images were transferred through fax and later high resolution laser and CCD scanners were used. These film sensors are similar to fax machines that convert analog data to digital data. Charge coupled devices (CCD) have minute photocells that receive data from a transilluminated film. Laser scanners have less noise ratio than CCD scanners. Though they provide high resolution images with superior contrast, they are expensive. Other methods of image digitization are video camera capturing of hard copy film images placed on a light box. Though this is an easy method, it is not widely used due to the inferior quality of images. Researchers later developed a java program that can be used on various platforms with minimal training and maintenance. It consisted of the following:

- Image server subsystem
- Database server subsystem
- Client subsystem⁸

Recently, images like CT, CBCT, MRI, ultrasound, nuclear medicine, computed radiography, digital radiography and digital fluoroscopy are in high demand and all of them are basically digital images. These images can be directly linked to a TR system in a standard format. The most widely followed format is ACR-NEMA DICOM³ standard (National Electrical Manufacturers Association). Though different manufacturers follow different standards,

DICOM³ is the most important image acquisition software as it offers 12 bit data set (2056 gray scales) with no loss or image degradation. In a 1 year study done in 2014 among 14 hospital facilities receiving teleradiology services, the images were evaluated for a set of 15 criteria including positioning, collimation, exposure, artifacts and markers. The authors found that the images that were converted to DICOM format using computed radiography had superior quality compared to the hard copy x-ray films that were digitized to JPEG images using a digital camera.⁹

Image compression

Large medical images have to be reduced in size to be shared across TR platforms. Compression of images should not lead to loss of image quality. A compression ratio of 3:1 is ideal for good reproduction. The final image is shared in jpeg standard as it is supported by DICOM-3. It is inexpensive and accepted by most hardware and software. One limitation of JPEG format is block artifacts at higher compression ratios. Another method of image compression is wavelet compression that is also as effective as jpeg. Wavelet compression involves three procedures of transformation, quantization, lossless coding.

Image transmission

Transmission is done using communication equipment like a modem (DSL modem, cable modem), terminal adapter or channel service units. Speeds of transmission using internet can vary from 750 kbps upto 10 Mbps.

Image interpretation

The images are received at the TR end using WAN (Wide area network). At the interpretation site an image server permits distribution within the institution or company. A monitor is needed to read the images. The ACR recommends a minimum resolution of 2000*2000 pixels *12 bits for image acquisition of conventional radiographs. For lower resolution images 512*512*8 bit resolutions is enough as this is the most common configuration available in home personal computers. CBCT images can be processed using softwares like CS 3D imaging, ZORAN CT, ICAT. Next generation unit, ZORAN Tech, ANN-ARBOR, MI, I-DIXEL, E23D plus. These software applications are compatible with Windows and Mac. Other options for image display and interpretation are platforms like Any desk and Team viewer. A high speed internet connection is needed. Apart from these softwares, PACS (Picture Archiving and Communication System) can be installed to enable storage, access,

analysis and sharing of interpreted images.¹⁰

Applications of teleradiology

1. On call, off-duty radiologist can provide their service to hospitals which lack a 24 hour radiologist at their facility.
2. Emergency imaging services needed at extended hours can be effectively handled.
3. Such outsourcing services save time, as several countries like the UK require a time duration of 21 days for an MRI interpretation due to the overall lack of diagnostic radiologists.
4. Increased opportunities and remuneration for the oral radiologists
5. Promotes international ties and exchange of health services
6. Subspecialty coverage can be augmented to rural, remote and under served areas.

Current regulations for oral teleradiology

AAOMR (*American Academy of Oral and maxillofacial radiologists*): AAOMR executive council endorses the use of oral teleradiology to promote oral care. They have given a few examples for the use of teleradiology in dentistry as follows;

- A general dentist shares a set of full mouth radiographs with another general dentist for an opinion (verbal or written).
- An endodontist shares an intraoral periapical radiograph or a CBCT image with another endodontist for an opinion.
- An orthodontist sends a lateral cephalograph to an oral surgeon for an opinion or interpretation.
- A general dentist or a specialist sends an orthopantomogram or a CBCT scan to a surgeon for an opinion.¹¹

ADA (*American Dental Association*): The ADA had released two documents namely:

- The comprehensive ADA policy statement on Teleradiology (2015)
- ADA Technical report no 1060: The secure exchange and utilization of digital images in dentistry (2011).

The ADA further says that any dentist providing or receiving teleradiology services should be licensed in the state where the patient receives the services.¹²

RCR (Royal College of Radiologists): The RCR also has provided written guidelines on the use of teleradiology which can be extrapolated to dental care as applicable. It says that there should be clear, transparent systems that allow rapid and secure transfer of images. Patient data should be stored if necessary and a secure data transfer service should preferably use a 256 bit Encryption.¹³

Current trends and future scope for teleradiology services

- The use of teleradiology in dento-alveolar trauma has good scope. A study done in Italy evaluated maxillofacial trauma cases that were consulted using teleradiology. The authors found teleradiology helpful for appropriate triaging of trauma patients.¹⁴
- Oral teleradiology can be particularly of good use in providing differential diagnosis of oral lesions. A study done in 2013 evaluated 275 cases that were presented to the Korean academy of oral maxillofacial radiologists for assessment and case presentation. The authors found that teleradiology was useful in giving differential diagnosis of oral lesions. It also reduced unnecessary costs.¹⁵
- So many dentists practicing in rural and semi-urban areas do not have access to oral and maxillofacial radiologists near their vicinity. They can adopt teleradiology and set up basic system requirements for sharing radiographic images of patients with oral radiologists and thus create their own local teleradiology network that can be mutually beneficial to all dentists practicing in remote locations.
- Oral radiologists can consider providing TR services to local hospitals initially. In a 2020 study among the ACR members, 44.5-79.6% of radiologists preferred to perform teleradiology reporting in the evenings, overnights or in the weekends. This seems to be a good suggestion to be with. Part time oral teleradiology can provide a wider scope for practicing the sub specialty of radiology by interpreting special cases. It also provides lucrative remuneration without the hassles of physical consultation.⁴

Limitations in head and neck practice

- The most significant disadvantage of teleradiology is the loss of value of a radiologist as an integral part of a healthcare team. This is the result of commoditization

where the value is given to a service solely based on the cost rather than considering its benefits.

- There is lack of collaboration, face to face interaction that can occur in a physical hospital environment.
- Some researchers predict that artificial intelligence (AI) will replace radiologists. However we need to understand that high end AI systems can only be adjuncts to human perception and cognition but cannot replace what a radiologist can offer.
- Generally when the TR service is given within the locality or within a country there is good acceptance among the physicians. But when it comes to international TR services there is a lack of credibility. A study done in 2005 among 350 US physicians stated that in spite of faster interpretation and lower costs, the physicians expressed their lack of credibility over international TR services and ultimately prefer local services.¹⁶

CONCLUSION

With the evolution of telemedicine, tele-surgery, tele-rehabilitation and tele-intensive care units, oral teleradiology too, is sure to reach accelerated developments and higher implementation in the near future. Global shortage of subspecialists like oral radiologists and a geographic maldistribution of the dental workforce will promote oral teleradiology across lower and middle income countries like India. As with every innovation, oral teleradiology has its limitations but these can be addressed with the help of exclusive committees comprising of representatives from the field of oral and maxillofacial radiology. Strict regulations for teleradiology companies with special emphasis on patient confidentiality, radiologists' remuneration and job security agreements can be discussed and implemented. New and updated guidelines issued by professional bodies can help guide dentists towards the effective and safe practice of oral teleradiology.

REFERENCES

1. Silva E et al. ACR White Paper on Teleradiology Practice: A report from the Task Force on Teleradiology Practice. JACR 2013;10(8):575-585.
2. Sending dental X-rays by telegraph. Dent Radiogr Photogr 1929;2:16.

3. European Society of Radiology. ESR teleradiology survey: results. *Insights Imaging* 2016; 7:463–479.
4. Rosenkrantz AB, Hanna TN, Steenburg SD, Tarrant MJ, Pyatt RS, Friedberg EB. The current state of teleradiology across the United States: a national survey of radiologists' habits, attitudes, and perceptions on teleradiology practice. *J AmColl Radiol*2019; 16:1677-1687.
5. Quraishi et al. Off-site radiology workflow changes due to the coronavirus disease 2019 (Covid-19) pandemic. *Studies in Clin Prac Management* 2020. <https://doi.org/10.1016/j.jacr.2020.05.008>.
6. The New England Journal of Medicine. Downloaded from nejm.org at University of Sussex on August 11, 2015. *NEJM* 2007.
7. Boland et al. PACS: A guide to the digital revolution: Pg 523-530.
8. Lee et al: Consulting with radiologists outside the hospital using Java software. *J Inforad* 1999. 19(4).
9. Spijker et al. Quality assessment of x-rays interpreted via teleradiology for Medicins sans Frontieres. *J Telemedicine and Telecare* 2014;20(2) 82–88.
10. Lucas et al. Dental teleradiology: A powerful strategy to overcome the impact of Covid-19. *Academic Radiology* 2020;27(10).
11. American Academy of Oral and Maxillofacial Radiology Executive Committee Springfield, IL, USA. <http://dx.doi.org/10.1016/j.o000.2016.06.020>.
12. American Dental Association. Comprehensive Statement on Teledentistry. American Dental Association House of Delegates. Chicago, IL: ADA; 2015.
13. The Royal College of Radiologists: RCR calls for regulation of overseas teleradiology: Report release date : 12 March 2015.
14. Brucoli M et al. The Use of Teleradiology for triaging of maxillofacial trauma. *J CranioMaxillofac Surg*. <https://doi.org/10.1016/j.jcms.2019.07.007>.
15. Choi et al. Clinical usefulness of teleradiology in general dental practice. *Imaging Science in Dentistry* 2013; 43: 99-104 <http://dx.doi.org/10.5624/isd.2013.43.2.99>
16. Lewis et al. Radiology practices' use of external off-hours. Teleradiology services in 2007 and changes since 2003. *AJR*:193, November 2009.

