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The application of teleradiology in dentomaxillofacial radiology

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ABSTRACT

Radiograph interpretation which is conducted by dentomaxillofacial radiologist has a problem with distance, time and limited number of dental radiologist in Indonesia that it becomes an obstacles to provided expansive and be spread evenly radiograph interpretation services. The objective of this review to provide information to general dentist and other dental specialist about teleradiology advantage in dentomaxillofacial radiology as communication media between dental radiologist and other dental specialist using teleradiology system. Radiographs imaging can be easily sent from dental radiologist to other dental spesialist not only in the sections of the hospital but also other locations throughout the world. The teleradiology system need adequate internet capacity, internet speed and bandwith. Benefits of using teleradiology is able to achieve efectivity dentomaxillofacial radiology services. As conclusion, teleradiology can be used as communication media between dentomaxillofacial radiologist with other dental specialists, especially in providing services radiograph interpretation thus can provide patient services effectively and efficiently, without problem of human resources, time, distance and location.

Keywords: teleradiology, digital, radiograph, interpretation.

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INTRODUCTION

The Dentomaxillofacial radiology services in Indonesia is growing in line with technological developments. There are still problems that disrupt dentomaxillofacial radiology services, particularly in terms of location, time, limitations of x-rays machine and human resources. Secluded areas that are not founded radiology services especially at a time outside working hours or in emergencies, the dentomaxillofacial radiology services performed by a dentomaxillofacial radiologist is necessary. Quantity of dentomaxillofacial radiologist in Indonesia is very limited and should required demand all of dentomaxilloradiograph services.

As the development of science at the present time, there are various problems of distance, time and human resources can be solved by communication techniques. The remote communication can be done in the field of dentomaxillofacial radiology, called by "The teleradiology".

The teleradiology systems in use once known for their digital imaging along with the development of telecommunications technology, begins with arising internet. This time, the imaging

can be sent, not only within the hospital but also outside the hospital and at other locations around the world. The teleradiology system has been widely used in the medical area, even in doing the interpretation by hand phone can also be done at a distance.¹

The aim of this paper is to give information to the dentist about the using of teleradiology in the field of dentistry to be used as a media remote communication between dentomaxillofacial radiologist with colleagues using teleradiology system.

LITERATURE REVIEWS

The teleradiology is the practice of radiology through remote transmission and display the results of diagnostic imaging radiographic examination of the patient. The dentomaxillofacial radiologist interpretation prepared transmitted at a different location where imaging is done. The dentomaxillofacial radiologist can provide interpretation in writing either interpretation. Teleradiology practices include conventional procedures are intra oral and extra oral radiography, computed tomography (CT),

ultrasound (US), magnetic resonance imaging (MRI), and nuclear medicine (NM).⁹

The interpretation of radiographic imaging by teleradiology can be performed with minimal time and can provide access to a lot of consultation. Teleradiology techniques can also developed continuing education. One of the advantages of this technique are teleradiology users in different locations can simultaneously view the image being sent. If this teleradiology can function properly, it can increase access to the use of radiological interpretation done so as to improve services to patients significantly. The teleradiology system less useful if the image is sent does not provide adequate imaging quality.²

Teleradiology has the purpose:

1. To provide consultative and interpretative radiology services.
2. To make a radiology consultation is available at medical facilities without the support of a dentomaxillofacial radiologist in place.
3. Providing timely services to radiological imaging and interpretation in clinical care.
4. To facilitate the interpretation of radiology in situations of on-call.
5. To provide support subspecialty radiology is needed.
6. To improve the continuing education for a dentomaxillofacial radiologist.
7. Promoting efficiency and improving quality of service.
8. To provide imaging interpretation for referral.
9. Supporting telemedicine.
10. Providing quality surveillance imaging.

Some terms that need to be understood in teleradiology is DICOM and PACS. DICOM (Digital Imaging And Communication In Medicine) is a standard radiological imaging processing of imaging and communication of medical information between computers³. PACS (Picture Archiving and Communication System) is imaging without films made by the method of computerized communication and data store medical imaging such as computed radiographic, digital radiographic, computed tomographic, ultrasound, fluoroscopic, magnetic resonance and x-ray radiograph⁴.

The teleradiology first published in an article the New York Times (1907) that describes telephotograph idea. The first experiments performed at two dental radiographs were shipped from the USA with the telegraph in 1929. The early generation teleradiology clinical use analog TV transmissions and video technology made in

late 1950 and continued in 1980 where teleradiology start using computer.⁵

Larson survey's (1999) stated that there are dentomaxillofacial radiologists using teleradiology in practice together 75% and in private practice radiologists by 30%. The radiological practice using teleradiology to provide interpretation services on a call by 92%. Utilization of teleradiology in conventional radiography only by 43% and magnetic resonance imaging of 47%. Another survey conducted by Saketk hoo et.al against 114 private hospitals, 97 hospitals respondent institutions, there are 82% who use teleradiology at night time. These data indicate that the dentomaxillofacial radiologist greatly benefit from the application of teleradiology so trustworthy and be a critical requirement to be a concern in matters of accuracy and appropriate services time.⁶

The Principles of Teleradiology

Components required in teleradiology system⁵:

1. Image Sending Station

At the image sending center, radiographs captured in digital format by the digitizer, if initially in the form of x-ray films using a film scanner CCD (charge coupled device). Today, most of the image already in digital format DICOM (digital imaging and communication in medicine), which is a direct result of digital modalities.^{3,5}

2. Transmission Networks

The communications network is essential for teleradiology. Networks can be either wired or wireless. The simplest cable network is a telephone line or ISDN (integrated services digital network) digital that can be used as a connection point to another with the help of a modem that is known as a dial-up connection, because they appear if required. This is less stringent security requirements, because there is no other partners in the communication path. The speed that can be used ranging from 9.6 kbit / s for modem connections and 64 kbit / s for the ISDN connection path. ISDN connections can be duplicated; using 2 to 6 parallel channels with a speed of 128-384 kbits / s.^{3,5} Connections Wide area network (WAN) is a fixed connection between the local area network (LAN) at different installations, providing higher speeds and reliable connections. Solutions with lower

costs for the WAN connection is using DSL (Digital Subscriber Line) connection at the customer site. One of the WAN connection is the Internet, but includes the possibility for an easier relationship, even an ad hoc basis. Wireless network connection to teleradiology including satellite transmission, microwave transmission and mobile phone connections. Satellite connections are used directly or as part of a WAN connection. Microwave transmission usually involves the direct connection point-to-point. Phone's network connection based on the ability to transfer data from the line operator and is usually connected to the LAN at the delivery location.⁵

3. Review Station

In a review of teleradiology systems, monitor resolution is recommended for cross-sectional images that high-end monitor 1024 × 1024 pixel (1 K) and for primary diagnostic digital radiography resolution of 2048 × 2048 pixels (2 K). Workstations should include local storage for images and software that is user-friendly to manage and display images and relevant patient data. The teleradiology workstation should be connected to the local PACS for storing images and image capture, administration tools for reporting and billing is also required.⁵

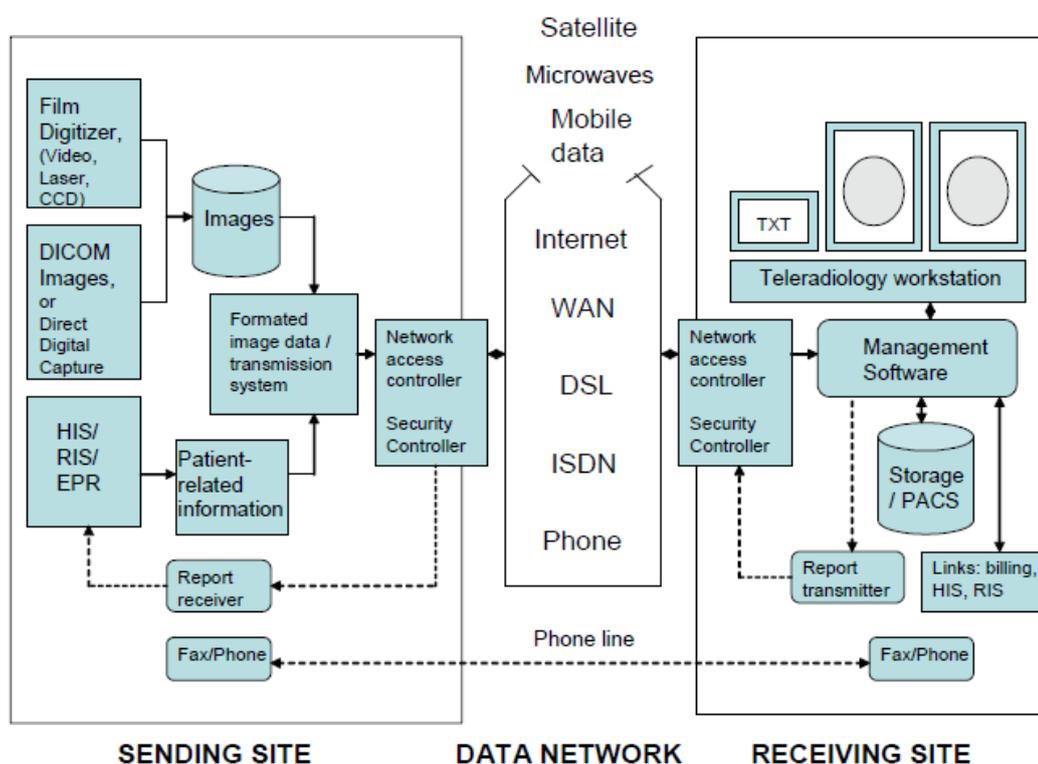


Figure 1. Teleradiology Component^{8,7}

The electronic radiographic imaging patient is done by creating a code in digital format on the imaging dispatch center sent over transmission lines, received, displayed and stored in the reception center imaging.

Web-based teleradiology system with a web browser can use commonly found in personal computers, but the software needed to display the advanced digital imaging. The ability for all

types of computers to display the image in a way that is easy, safe, and reliable, and it is important to distribute the image to users. Workstations that such is necessary but requires a relatively expensive cost that is only possible done in the radiology department of dentistry, which has a substantial funding anyway.

Compression imaging, internet connection, and a standard document format is very useful to

do to achieve that goal. Three concepts can be implemented together with a solution for imaging consultation remotely without requiring special software to display DICOM. The appropriate solution is applied to a secluded place where broadband connections are less adequate.⁸

The workflow of teleradiology in general are¹⁴:

1. The referral from dentist will send all the information into an online form with your dentomaxillofacial radiologist who have competence as teleradiology.
2. The dentomaxillofacial radiologist receives consul and sent to the operator radiologist (in the radiology department of dentistry).
3. Operator radiologist techniques in accordance with the referral is received.
4. The results are sent to dentomaxillofacial radiologist to do interpretation
5. The dentomaxillofacial radiologist sends the results interpretation online.¹⁴

Radiological examination in the hospital should be done at least by expertly trained operator. All components in this case that the operator must be licensed or registered radiology. Operators should be under the supervision of a licensed physician and quality and have a qualified medical physicist or expert in imaging management. Interpretation of imaging should be performed by physicians who have an understanding of the basic technology teleradiology, which covers aspects of the strengths and weaknesses (and limitations), and who is knowledgeable in the use of teleradiology equipment, and be able to demonstrate appropriate qualification standards for diagnostics by teleradiology. Operator radiology, radiation therapists, nuclear medicine operator, or sonogram operator must be certified or state licensed and trained to operate and supervise the system teleradiologi.^{1,13}

Teleradiology has advantage on patient care. The potential positive advantage teleradiology is the process of evaluating patients in emergency room use teleradiology can reduce the factors distance from home to the hospital and can be used to serve the needs of radiography and its interpretation of the different locations.¹² It can be a strategy for dentomaxillofacial radiologist in overcoming the limited amount of resources dentomaxillofacial radiologist and distance factors in an effort to meet the needs of the practice of radiology

services in the field of dentistry. Potential negativeteleradiology was rising costs in this service because it requires a fairly expensive digital devices in preparing the software and hardware to provide a good service.¹⁰

Some of the benefits of teleradiology is :⁸

1. Teleradiology create a community of patients who are in distant places with limited visits to a dentomaxillofacial radiologist is easy to obtain radiographic imaging results and send it back.⁴ This makes more efficient use of teleradiology system of aspects economy.^{3,5}
2. Imaging with complex problems can be transmitted from the hospital to do service to other hospitals. This is advantageous because hospital patients are more able to decide whether or not a patient is transferred from smaller hospitals to the large hospital without disturbing the comfort of patient.⁴ It also said that the use of teleradiology system led to a reduction of 50% in the case of patient transport is not necessary.^{3,5}
3. The use of teleradiology can be used as an efficient method to manufacture reports quickly to emergencies where no dentomaxillofacial radiologist at the hospital during that study.⁴ Fernandez Salazar reported that teleradiology can reduce delays in care after doing diagnostic.^{3,5}
4. Allows teleradiology into educational media presentations and tutorials in the radiology department at the hospital.⁴
5. It can display images in different locations simultaneously for the discussion purpose.⁴

Teleradiology is big business in the United States where there are many private teleradiology company that employs radiologists to provide teleradiology interpretation. Survey a few years ago showed the majority of radiology practices using teleradiology services.¹⁰

Deficiencies In The Diagnostic Accuracy

Since the teleradiology system was introduced, which became the main concern is the accuracy of diagnostics. In 2002, Jacobs et al reported that telediagnostic as accurate condyle fractures compared with direct visualization; but through fractures midfacial transmitted through the film to show the is simply quality and the

accuracy of diagnosis is lower than with vision indirect.¹¹

Confidentiality of Data

Teleradiology 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 teleradiology systems must be kept secret. Therefore, teleradiology system users in the service must be educated about the confidentiality of the data security information.³ A method to protect data from unauthorized access to privacy patient.⁹ It also calls for the protection of data and guarantee data integrity to prevent damage data intentionally or not.¹

Studies in teleradiology has focused on three main objectives:

- a. Reduce the amount of memory required to encode imaging radiography, keeping information, improvement of digital imaging and communications in medical
- b. Increase rate of transmission on the network, although the distribution of broadband internet connections in western countries is very good, but in some areas other than western countries is less than optimal.
- c. Fix the display of digital imaging and communication in medical.⁷

DISCUSSION

Dentomaxillofacial radiology science in indonesia haddeveloped rapidlyin recent years. Consulting services of dentomaxillofacial radiology interpretation should be efficient and effective to supported diagnostic and treatment plan in dentistry. There are commonly obstacles that arise in Indonesia:

1. During the processing and radiographic interpretation patients should waiting because of there are still using the conventional system, processing dental film and delivery of radiographic films to interdepartmental with distances that need.
2. Another obstacles consultancy services and radiographic interpretation is the distance, the services cannot reach the remote area.
3. One of the biggest obstacles is the limited ratio of dentomaxillofacial radiologist compared with the quantity of service needs that exist.

Increasing of necessity for efficient and effective consulting services and dental

radiology interpretation as supporting diagnostic and treatment plan. Various obstacles that lead to not fulfilled demand of efficient and effective consulting services and dental radiology interpretation.

Among the developmental of digital imaging technology in medical, whereas medical digital imaging become a necessity at this time for diagnosis and treatment planning. Teleradiology is used as a media of communication in the field of dentomaxillofacial radiology especially to provided effective patient services, without the issue of limited human resources, time, distance and location.

Because of insufficient quantity of dentomaxillofacial radiologist throughout Indonesia there are required alternative techniques in the field of remote communication to supply the needs dentomaxillofacial radiography services of any hospital that's spread all over Indonesia. To resolve this obstacles required a comprehensive system. The development of technology facilitate various things: the long distance, time, and human resources which can be resolved by long-distance communication.

Communication at distance using electronic transmission in the field of radiology known as teleradiology. Teleradiology systems provide services to patients more efficient, especially for nighttime include emergency room or hospital in a remote area with limited dentomaxillofacial radiologist. Dental imaging can easily sent not only within the hospital but also outside the hospital and at other locations around the world.

The existence of this teleradiology systems can resolve the obstacles, but there is still less socialization of teleradiology in the field of dentistry. This discussion is intended to introduce teleradiology system in the field of dentistry in Indonesia which is expected to be applied and further developed in the field of dentistry in Indonesia.

Developments in informatics technology leading to the rapidly development of teleradiology. The electronic transmission of radiographic imaging from one location to another for various purposes, especially for interpretation radiograph, consultation and research.^{6,7,11} Users in different locations can view simultaneously radiograph image. Utilization of teleradiology appropriately can

increase access to radiograph interpretation which would improve services to patients.¹⁰

The supporting key factor of teleradiology systems is the changing paradigm about processing and using of radiograph imaging. Since the discovery of x-rays by Roentgen in 1895, the imaging process since hundreds of years ago based on the chemical of photograph and physics of imaging. Modern appliance such as the Nuclear Medicine and Computed Tomographic imaging is displayed and stored digitally using a computer in 1960 and 1971 which was the beginning of the changing from conventional into digital imaging. The positive

impact of the use of digital imaging and teleradiology can also reduce the use of cd, chemical waste use than conventional radiograph.

CONCLUSION

Teleradiology can be used as communication media between dentomaxillofacial radiologist with other dental specialists, especially in providing services radiograph interpretation thus can provide patient services effectively and efficiently, without problem of human resources, time, distance and location.

REFERENCE

1. Choi JW. Clinical usefulness of teleradiology in general dental practice. *Imaging Science in Dentistry* 43 (2013): 99-104. <<http://dx.doi.org/10.5624/isd.2013.43.2.99>>.
2. American college of Radiology. ACR Standard for teleradiology. 13-21. Available at : www.acr.org.
3. Huang, HK. 2004. PACS and imaging informatics basic principles and applications Hoboken : John Wiley & Sons, Inc
4. Tong Carrison KS and Wong, E. 2009. Governance of Picture Archiving And Communication Systems : Data Security and Quality Management of Filmless Radiology. Hershey: information Science Reference
5. Reponen J. Teleradiology Changing Radiological Service Process From local to regional, international and mobile environment. ACTA Universitatis Oulu. 2010.
6. Larson DB, Cypel YS, Forman HP, Sunshine JH. A comprehensive portrait of teleradiology in radiology practices: results from the American College of Radiology's 1999 survey. *AJR Am J Roentgenol.* 2005;185:24–35.
7. Kalyanpur A, Neklesa VP, Pham DT, Forman HP, Stein ST, Brink JA. Implementation of an international teleradiology staffing model. *RSNA.* 232. 2. 2004. 415-419.
8. European society of radiology. Teleradiology I. 2004. Available at : www.myESR.org
9. Hunter TB, and Krupinski EA. University-Based Teleradiology in the United States. *Journal of Healthcare.* 2014, 2, 192-206; doi:10.3390/healthcare2020192 available at : www.mdpi.com/journal/healthcare
10. Jelic D, Dragutinovic G. Development of teleradiology in private practice in Serbia and its influence on increased efficiency and effectiveness of medical professionals. *Journal for theory and practice management.* 69. 2013. 85-91
11. Luccichenti G, Cademartiri F, Pichiecchio A, Bontempi A, Sabatini U, and Bastianello, S. User Interface of Teleradiology System For MR Assessment of Multiple Sclerosis. *Journal of Digital Imaging.* 15 July 2009. doi: 10.1007/s10278-009-9222-8.
12. Saketkhoo DD, Bhargavan M, Sunshine JH, Forman HP. Emergency department image interpretation services at private community hospitals. *Radiology* 2004;231:190–197.
13. Silva E, Breslau J, Barr RM, Liebscher LA, Bohl M, Hoffman T, Boland GWL, Sherry C, Kim W, Shah SS, Tilkin M. ACR White Paper on Teleradiology Practice: A Report From the Task Force on Teleradiology Practice. *J Am Coll Radiol* 2013;10:575-585
14. Martinon A, Berthezene Y, Thomson V, Mougnot V, Girouin N, Journe C, Cheikh AB, Le Pogam MA. Evaluating The Impact Of Teleradiology On Emergency Care in Lyon France. *EPOS.* 2012. 1606: 1-22.