

Tele - Dentistry: An Un-charted Tool

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Received: September 19, 2020

Published: September 30, 2020

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Abstract

Background: Tele-dentistry has been considered as a practical and potentially cost-effective method of providing healthcare to the general population including those living in remote or rural areas and those who lack regular access to routine dental care.

Objectives

- To assess the feasibility of Tele-diagnosis in the field of Oral Medicine and Radiology.
- To assess the accuracy of Tele-diagnosis in the field of Oral Medicine and Radiology.
- To assess the time lapse in initiating the treatment based on Tele-consultation.

Materials and Methods: A Multi-centric study comprising of 30 patients, with questionable lesions/conditions in the Oral and Maxillofacial region which posed as a diagnostic challenge and further required confirmation of diagnosis with additional investigations (Histo-pathological, serological or advanced radiographic investigations) were included in the study. Three remote consultants specialized in the field of Oral Medicine and Radiology were consulted by the path of tele-dentistry, whose diagnosis was correlated among them and with that of the gold standard.

Results: Remote consultant 1, 2 and 3 had given a correct diagnosis in 70%, 80% and 76.7% cases respectively, which accounts for about 75.5% cases, in which the correct diagnosis was given. The cross tabulation of the diagnosis given by remote consultant 1 and 2, 1 and 3, 2 and 3 showed a kappa value of 0.3, 0.8 and 0.3 respectively.

Conclusion: Further research in the field of tele-dentistry with a larger study sample of may change the face and future of tele-dentistry and in reality it may be used in our day to day clinical practice. The importance of early identification, diagnosis and timely management of the diseases is the need of the hour.

Keywords: Tele-dentistry; Consultants; Diagnosis; Time; Tele Communication; Distant

Introduction

In today's world, the fast pace of life being favored by the emergent technology embarks the beginning of a new era, which also incorporates medicine within its shadow with dentistry being a part of it. These advancements have revolutionized the diagnostic and treatment protocols being followed over the years. The practice of telecommunication technology by the dentists, which provides seamless boundaries has been termed as "Tele-dentistry" [1,2].

In 1997, Cook defined Tele-dentistry as "the practice of using video-conferencing technologies to diagnose and to provide advice about the treatment over a distance." The word "Tele- dentistry is derived from the greek word "Tele" and the latin word "mederi" in which the former means "distance" and the latter stands for "heal" [1,3].

Tele-dentistry has been considered as a practical and potentially cost-effective method of providing healthcare to the general population including those living in remote or rural areas and those who lack regular access to routine dental care [4-7]. Many medical specialties are investing in telehealth technologies to deliver clinical services to remote areas devoid of human resources for specialized care [4,8,9].

Tele-dentistry is a boon for the dentists wherein they can communicate and diagnose diseases/conditions within a very short period of time. The advantage being quick and the right diagnosis at the same time within a very short span of time, which will alter the treatment protocol of the patient and provide immediate relief to the patient.

The quick response given by the tele consulting physician from the other side not only changes the treatment plan but also has the chance of changing the final diagnosis of the patient, all of which enhances the timely management of the health of the patient. Tele-health systems can be set up in hospitals, clinics, private offices, nursing homes, rehabilitation facilities, homes, assisted living facilities, schools, prisons and health departments [10].

In a country like India, with its diverse landmass, huge rural population and existing health care delivery mechanism clubbed with advances in telecommunications technology, could be an ideal setting for teledentistry.¹¹Teledentistry in India can set up a pivotal role in expanding and improving the oral health and other related ill habits such as smoking and tobacco chewing etc., in large extent [10].

Aims and Objectives of the Study

- To assess the feasibility of Tele-diagnosis in the field of Oral Medicine and Radiology.
- To assess the accuracy of Tele-diagnosis in the field of Oral Medicine and Radiology.
- To assess the time lapse in initiating the treatment based on Tele-consultation.

Materials and Methods

The present study enrolled 30 participants with oral mucosal diseases/conditions with/without systemic diseases, diagnosed clinically/histo-pathologically/radiographically over the period from January 2017 to August 2018.

A thorough clinical examination was done and the data was recorded in the electronic form and stored in a word document. Clinical photographs of the lesions and other necessary information (Radiographs and Serological investigations) required for the diagnostic purpose was mailed to three different specialists in the field of Oral Medicine and Radiology.

The data was forwarded by "store and forward system" to a minimum of three distant consultants separately, who were oral medicine specialists, each having a minimum experience of 10 years or more. They analyzed the electronically transmitted images and clinical information. A time frame of 48 hours was awarded to each consultant to provide one working diagnosis with three differential diagnoses for each case, from the time they receive the data.

Further, in our study the oral mucosal lesions requiring histopathological reports were subjected to biopsy, which was considered as a "gold standard" for the definitive diagnosis. Odontogenic lesions or long standing soft tissue lesions required advanced radiological investigations like CT, MRI or CBCT was done accordingly. Further on, the hypothesis made by the consultants was compared with the definitive diagnosis arrived at after obtaining the Histopathological or the radiology report. The agreement between the consultants and the definitive diagnosis was measured by the *k* coefficient of agreement.

Inclusion criteria

Patients with questionable lesions/conditions in Oral and Maxillofacial region which were a diagnostic challenge and required confirmation of diagnosis with additional investigations like histopathological, serological or advanced radiographic investigations.

Exclusion criteria

- Patients who were not willing to be a part of the study.
- Pregnant patients.
- Patients with psychological disorders.

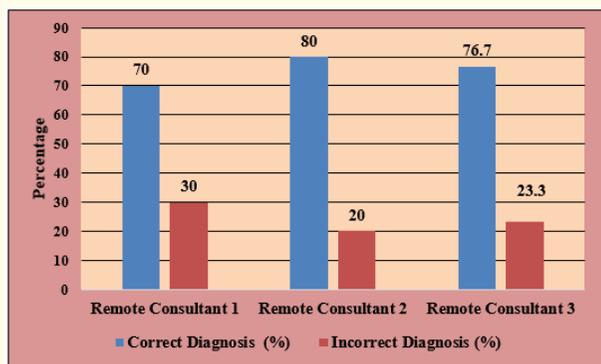
Results

The statistical analysis for our study was carried out in two aspects with the sensitivity of tele-diagnosis, which is considered the probability that a test result was positive when the disease is present (true-positive) and the specificity, which is considered the probability that a test result was negative when the disease is not present (true-negative) was calculated. Further, the agreement between the consultants and the definitive diagnosis was measured by the *k* coefficient of agreement.

Table 1 and graph 1 shows the number and percentage of correct and incorrect diagnosis by the 3 remote consultants. We found that remote consultant 1, 2 and 3 had given a correct diagnosis in 21 (70%), 24 (80%) and 23 (76.7%) cases respectively.

	Correct Diagnosis N (%)	Incorrect Diagnosis N (%)	Total N (%)
Remote Consultant 1	21 (70)	9 (30)	30 (100)
Remote Consultant 2	24 (80)	6 (20)	30 (100)
Remote Consultant 3	23 (76.7)	7 (23.3)	30 (100)

Table 1: Percentage of correct/incorrect diagnosis by remote consultants.



Graph 1: Percentage of correct/incorrect diagnosis by remote consultants.

Table 2 and graph 2 shows the time taken by the 3 remote consultants to diagnose the disease by tele-dentistry. We found that remote consultant 1 had given a diagnosis in the time of- <24 hours, 24 - 48 hours, in 28 (93.3%), 2 (6.7%) cases respectively. Remote consultant 2 had given a diagnosis in the time of- < 24 hours, 24 - 48 hours, 48 - 72 hours, > 72 hours in 21 (70%), 3 (10%), 3 (10%) and 3 (10%) cases respectively. In case of remote consultant 3 had given a diagnosis in the time of- < 24 hours, 24 - 48 hours, 48 - 72 hours, > 72 hours in 17 (56.7%), 5 (16.7%), 3 (10%) and 5 (16.7%) cases respectively.

Time	Remote Consultant 1 N (%)	Remote Consultant 2 N (%)	Remote Consultant 3 N (%)
A (<24hrs)	28(93.3)	21(70)	17(56.7)
B (24 to 48 hrs)	2(6.7)	3(10)	5(16.7)
C (48 to 72 hrs)	0	3(10)	3(10)
D (> 72 hrs)	0	3(10)	5(16.7)
Total	30(100)	30(100)	30(100)

Table 2: Time taken by the remote consultants to provide a diagnosis.

Graph 2: Time taken by the remote consultants to provide a diagnosis.

Table 3 shows the cross tabulation of the diagnosis given by remote consultant 1 and 2 showed that correct diagnosis was given in 19 cases and incorrect diagnosis was given in 4 cases, which showed a Kappa value of 0.3. Chi square test analysis was found to be statistically significant (*p* < 0.04).

Table 4 shows the cross tabulation of the diagnosis given by remote consultant 1 and 3 showed that correct diagnosis was given

in 21 cases and incorrect diagnosis was given in 7 cases, which showed a Kappa value of 0.8. Chi square test analysis was found to be statistically significant ($p < 0.0001$).

Table 5 shows the cross tabulation of the diagnosis given by remote consultant 2 and 3 showed that correct diagnosis was given in 20 cases and incorrect diagnosis was given in 3 cases, which showed a Kappa value of 0.3. Chi square test analysis was found to be statistically insignificant ($p < 0.1$).

Remote Consultant 1	Remote Consultant 2		Total
	Correct Diagnosis	Incorrect Diagnosis	
Correct Diagnosis	19	2	21
Incorrect Diagnosis	5	4	9
Total	24	6	30
k = 0.3			
Chi-sq = 4.8 ($p < 0.04^*$)			

Table 3: Comparison in between remote consultant 1 and 2, Kappa value and their statistical significance (Chi- square test).

Remote Consultant 1	Remote Consultant 3		Total
	Correct Diagnosis	Incorrect Diagnosis	
Correct Diagnosis	21	0	21
Incorrect Diagnosis	2	7	9
Total	23	7	30
K = 0.8			
Chi-sq = 21.3 ($p < 0.0001^*$)			

Table 4: Comparison in between remote consultant 1 and 3, Kappa value and their statistical significance (Chi- square test).

Remote Consultant 2	Remote Consultant 3		Total
	Correct Diagnosis	Incorrect Diagnosis	
Correct Diagnosis	20	4	24
Incorrect Diagnosis	3	3	6
Total	23	7	30
K = 0.3			
Chi-sq = 2.9 $p < 0.1$			

Table 5: Comparison in between remote consultant 2 and 3, Kappa value and their statistical significance (Chi- square test).

Discussion

Telemedicine has been practiced since the late 1950s [12,13], and a substantial amount of money has been spent on research and demonstrations. However, telemedicine still has no universally accepted (all-inclusive definition), till date.

One of the best definitions of telemedicine is that expressed by the Association of American Medical Colleges, or AAMC: “Telemedicine is the use of telecommunications technology to send data, graphics, audio, and video images between participants who are physically separated (i.e., at a distance from one another) for the purpose of clinical care” [12,14].

Dentists can share patient information, radiographs, graphical representations of periodontal and hard tissues, therapies applied, lab results, tests, remarks, photographs, and other information transportable through multiple providers [7,11,15-18].

Hence, in our study we have tried to make use of tele-dentistry for the diagnosis of oral lesions by three remote consultants with the help of photographs which were mailed to the consultants and also intimation was given to them about the same through WhatsApp as we have also considered time as a factor in our study. Our consultants were specialists in the field of oral medicine and radiology with an experience of more than 10 years which gives us a chance of an accurate diagnosis.

Our study consisted of 30 cases with oral lesions whose photographs were taken and sent to the remote consultants who provided us with a diagnosis and a differential diagnosis. Also, in our study we have taken time into consideration as it plays a pivotal rule in diagnosis and treatment plan of the patient. The diagnosis given by the remote consultants was cross verified with the histopathology report from the biopsy which was procured from the patient. Biopsy is still being considered the gold standard.

In our study we found that remote consultant 1, 2 and 3 had given a correct diagnosis in 70%, 80% and 76.7% cases respectively (Table 1 and graph 1), which accounts for about 75.5% cases, in which the correct diagnosis was given. An accurate diagnosis at this rate is quite impressive as it is the diagnosis provided just on the basis of the images sent through mail, following the path of tele-dentistry.

Similarly in a study done by Torres-Pereira, *et al.* (2008) investigated the feasibility of distant diagnosis in oral medicine; their

objectives were to study tele-dentistry via e-mail and to use digital photography to quantify the accuracy of diagnosis by remote specialist consultants. Clinician 1 had a 72% correct diagnosis rate (n = 18), and Clinician 2 had a 76% (n = 19) correct diagnosis rate. Thus in 88% of cases, at least one consultant was able to provide the correct diagnosis [19].

Another study done by Torres-Pereira, *et al.* in 2012 to evaluate the applicability of tele-diagnosis in 60 patients in oral medicine, through the transmission of clinical digital images by e-mail found similar results with consultant 1 making correct diagnosis in 70% of the cases while consultant 2 was correct in 63.3% cases [4].

A study done by Piccolo, *et al.* (2000) on tele-dermoscopy with 43 pigmented skin lesions in a multicenter study, has found a mean of 85% correct diagnoses using e-mail [4,19,20].

A Study done by Massone, *et al.* (2007) involving 46 subjects reported correct diagnoses in 73% and 74% of cases by the consultants, compared with the presenting diagnosis and to the histopathological diagnosis, respectively [4,19-21].

We also considered time as a factor and hence recorded the time within which the consultants had replied with a diagnosis. Time frequency was divided into 4 sections i.e. 24 hours, 24 - 48 hours, 48 - 72 hours, > 72 hours. In a span of 24 hours, remote consultants 1, 2, 3 had replied for 93.3%, 70% and 56.7% cases, while they replied for about 6.7%, 10% and 16.7% cases in the time duration of 24 to 48 hours (Table 2 and graph 2). Both the remote consultants 2 and 3 reverted back in a time span of 48-72 hours in about 10% cases. After 72 hours, remote consultants 2 and 3 provided a diagnosis for about 10% and 16.7% cases (Table 2 and graph 2).

The cross tabulation of the diagnosis given by remote consultant 1 and 2 showed that correct diagnosis was given in 19 cases and incorrect diagnosis was given in 4 cases, which showed a Kappa value of 0.3. Chi square test analysis was found to be statistically significant ($p < 0.04$) (Table 3).

The cross tabulation of the diagnosis given by remote consultant 1 and 3 showed that correct diagnosis was given in 21 cases and incorrect diagnosis was given in 7 cases, which showed a Kappa value of 0.8. Chi square test analysis was found to be statistically significant ($p < 0.0001$) (Table 4).

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In a similar study done by Torres-Pereira, *et al.* (2008) investigated the feasibility of distant diagnosis in oral medicine; their objectives were to study tele-dentistry via e-mail and to use digital photography to quantify the accuracy of diagnosis by remote specialist consultants showed that in 88% of cases (22 of 25), at least one consultant was able to provide the correct diagnosis and inter-observer agreement showed a kappa value of 0.30 and 0.27 for observer 1 and 2 respectively [19].

Torres-Pereira, *et al.* in 2012 to evaluate the applicability of tele-diagnosis in 60 patients in oral medicine, through the transmission of clinical digital images by e-mail also showed that in about 51.7% cases correct diagnosis was given by both the consultants [4]. Further the kappa value in between the gold standard and consultant 1 and 2 was found to be 0.575 and 0.516 which was fair [4].

Distance diagnosis of oral diseases, decreased time and labor required to store the data, no piles of papers and files with patient records with ease of storing data on computer along with the diagnostic images and other relevant information are the main advantages of teledentistry [10].

Technologies provides a growing population of underserved patients with much-needed oral health services and benefits all the members of the digitally linked oral health-care team [10].

Even though there are many advantages in the field of dentistry, certain limitations have restricted its use in our day to day life.

Tele-dentistry has yet to be accepted as a widely used or fully accepted adjunct to dentistry. Many constraints like technical, legal, educational and insurance are to be addressed before making tele-dentistry a vital part in the health sector. Proper internet connections are required for teleconferencing. A backup communication system and technical support group is required. Experience of the peer dentist and his knowledge is also varied [10].

Further, discussion of problems on social networking sites is also risky as we don't know whose opinion is the best and we have to rely on our judgment only though one of the advantages of tele-dentistry is its ability to increase access to more than one expert dental opinion [10].

Privacy and security are important issues in cyberspace. If patient's data is lost or stolen during the process of transmission, the entire project may need to be discontinued, especially once the Health Insurance Portability and Accountability Act becomes law [10,12,22,23].

The ability of providers to bill and collect fees for health-care services provided through telehealth is a large issue for sustaining a telehealth program. Reimbursement for telehealth services is limited [10].

Also, liability or medical malpractice exposure will attach to any health-care practitioner who actively participates in the treatment of a patient. Liability will attach regardless of whether the health-care practitioner participates in person or via an interactive telehealth link or via store and forward technology and regardless of whether his or her participation is regarded as a direct patient encounter or a consultation. Any provider should inquire as to whether his or her existing malpractice policy, covers procedures performed utilizing telehealth technology. Since tele-dentistry involves the electronic transmission of healthcare data, issues regarding whether to record and store this data are relevant [10].

In our study we found that with the help of remote consultants a correct diagnosis rate of about 75.5% was achieved within a limited period of time, with the majority of it being diagnosed within 24 hours. The combined clinical acumen of all the 3 remote consultants showed that in more than 60% of the cases, the diagnosis was found to be correct.

Conclusion

In our study we found that remote consultant 1, 2 and 3 had given a correct diagnosis in 70%, 80% and 76.7% cases respectively, which accounts for about 75.5% cases, in which the correct diagnosis was given. Further research in the field of tele-dentistry with a larger study sample of may change the face and future of tele-dentistry and in reality it may be used in our day to day clinical practice. The importance of early identification, diagnosis and timely management of the diseases is the need of the hour.

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