

Teledentistry Applications: Potential Dental Care Facilitator amidst a Pandemic

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ABSTRACT

This article illustrates the various accessible Teledentistry Applications (Apps), available on Google play store and Apple app store for android and iOS software, respectively, which can facilitate dental care amidst global health crisis such as pandemics, specifically the current COVID-19 pandemic. Online searches, according to set criteria, were conducted on Google search engine using the WorldWideWeb and Google play store. Search yielded 499 applications of which, 478 were excluded to include a total of 21 applications. Each included app was reviewed for downloads, user ratings, customer support and key features. Teledentistry in the form of mobile or web based application is a viable option for continuing dental services during periods of lockdown. Effective use of the existing apps requires increased patient awareness and dentist acceptance. Newer and efficient apps are required to facilitate comprehensive care in a hospital based dental practice.

Keywords: Offline dental care, Oral health, Smartphones

INTRODUCTION

COVID-19, a pandemic as declared by the World Health Organisation (WHO) on March 11, 2020, has put the entire human race to test. The virus spreads from person to person with increased risk of spread when people are in proximity (within 6 feet). Source of spread is through respiratory droplets generated by infected, symptomatic or asymptomatic persons during activities like talking, coughing or sneezing. All dental procedures require close contact with patient's oral cavity, saliva, blood, and respiratory tract secretions, putting the dentists, auxiliaries and patients at high risk of cross-infection. The current crisis has restricted dental care to providing only urgent and emergent cases, becoming the new normal. It has become inadvertent for dental professionals to stay home and temporarily shut their practices which has led to provision of treatment via teledentistry.

Teledentistry, is a combination of telecommunications and dentistry, involving the exchange of clinical information and images over remote distances for education, consultation and treatment planning [1,2]. Dentists can harness the increasing use of smart phones by common man to provide real-time and offline dental care to not just keep their practices going but also ensure that oral health of the community at large is not neglected [3,4]. Teledentistry is easily accessible through various internet-based, applications (apps) providing numerous functions like diagnosis, consultation, treatment planning, appointment management etc., and that can be freely downloaded too [5].

Various kinds of dental consultations are provided by these smartphone apps. General dental consultations, monitoring tooth movement for orthodontic treatments, caries assessment, oral hygiene assessment, smile analysis and follow-up consultations (by keeping a record of pre-treatment and post-treatment conditions) are facilitated by the variety of features offered by the apps. Emergency consultations and dental triaging are two key areas where mobile dental apps can be useful in times of restricted dental services during a lockdown situation.

However, less has been mentioned about such teledentistry smartphone apps in the scientific literature. Presently, the number of apps available in the app stores outnumbers the evidences available in databases such as PubMed, etc. This indicates the fact that app developing and making them available on the app stores has become a faster process aided by rapidly advancing technologies

and with the presence of skilled app developers. Comparatively, study designing, executing followed by publishing results, is a much slower process than the fast-paced timeline for app development.

This article reviews the available mobile teledental applications for iOS and android systems and discusses their potential in dealing with oral healthcare needs of the population during such crisis.

MATERIALS AND METHODS

An online search was conducted from 1st July, 2020 to 22nd July 2020, via Google search engine using keywords, 'Teledentistry apps on App store.' A second search was made on Google Play store using keywords, 'Dental consultation' and 'teledentistry.' Only those apps were included which were available on either Google Play Store or on App Store and aimed to provide online dental consultation. Those excluded were non-dental apps, apps based on knowledge for dental students, dental clinic management and booking appointments, dentistry-based games for children and online dental stores.

Each app was reviewed for number of installs (total downloads), user ratings, customer support, and key features.

1. Number of installs- Google Play store provides an approximate number of downloads for each app available on the store unlike Apple App store. The number of downloads were noted from this data wherever provided.
2. User ratings and reviews- The user ratings and reviews of last one year, i.e., from July 2019 to July 2020 were analysed for apps having 100+ downloads on the app stores. Only those reviews providing a 5 star or a 1 star rating were taken into consideration.
3. Key features- Key features of each app were obtained from the app description provided in the app stores.
4. Customer support- Customer support for each of the key feature was assessed by the information provided in the app description. Customer support was categorised into four categories- online (features like tracking location of dental team, video conferencing for consultations, online clinical data collection), phone-based (features like phone calls, text messages), knowledge-based (features like answers to preliminary oral health questions, patient education videos) and video tutorials (training tutorial videos to take better pictures).

RESULTS

The searches yielded a total of 499 apps of which 478 were excluded, with 23 being apps related to appointment management; 33 were dental gaming apps intended for children; 87 were educational apps for dental students; 15 were online dental stores; 24 apps were an online platform for the dentists to connect with other fellow dentists and 30 apps were mainly based on patient education. Remaining were non-dental apps. Finally, a total of 21 apps were included for review in this article [Table/Fig-1-3].

With more than 50,000 downloads on Google Play Store, "Dental monitoring" is one of the few popular android based applications offering teledental consultation. This app is also available for iOS users, however, "Denteractive" was seen as the most widely used iOS-based app. [Table/Fig-4] shows the results of the popular teledentistry apps based on number of downloads.

With respect to user ratings, "Dentist" available on Google Play Store, has the highest user rating of 5.0 followed by "dentalchat"

and "dental monitoring." User ratings of other reviewed apps are presented in [Table/Fig-5].

Majority (12 apps) of the reviewed apps are available on both android and iOS operating systems except three which are exclusively available for android operating systems (Dguard, Dentist and DenToGo Monitoring) and four being exclusively available for iOS (Denteractive, Smiles To Go Dentistry, Dentist on Demand and DentalStat). Two apps (Teledent and Teledentix) also have a web support, and therefore users can use them without downloading their mobile app.

The commonly available features in these apps included; video, audio and text chatting, appointment booking, visual inspection of oral cavity using cameras, and reminders. Some apps also provide certain exclusive features like emergency care facilities (Dentulu patients- virtual dental consultations, and Denteractive), electronic prescription (by Teledentistry), online report generation (Toothpic), and search for dentist in a specified area (DentalChat). Dental Monitoring provides a cheek retractor to the users to help take better pictures. They also provide tutorial videos to enable patients

Name	Installs (On Google play store)	User rating		Customer support	Key features
		Google play store	Apple App store		
Dentulu patients-virtual dental consultations	1,000+	4.2	3.9	Online, Knowledge-based, Video tutorials	Booking appointments Tracking location of dental team Emergency call facility Scheduling emergency home calls Video conferencing for consultations Patient education videos
Dentists for me	5000+	(Not available)		Online	Video, audio and text chat with dentist Get a consultation by scheduling an appointment at your convenience Free dental consultations
Dental chat	1000+	4.8	(Not available)	Online	Online dental consultations from certified dentists Online query resolving Search for dentist in specified area
Dental monitoring	50000+	4.7	4.9	Phone, Online, Knowledge-based, video tutorials	Dental exams for monitoring purposes Provision of cheek retractor for better picture taking Clinical notifications A picture wall to visualise past and current teeth conditions Reminder management A training tutorial to take the best photos for the monitoring process
Teledentistry	500+	3.3	3.7	Online, Phone	Online clinical data collection, Consultation and treatment planning Connect with the first available dentist within three hours Electronic prescriptions sent to a local pharmacy selected by the patient
Smilemate	100+	(Not available)	5.0	Online, Phone	Online consultation for orthodontic, dental and periodontal needs Analysis of patient's smile photos by Artificial Intelligence and evaluation by licensed clinicians Bilateral communication with data sharing
Teledentix	100+	(Not available)	5.0	Phone, Online, Knowledge base, Video tutorials	Appointment management, reminders live video conferencing with dentist
Dentocontrol	100+	(Not available)		Phone, Online	Visual inspection of oral cavity using cameras Direct message communication with dental practitioner
Couch dentist	100+	(Not available)	5.0	Online, Knowledge-based	Provides answers to patient queries Cost comparison in patient's area Blogs, videos and educational links Group conversations Professional guidance from expert dentists Personalised answer to query within 24 hours
Straightteeth direct	1000+	2.7	3.0	Online	Remote teeth straightening and custom invisible aligners delivery platform Direct connection to: customer service, dentist, clinical team Document storage Tracked treatment progress Secure messaging platform and access to all conversation history Provision of impression kit and instruction video for home-based impression taking Smile 3D simulation of treatment results
DDS anywhere	5000+	4.1	1.0	Online	Direct communication between dentist and patient Alert dentists in emergency situations Access treatment information, Sync appointments with calendar
Dentoxpert	100+	5.0	(Not available)	Online, Knowledge-based	Exclusive directory of dental care specialists Answers to preliminary oral health questions Online consultations
Toothpic	1000+	4.4	4.6	Online	Online report generation based on the photographs uploaded by the user Case reviewed by a fully licensed dentist within 24 hours

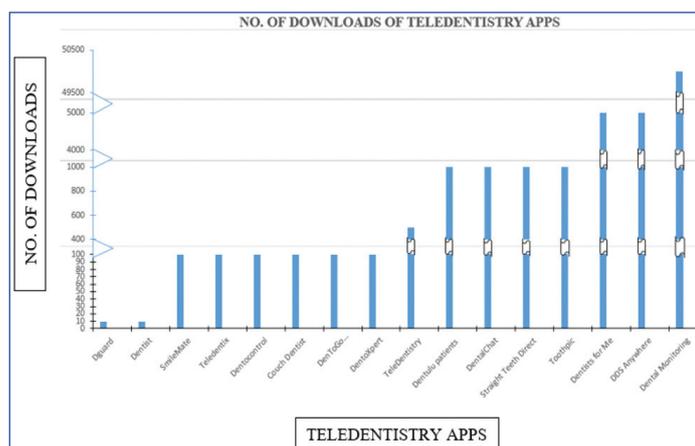
[Table/Fig-1]: Teledentistry Apps available for both Android and iOS softwares (Original).

Name	Installs	User rating	Customer support	Key features
Dguard- dentist, book appointment, consult online	10+	(Not available)	Online	Appointment management Online consultation Image capturing using camera
Dentist	10+	5.0	Online	Online consultation Free chatrooms
Teledent	(Not available)	4.67	Phone, Online, Knowledge base	Appointment management Live video streaming Remote examinations Provision to store medical information Collaborate with patients in real-time
Dentogo monitoring	100+	(Not available)	Online	Image-based dental monitoring by expert dentists Picture wall to visualise past and current teeth conditions Exam timeline to maintain records of past teeth conditions Appointment reminders 3D matching system to monitor changes in teeth movement Training tutorial to take the best photos for the monitoring process

[Table/Fig-2]: Teledentistry Apps available for android software (Original).

Name	User rating	Customer support	Key features
Denteractive	4.3	Online, Phone	Search for new or existing dentists Search for dental specialists Booking dental appointments Video consultation with dentist of choice Private messaging service for dental consultation Emergency consultations Facility to upload investigations before consultation Track treatment history
Smiles to go dentistry	5.0	Online	Live dental video education Individualised treatment plan for patients. Dental examination, oral cancer screenings Consultations and referrals mainly for braces or wisdom teeth Online prescription
Dentist on demand	5.0	Online	Mobile platform to consult with and receive advice from a licensed and qualified dentist.
Dentalstat	5.0	Online	Videochat with dentist for dental consultation

[Table/Fig-3]: Teledentistry Apps available for iOS software (Original).

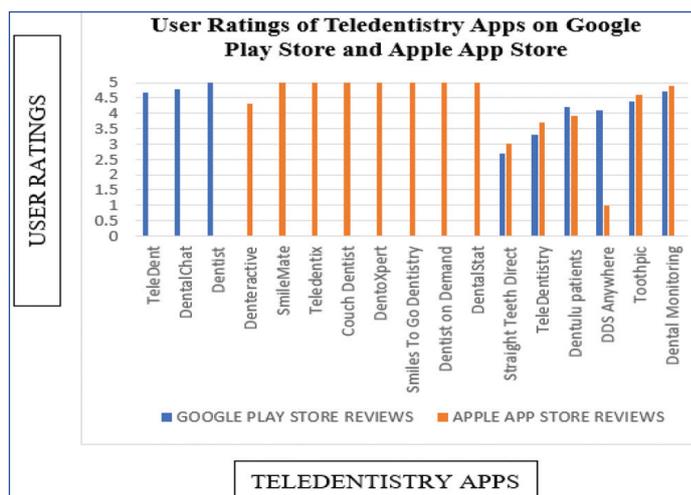


[Table/Fig-4]: Number of downloads of various Teledentistry apps (Original).

in clicking better intraoral selfies. As seen by user reviews, the commonly used features in these apps included chats, video calls, oral scans, appointment booking, searching for a dentist, patient queries, reminders and instructional videos.

DISCUSSION

The non-availability of physical healthcare during the COVID-19 pandemic has alarmed the general public and in this chaotic situation, oral healthcare has definitely taken a back seat [6]. Classifying dentistry as “non-essential” during the pandemic, and limiting it to emergency care, has taken us back to ancient dentistry when treatment was provided only when there was toothache. Restricting



[Table/Fig-5]: User ratings of Teledentistry apps on Google Play Store and Apple App Store (Original).

dental services to emergency care accounts for a small portion of dental care. Due to the high-risk nature of dental procedures, only limited care can be offered for patients suffering with decay, infections or injuries. Oral healthcare is affected significantly and even patients with salvageable teeth are left with no option but to get their tooth extracted to relieve their symptoms. Teledentistry can contribute during these times by enabling patients to reach their dentists for emergencies as well as for trivial queries or when in some conundrum.

Previous studies show that patients consider teledentistry as an exciting and valuable advancement when it comes to patient satisfaction, ease of use, the effectiveness including increasing access to clinical services, reliability of the teledentistry system and usefulness for patients [7]. Availability of teledental consultations, easy appointments, health promotion and education, risk assessment and preventive procedures makes teledentistry quite popular among working people, children and those with disabilities.

“Dental Monitoring” app, which had more than 50,000 installs, is an app that allows remote monitoring of patients receiving orthodontic treatment. It has been well-received by patients in the pre-COVID era and orthodontists had found the 3D digital dental models generated by the app accurate for clinical application [8,9]. User review records during the COVID-19 pandemic (April-July 2020) suggest that the app was found useful especially during the lockdown phase by reducing in-person office visits and facilitating easy communication with treating orthodontists. “Dentists for Me” and “DDS Anywhere”, two next highly downloaded apps provided users with free dental consultations over video, audio or text chats. User reviews of the “Dentist for Me” app gave a mixed user response, where some users found it convenient and easy to handle; others

faced difficulties in registration and login procedures and delayed responses from dentists. This app was found useful by the users during the pandemic for emergency dental consultation in many specialities of the dental field. "DDS Anywhere" app allows users to have a direct communication with their dentists and also has the feature to alert dentists during emergency but the app has had no reviews during the lockdown period.

A thorough analysis of user review record data of the apps revealed the highly useful features of each app and additionally, gave an idea of the frequently used features in these apps. The most useful features were (based on user reviews)- emergency consultations, chats, video calls, oral scans, appointment booking, searching a dentist, patient queries, reminders and instructional videos. The usefulness of the above-mentioned features can be attributed to the following reasons.

1. **Emergency consultations:** User reviews of "Dentulu patients-virtual dental consultations" and "Dentalchat" from April 2020 suggest that the app feature of emergency consultations was found to be highly useful and convincing to the users.
2. **Chats and video call features help the dentist with online history taking:** This is an essential requirement for addressing specific queries or a persistent dental problem which require personalised dental consultation. The patient may need to schedule an appointment for such customised dental care. For most of the general queries, certain apps (like Dentulu patients-virtual dental consultations) have the feature of Frequently Asked Questions (FAQ), which provide a detailed set of answers to commonly asked questions about the app, oral health, consultations and fee structures.
3. **Oral scans:** Certain apps (like Dental Monitoring and SmileMate) allow users to take pictures of their oral cavity and upload them on the app which can be examined by the dentist for making a diagnosis or follow-up a pre-existing condition.
4. **Appointments booking, searching for a dentist, reminders:** With the necessity of social distancing in times of the current pandemic and increased risk of cross-infection to patient in waiting area, this app feature can ensure that patients do not have to wait for their turn in dental offices, and rather they can schedule their meeting with the dentist and visit the clinic on a specified time.
5. **Instructional videos:** The most widely mentioned and appreciated instructional videos on the apps were regarding oral hygiene practices, tooth brushing, and paediatric dental care. The 'Dental Monitoring app' featured a video to guide users to take good oral scans. This feature was again appreciated by many users in their reviews.

Apart from listing out the frequently used features in the apps, the user review analysis yielded one important inference that users are aware and willing to use smartphone based teledentistry apps for routine as well as emergency dental care. Along with patient willingness, user reviews highlight the shortcomings in these apps stressing the need for newer features and better services for the ever-changing demands of the population. Customer support details of the apps show that most of the features are online or phone network-based necessitating that users have either good internet support or phone network or both to utilise these features.

Well most of the apps provide general dental consultations; apps like "Dental monitoring", "Smilemate", "Straight teeth direct" and "Smiles to go dentistry" are more inclined towards providing orthodontic treatment related consultations. Hence, it can be said that orthodontics has made well advancements in the fields of teledentistry based services.

It is necessary to adapt to changing times and changing world situations. With increased awareness it is possible to create a culture of teledentistry based dental practice and improve access

and quality of care by improving treatment planning process and better communication between dentists and patients [10]. This will ensure immediate remote connection with a dentist during emergency, allowing the dentist to assess the problem accurately, medicate, and save time, money, and frequent trips to a hospital or dental clinic and waiting in dental practices. The advantages of such a system prove that it is only a matter of time for teledentistry to soon become an essential medium for future oral healthcare. Additionally, such a system will encourage patients with treatment needs, especially the high-risk groups of COVID-19 [11], to not neglect oral health but seek treatment without having the need to travel for fear of exposure to the virus.

A major advantage of app-based teledentistry is in triage of emergency cases. Dentists can examine patients with the help of screening tools in the apps to decide the exact nature of emergency. This will help in cutting the amount of time and the number of visits for the dentists and the staff to screen for emergencies reducing the risk to dental professionals. Treatment procedures like orthodontics and periodontics benefit much with app-based teledentistry services in monitoring teeth movement and oral hygiene status remotely, reducing inconvenient follow-up appointments. Overall, with such a system, dental care becomes more efficient by providing quick online analysis of second opinions, referrals, pre-authorisation and other insurance requirements by real-time clinical images and cost savings for dental offices, patients and third-party payers. Online consultations and screenings reduce overhead costs, maximise time for both providers and patients, and allows a streamlined workflow. Coordination, as provided by these apps, in patients, providers, and specialists helps treatment planning and expanding the options of treatment phasing in complex cases.

No new technological advancement comes without disadvantages or inherent flaws. According to the user reviews on Google Play Store and App Store, some users found these apps expensive, and with long refund procedures. Also, accuracy, treatment limitations, and assurance of the advice given were questioned. The success of teledentistry depends on proper internet connections, a backup communication system and technical support group which may not be available in all parts of the country [12]. One issue of great concern is the failure of accurate transmission of data. During transmission, data may be lost, image resolution may decrease and the pictures may become unclear which may alter the clinical diagnosis and subsequent outcome. Privacy is another important aspect. Electronic transfer may at times lead to interception, inspite of the passwords and access codes being used. Also, insurance coverage and claiming reimbursements for mobile telehealth services are still unclear.

Inspite of these shortcomings, there is immense potential in teledentistry based dental healthcare systems for the future. With more frequent use, the costs are bound to come down. Technological accuracy and data privacy are areas where app producers can definitely improve. Indian telehealthcare services have progressed immensely to gain a stable market and economy. Sites like Practo, Lybrate, Zocdoc, etc., are some of the benevolent market players in the domain of medical teleconsultations. Partnership with these websites will positively connote and contribute in the curve of teledentistry app market in creating awareness and a surrogate unlike magnetic pole scenario bringing in more customers.

Although, it is impossible to have an ideal model but there can be scopes for future innovations and improvements in teledentistry smartphone apps. Other than having features for emergency consultations, chats, video calls, oral scans, appointment booking, searching a dentist, patient queries, reminders and instructional videos, feature like customised language setting option should be included. Additional features of patient follow-up system reminders for postoperative instructions, easy data storage for reassessment and technological adequacy for smooth functioning may enhance the

usability of the existing mobile dental apps for successful transition into a teledentistry based dental practice system. This would result in an app that would provide complete dental consultation and follow-up services as available in a typical dental healthcare setup.

Moreover, the role of Dental Council of India (DCI), Indian Dental Association (IDA) and the FDI World Dental Federation cannot be ignored. Recognising smartphone teledentistry apps as important facets of dental care by them, will pace up the flourishing field, help the companies garner profit, and also benefit the patients by regulating the fee structures of the procedures and the other technical issues faced by them. Since these bodies play an important role in syllabus management for dental students, it is advisable to introduce the tools of teledentistry as part of curriculum for dental undergraduates to prepare them for effective and efficient services even during difficult times. An important factor for success of teledentistry is willingness of the dentist to adapt to changing circumstances and modify existing dental practice systems.

Limitation(s)

This article is restricted to the apps available on the two most popular app stores for android and iOS users- Google Play Store and the Apple App store, respectively. However, the apps which have not been launched on any app store; those available in prototype form, for research purposes and those available in scientific evidences have not been listed.

Clear cut distinction between the apps most used by the dentists and those most used by the patients could not be established as the app stores do not provide any information about the users as to how many of the users are dentists and how many of them are patients.

Each app store has a different search function. They use unique proprietary criteria's for obtaining the results. Thus, it is difficult to compare results over different app store platforms.

CONCLUSION(S)

It is evident that teledentistry applications in the form of smartphone apps have the potential to facilitate dental care especially during health emergencies such as pandemics when public movement is

restricted, and healthcare systems tend to pay more importance to general systemic diseases than dental problems. With proper coordination with dental care providers, teledentistry smartphone apps can play a major role in managing dental problems and facilitating emergency as well as routine dental care of the population to a great extent.

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