Teledentistry Platforms for Orthodontics

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Technology has transformed almost every aspect of our lives. Smartphones enable patients to request, receive, and transmit information irrespective of the time and place. The global pandemic has forced healthcare providers to employ technology to aid in 'flattening the curve. The Novel Coronavirus, which is responsible for COVID-19, is transmitted primarily through person-to-person contact but may also be spread through aerosol generating procedures, so many clinics have severely limited interpersonal interactions.[1] The purpose of this article is to provide helpful information for those orthodontists considering some form of remote practice. Various HIPAA-compliant telecommunication or teledentistry systems that can be used for orthodontic treatment are introduced and discussed. Detailed information about each platform that can potentially be used for orthodontics is provided in Figure 1. The authors do not endorse any of the products listed and the included software is not all inclusive but instead is a glimpse into the options available.

Keywords: *Telecommunication, Teleconsultation, Patient Management, Artificial Intelligence (AI) assisted*

INTRODUCTION

Teledentistry, a subset of telehealth, is the transmission of a patient's dental health information via telecommunication platforms either asynchronistically or synchronistically to diagnose and provide advice about treatment over a distance.[2] Asynchronistic software uses archived health information including radiographs, photographs, video and digital impressions which are analyzed by a doctor at some future time.[3] Synchronous telecommunication employs a live video chat in which the patient is directly examined.[3]

In orthodontics, advancement in technology and the need for social distancing due to COVID-19 has aided in transitioning in-person consultations and monitoring to virtual patient encounters where the patient is not physically in the office.[4] In addition, some patients prefer orthodontic treatment with less frequent in-office visits.[4,5] It has been postulated that the adoption of virtual check-ups to supplement chairside appointments could have a positive economic impact on orthodontic offices by decreasing chair time.[2,5] Teledentistry can be particularly useful when monitoring, leveling and aligning; evaluating maxillary expanders; checking patient cooperation with elastics; and guiding parents with minor emergencies that can be handled at home.[5]

Currently, three main forms of virtual communication technology are used in orthodontics: virtual consultation or live chats, treatment progress photo uploads by patients for orthodontic review at a later time, and artificial intelligence (AI) assisted treatment monitoring with photos or videos taken by patients. Various HIPAA-compliant telecommunication or teledentistry platforms are available for orthodontic use (Fig. 1).

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Telecommunication Tools for Orthodontics

All communication about a patient's medical information must be Health Insurance Portability and Accountability Act (HIPAA) compliant. For a telehealth service to be considered HIPAA compliant, it must have all the necessary controls to ensure that Personal Health Information (PHI) is sent securely, and must include access controls, audit controls, and full end-to-end encryption.[6] Some readily available web conferencing software such as Zoom, Google Meet, GoToMeeting, Skype, BlueJeans, Microsoft Teams, and ReadyTalk offer HIPAA compliant versions for healthcare professionals. Since most of these programs were not originally designed for medical or dental use, their functions are generally limited to live virtual consultation, a chat feature, and document transfer without additional features commonly found in systems built especially for medical or dental purposes. Other popular platforms such as Apple FaceTime, Facebook Messenger video chat, and WhatsApp lack HIPAA compliance.[6] All healthcare providers working with an outside vendor that handles PHI (this includes telecommunication platforms) are required to have a Business Associate Agreement (BAA) in place to ensure that these third-parties will only use PHI in a secure and established manner.[7]

Figure. 1. Various teledentistry platforms for orthodontics.

Legend: Fully capable / Partially capable / Not capable / Insufficient information	Telecommunication			Teleconsultation						Patient Management			AI
	Zoom Healthcare	Skype	Google Meet	ToothPic	Dentulu	Smile Virtual	Review Tool	Smile Snap	Rhinogram	Carestack	TeleDent	Teledentix	Dental Monitoring
1. Privacy													
HIPPA compliant/ Provides BAA													
2. Online platform functions													
Compatible with any phone brands/ computer processor													
Cloud back-up													
Screenshare													
Recording virtual consultation													
Live Chat (synchronous)													
Asynchronous Messaging													
Asynchronous photo-uploading/viewing													
Designated photo template													
Payment collection													
Self-scheduling													
Share documents and obtain signatures													
Customizable patient reminders and alerts													
3. Practice management and marketing													
Generates leads													
Generates reports													
Clinical data sharing with other providers													
Compatible with management software (e.g. Dolphin)													
Customizable: Dr.'s Name / logo													
4. Advance Technology													
Photo-taking device provided													
Compatible with intraoral camera													
Treatment outcome projection													
AI-assisted evaluation of pictures													
5. Cost													
Cost	$	Call Rep	$	+$	+$	$$$	$	$$	Call Rep	$	$$	$$$	$$$$

While the standard version of Zoom is not HIPAA compliant, Zoom for Healthcare is HIPAA compliant, uses bank-grade 256-bit Advanced Encryption Standard (AES) encryption, and provides a signed BAA for a starting cost of $200 per month with a 12-month commitment for 10 hosts.[8,9] Zoom for Healthcare also provides encrypted chats, dual screen-share, document transfer, live video recording, and screenshot functions.

Google Meet offers HIPAA compliant teleconsultation services through paid "G Suite" accounts starting at $6 per month for each Gmail account the company uses.[10] The BAA (G Suite/Cloud Identity HIPAA Business Associate Amendment) can be reviewed and accepted through the Google Admin console page (Fig. 2).[10] This BAA also covers many other widely used Google services including Gmail, Google Calendar, Google Drive (including Docs, Sheets, Slides, and Forms), Google Hangouts (chat messaging feature only), Google Chat and many more.[11] For orthodontists and offices already familiar with Google services, the software can be utilized in numerous useful ways. Google uses 128-bit or stronger AES to protect data in transit and in its data centers.[12]

When using these universal telecommunication platforms for orthodontic purposes, care should be taken by the providers and their staff to adhere to the HIPAA Minimum Necessary Standard by properly configuring the settings and following compliant use of the platform.[13] Many companies provide detailed guidelines for their customers to follow in order to ensure that the platform is used compliantly.

Teleconsultation for New Patient Encounters

There has been an increase in the development of telecommunication tools designed specifically for dentistry.

Currently, a number of companies such as Dentulu and Toothpic provide software for limited dental conferencing. These programs allow a prospective new patient to seek out a provider virtually for a diagnosis or recommendation based on the photos they provide. The doctor sets his/her availability and allows patients to request an appointment similar to how UBER lets its employees set their own work schedules according to their availability. With this software, patients pay for the provider's time and advice with the platform receiving a portion of the revenue generated.[14,15] The provider is not required to give definitive treatment but can invite patients to their office if desired.[15] While the American Association of Orthodontists believe that treatment should not begin prior to an in-person evaluation, these platforms allow orthodontists to initiate a discussion with patients about their treatment and to provide education regarding the orthodontic process.[16] While this type of teledentistry software is geared towards generating an extra revenue stream rather than as an alternative to in-office visits for regular patients, orthodontists can still use it to allow their patients to talk directly to them for a fee.

Other platforms are available for virtual treatment consultations. Smile Virtual, Review Tool and Smile Snap are three of the teledentistry companies that allow dentists to asynchronistically prescreen and recruit new patients virtually. These platforms generate leads with customizable landing pages that are integrated directly into the office website.[17-19] The patient uploads a few requested photos to the platform via the dentist's website and shares concerns and desires regarding their teeth. The orthodontist reviews the information and records a personalized video consultation. After the patient views the virtual consultation, they can schedule a follow-up appointment.[17-19]

Smile Virtual is a tool for boosting new patient traffic and conversion rate for cosmetic dental procedures and orthodontic treatment, claiming an 87% treatment conversion. It has the additional feature of providing treatment outcomes of individuals with similar conditions.[17] Smile Virtual requests two patient-provided photos that are minimally diagnostic. The photos are best for brief treatment proposals but are not ideal for long-term patient monitoring. Review Tool requires five standard photos for initial orthodontic records[17,18] and provides synchronous consults through third-party platforms Zoom, FaceTime, Skype, iMessage and Gmail. With the built-in live video consult features, Smile Snap offers asynchronous and synchronous options for patients and is intended to be a communication tool both for new recruits and treatment monitoring. All three applications provide analytic tools to monitor conversion rate.[17-19]

Rhinogram is similar but comes with some very distinct features.[20] It allows for HIPAA compliant patient-to-practice texting for both new and existing patients. When a patient is interested in treatment, they send a standard text to the practice which responds in turn with a completely customizable reply through the app. It could be to schedule an appointment, request photos or offer a virtual appointment. No software download is required by the patient, as all communication including the virtual call and sending of secure legal documents is conducted via text or Facebook Messenger on the patient's smartphone. With Rhinopay, it is possible to help collect balances.

Teledentistry for Patient Management

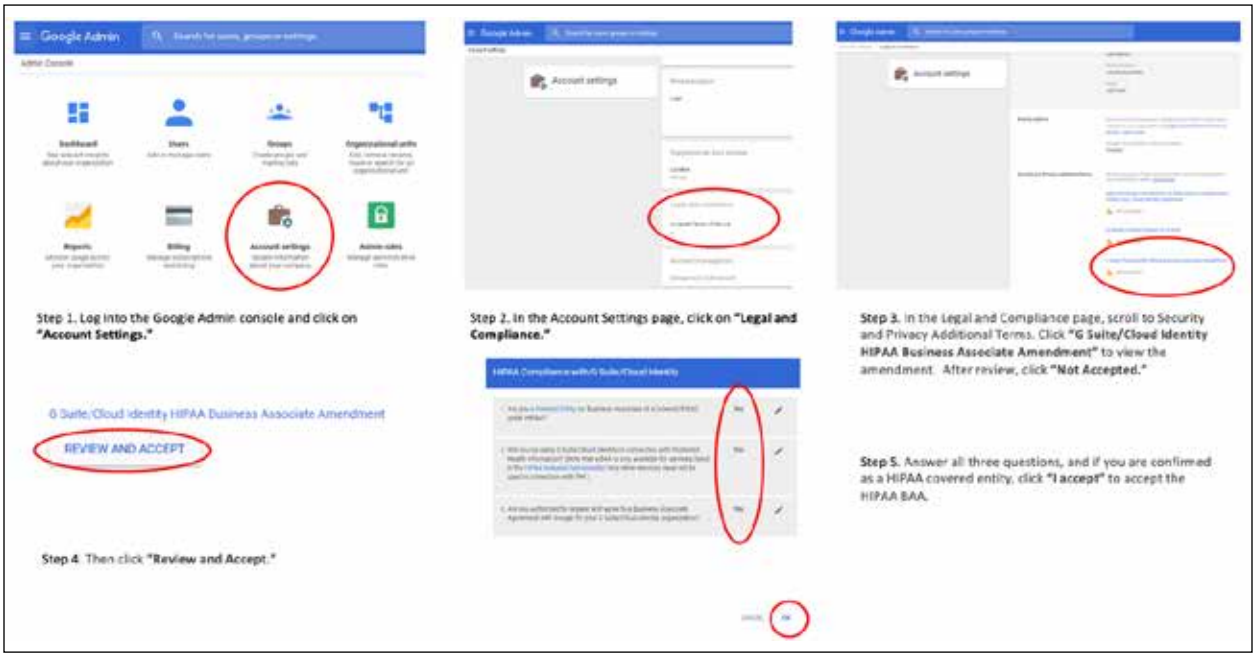
A limiting factor of the previously mentioned teledentistry software is the inability to remotely manage the practice and patient data out of office.

TeleDent was created by MouthWatch and provides a secure means of synchronistic or asynchronistic remote consult with established patients and is currently used in many public health and dental school settings. It was designed for both solo and multi-practice use and is fairly user friendly.[21,22] The patient can easily send and receive pictures following the company-provided instructions that are individually sent out by the office. While it has the ability to be used on a mobile device, its best use is on desktop computers. It does not sync with any of the major orthodontic management software, so patients need to be manually entered into the software and pictures must be downloaded and reuploaded. There is no limit on the number of patients and each license covers ten providers.

Teledentix is a virtual practice management software built for teledentistry. Patients can use it to complete and sign forms, make payments, and receive health education. Patient restoration chartings, images, periodontal chartings, treatment plans, treatment progress and progress notes can be uploaded to the dashboard. In addition, there is a tab for medical records, prescriptions, patient education materials, and appointment history. With Teledentix, available hours can be set by the practice, thus enabling patients to book their own appointments. The provider can send, track and store referrals with a network of providers.[23] Teledentix can potentially be a one-stop shop for managing a practice remotely.

Carestack is primarily a virtual practice management software with some telecommunication capabilities. Carestack provides access to an odontogram for basic dental charting, note taking capability, individual treatment plans for patient review, and portals for signing legal documents.[23,24] Compared to other dental management software, providers can also conduct virtual sessions with patients in which patients can schedule a live consultation. Asynchronous options are limited on Carestack. Dentists can customize

Figure. 2. Step-by-step guide for accepting BAA with Google for paid G suite business account owners.



text messages to patients with a link that lets them view and pay their invoices. Additionally, Carestack plans to automate software to collect outstanding balances through pay-by-text and intelligent payment reminders.[24]

AI-assisted Intelligent Oral Monitoring for Orthodontics

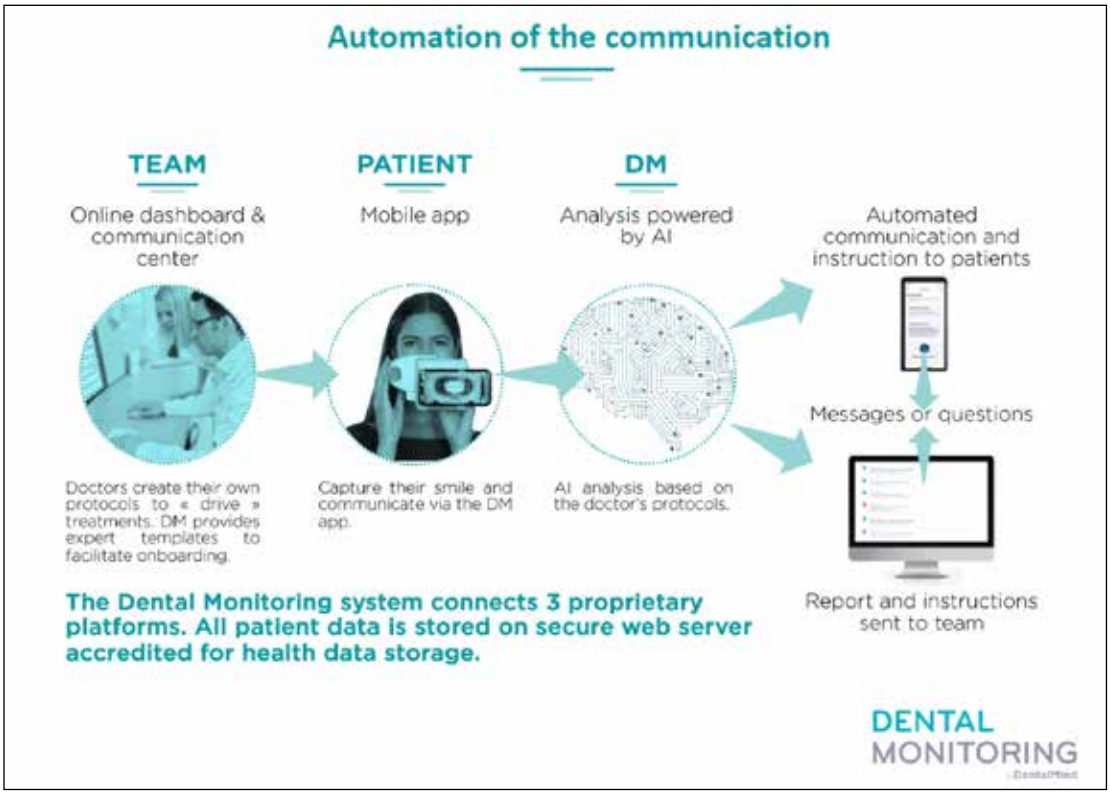
In an effort to reduce both the orthodontist's workload and the patient's chair time, Dental Minds has combined AI and teleorthodontics technology to provide a unique intelligent oral monitoring system called Dental Monitoring.[25,26] It uses AI to allow orthodontists to monitor orthodontic tooth movements and their patients' dental conditions remotely. The system works in three interconnected platforms: a smartphone application for patients, a patented tooth movement tracking algorithm, and an online doctor dashboard on which orthodontists can view patient treatment progress and posttreatment changes (Fig. 3). Dental Monitoring uses photographs or video scans taken and uploaded by patients with their smartphones with the assistance of its proprietary scan box, cheek retractor, and smartphone application. Dental Monitoring's patented AI system then remotely verifies and tracks the movement of each tooth with both fixed appliances and clear aligners. In addition, it can alert providers of common orthodontic conditions including distorted or broken brackets, worn-down or missing attachments, the condition and position of separators or bands, archwire engagement, and unseating of aligners. Dental Minds claims that it can monitor almost 180 dental conditions.[26] An automated communication system sends either an automated communication with instructions to the patient or a report to the orthodontic team for further analysis. Orthodontists can customize what information they see for each visit and under what conditions they are alerted.

In addition, its Smile Mate app uses self-uploaded pictures of patients' teeth, allowing the AI to detect and report notable dental and orthodontic conditions to the orthodontist. It does not have data storage functions but helps with synchronous new and existing patient consultations and integrates with a third-party app, Calendly, for scheduling activities. Dental Monitoring's Vision software uses AI for a more realistic orthodontic treatment projection to assist patients with treatment decisions. Its most novel technology enables reconstruction of three-dimensional (3D) digital models from these intraoral images by stitching them with the pretreatment CBCT and intraoral scan files for more accurate AI monitoring and 3D evaluation of tooth movements (including root movements). While the diagnostic accuracy of its AI-assisted dental monitoring and image reconstruction process still needs to be verified, Dental Monitoring is the only platform reviewed that has the capability of full AI-assisted monitoring.

DISCUSSION

When selecting a teledentistry platform for an orthodontic practice, it is important to match the practice needs with the intended purpose and required functions of the software. Telecommunication platforms are great for general synchronous virtual communication but lack asynchronous communication options and are not designed specifically for dental practices. Teleconsultation platforms built for virtual consultations are not ideal for long-term patient care, but instead are designed to increase patient leads. Teledentistry software for patient management are well designed for long-term patient management and multipractice patient management. These platforms are comprehensive in that they provide some level of practice management and virtual patient interaction, but they do not sync with other orthodontic

Figure. 3. Automation of communication with intelligent oral monitoring by Dental Monitoring.



practice management software. If an orthodontic office simply needs to incorporate virtual consultations with a photo-uploading feature, Smile Virtual, Review Tool, Smile Snap or Rhinogram are good options. Intelligent oral monitoring for orthodontics is completely unique in that artificial intelligence is used to help detect orthodontic treatment complications and tracking.

Ease of use for providers and patients is also a very important factor. If the platform is unfamiliar or difficult to use, there will naturally be less motivation to use it. Most telecommunication software is user-friendly since many of the applications are already widely used in various other applications. Teledentistry platforms built for virtual consultations are also very user-friendly on the patient end, but less so on the provider end due to the new functions that the staff must be introduced to. In general, teledentistry software for virtual dental management and intelligent oral monitoring require lengthy instructions for use and more troubleshooting should be expected due to the multiplicity of their functions.

Obtaining a BAA is an essential part of HIPAA compliance. Orthodontists should perform proper due diligence to identify technology vendors that offer "HIPAA compliant" telecommunication. In addition to privacy issues, orthodontic clinicians should consider that inaccurate or insufficient data will lead to misdiagnosis or under-diagnosis, resulting in compromised treatment. Another practical concern is how to efficiently manage the doctor's and staff's daily schedules between in-person patient visits and remote teledentistry sessions.

Due to the continual advancement of technology, it is likely that some aspects of this article will become outdated. Technology is always advancing, as are these platforms, so a thorough evaluation of each option should be considered prior to selection. Unfortunately, some information is vague or poorly described by the companies.

CONCLUSIONS

- Advances in technology, increasing patient demands, and the current public health crisis have driven orthodontists to consider virtual appointments.
- Numerous platforms are available, but each offers different services. A thorough evaluation of intended use of the software should precede any commitment to a service.
    1. Zoom, Google, Skype, etc. have HIPAA compliant versions, but orthodontists must ensure all settings are properly configured.
    2. Dentulu and Toothpic are not suitable platforms for orthodontic patient monitoring or consultations as they are only intended for limited initial evaluations.
    3. Smile Virtual, Review Tools, Smile Snap and Rhinogram are great resources for increasing an orthodontist's virtual presence while obtaining new leads. The software is not intended for managing patients but can offer a HIPAA compliant means of communication.
    4. Carestack, TeleDent Teledentix are intended for remote management of patients of record. They include many features that aid in comprehensive virtual monitoring.
    5. Dental Monitoring is a unique teledentistry technology developed for orthodontic use. Artificial intelligence is employed to track progress and alert providers of potential treatment complications.
- HIPAA compliance of the system and a BAA provision of the teledentistry platform must be checked to protect personal health information.

Authors' Contribution

Authors (Leah Rogowski, Janet H. Kim and Sumayah Al Shami) contributed to the outline, design and research for this manuscript. Authors (Jae Hyun Park and Scott E I Howell) contributed to the direction and editing of this manuscript.

Conflict of Interest

Scott E I Howell is a clinical advisor for MouthWatch, LLC. The rest of authors do not have any conflict of interest.

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