Contributions and Concerns about the Use of Teledentistry in Clinical Orthodontics

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\textbf{Purpose:} Teledentistry uses computer-based technology to render remote healthcare-related therapy and/or consultation. The purpose of this study was to review the contributions and concerns about the use of teledentistry in clinical orthodontics.

\textbf{Materials and Methods:} The focused question was “What are the benefits and limitations of the use of teledentistry in clinical orthodontics?” PubMed/Medline, Scopus, Embase, Google-Scholar and ISI Web of knowledge databases were searched up to and including February 2021 using the following key words: 1. teledentistry; 2. teleorthodontics; 3. ethics; 4. orthodontics; 5. scope. The inclusion criteria were: (a) clinical studies; (b) case reports; and (c) case series. Studies on animal models, in vitro and/or ex vivo studies, letters, commentaries, and narrative and systematic reviews were not included in the search. The design of the study was tailored to recapitulate the relevant information.

\textbf{Results:} Four clinical studies fulfilled the eligibility criteria and were processed for data extraction. All studies had been performed after obtaining informed consent from the participants. Three studies reported that teledentistry was useful in clinical orthodontics. In one study, a clear conclusion could not be drawn regarding the benefits of teledentistry in clinical orthodontics. Two out of the four studies did not obtain prior approval from an institutional review board or ethics committee. Three studies did not report any measures that were undertaken to safeguard the electronic transfer of patient-related health information.

\textbf{Conclusions:} Teledentistry is a useful tool for initial patient assessments; however, it is not a reliable alternative for in-office clinical orthodontic practice.

\textbf{Key words:} benefits, clinical, COVID, limitations, orthodontics, teledentistry, telemedicine

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Traditionally, healthcare-related services are offered during and/or after personal interaction between the healthcare providers and patients.\textsuperscript{27} According to the United States Department of Health and Human Services, vast oral health disparities exist across the country, which points towards the need to develop new modes of healthcare treatment that can improve access to care among different populations.\textsuperscript{40} Access to healthcare is often challenging for elderly patients and those living in rural areas.\textsuperscript{41} Teledentistry uses computer-based technology to provide remote healthcare treatment and/or consultation.\textsuperscript{27,44} It uses digital technology to facilitate the exchange of health records such as images (e.g. radiographs, CT scans), photographs, results of laboratory-acquired healthcare information and medications/prescriptions between healthcare providers and/or related institutions.\textsuperscript{12} Teledentistry has been successfully used in various disciplines of the oral and maxillofacial sciences;\textsuperscript{27} and has been reported to be similar to...
comparable to in-person oral screening. According to Duka et al., diagnostic evaluation of impacted teeth using teledentistry is as effective as real-time patient assessment. Moreover, in the field of orthodontics, teledentistry can be used for identification of root canal openings and periapical lesions in the anterior dentition. Nevertheless, teledentistry cannot be considered a reliable replacement for clinical in-person oro-dental evaluation. Al-Shaya et al. tested the reliability of mobile-phone teledentistry in the diagnosis of caries among children. The authors observed that the reliability of teledentistry in terms of caries diagnosis was greater in the primary than in the permanent dentition. The authors concluded that without radiographs, teledentistry has limited accuracy in diagnosing caries.

In a clinical orthodontic setting, diagnosis and treatment planning is dependent on an in-person patient evaluation, which encompasses clinical dento-skeletal evaluation, photographs of the facial profile, and digital or plaster models of the dentition. Since fixed orthodontic treatment requires adjustments in the dimensions of appliances, multiple follow-up visits to the operator/orthodontist and stringent oral hygiene maintenance are generally considered a pre-requisite. According to Khan and Omar, application of teledentistry in orthodontic practice enables individuals residing in rural or remote locations to obtain consultations and diagnosis of their dento-skeletal and cranio-facial anomalies. From the patient’s perspective, this strategy may also have cost-related benefits, particularly for individuals residing in remote locations, by minimising in-person visits to orthodontists. These results reflect that teledentistry can successfully be used for diagnosis and treatment planning of dento-skeletal malocclusions. Nevertheless, erratic visits to oral healthcare providers, including orthodontists, may negatively influence patient compliance with routine oral hygiene maintenance and stringent implementation of the planned orthodontic therapeutic protocol. From the authors’ point of view, a lack of routine dental health follow-up may compromise the outcome of the planned orthodontic treatment. Additionally, fallacies such as direct-to-consumer (DTC) orthodontics, which are devoid of routine professional supervision, trigger therapeutic complications and grave ethical issues. With emphasis on the current global COVID-19 pandemic, Giudice et al. reported that teledentistry facilitates patient monitoring and simultaneously limits direct human contact, thereby minimising the chances of spread of this viral infection. However, Telles-
Araujo et al.\textsuperscript{42} suggested that teledentistry is not a reliable alternative for face-to-face patient visits, and whenever needed, every possible effort should be made to facilitate in-person patient examination.

It is hypothesised that teledentistry is a useful strategy for treatment planning and evaluation of patients undergoing orthodontic treatment. The purpose of this study was to review the contributions to and concerns about the use of teledentistry in clinical orthodontics.

**MATERIALS AND METHODS**

**Focus Question**
The focus question was “What are the benefits and limitations of the use of teledentistry in clinical orthodontics?”

**Study Eligibility Protocol**
The inclusion criteria were: (a) clinical studies; (b) case reports; and (c) case series. Studies on animal models, in vitro and/or ex vivo studies, letters, commentaries and narrative and systematic reviews were not included.

**Databases**
Indexed databases (ISI Web of Knowledge, Embase, PubMed/Medline, OVID, and Google Scholar) were searched up to and including February 2021 without time and language limits. Boolean operators (AND / OR) were applied to the literature search using the following key indexing terms: Benefits; Limitations; Orthodontics; Clinical; Teledentistry; Telemedicine; COVID. Althouht the present study is a narrative review, the authors adopted the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines strategy.\textsuperscript{36} This was mainly done to identify and report the relevant data according to an organised and scientific approach.

**RESULTS AND DISCUSSION**

**Studies Related to the Benefits of Teledentistry in Clinical Orthodontics**
Following an exhaustive literature search, 3 clinical studies\textsuperscript{6,35,37} that reported the benefits of teledentistry in clinical orthodontics were identified (Fig 1). In one study,\textsuperscript{37} the distance between maxillary canines and molars during maxillary expansion using plastic models (group 1) and dental monitoring software (group 2) were evaluated. The authors reported no statistically significant difference in the assessed parameters between groups.\textsuperscript{37} Berndt et al.\textsuperscript{6} assessed patients who underwent consultation by a general-dentist for orthodontic treatment via teledentistry and compared the same treatment protocol provided by postgraduate residents in clinical orthodontics. Those authors\textsuperscript{6} reported that the treatment outcomes were comparable with both approaches. According to Mandall et al.,\textsuperscript{35} a prior teledentistry-based orthodontic consultation facilitated referrals to orthodontists for future treatment.

**Studies with Inconclusive Outcomes**
The literature search yielded one clinical study by Dunbar et al.\textsuperscript{15} in which no definitive conclusion could be reached with reference to the values of teledentistry in clinical orthodontic practice.

**Prior Approval from Institutional Review Boards**
All four studies\textsuperscript{6,15,35,37} had been performed after attaining informed consent from the participants. Nevertheless, the protocols of only 2 of the studies\textsuperscript{15,37} were authorised by the Institutional Review Board (IRB). Three of the studies\textsuperscript{6,15,37} did not report the measures adopted for the protection of patient-related data during electronic exchange.

**Possible Limitations of Teledentistry in Clinical Orthodontics**

**Identification and management of factors affecting orthodontic tooth movement**
Identification of oral diseases, such as caries, endodontic infections and periodontitis, are a prerequisite for initiation of orthodontic therapy.\textsuperscript{4,21,33} Similarly, habits (e.g. smoking) and systemic conditions (e.g. diabetes mellitus, increased body mass index and mental disorders) may jeopardise the outcome of orthodontic treatment.\textsuperscript{1,11,28,39} There is abundant evidence to support the fact that medications including but not limited to bisphosphonates, thyroxine supplementation and non-steroidal anti-inflammatory drugs can affect the rate of orthodontically-induced tooth movement.\textsuperscript{7,17,20,30,45} This suggests that patient selection is an important factor that influences the overall success of orthodontically-induced tooth movement. It is proposed that patients using medications (such as those mentioned above) should be treated under direct operator supervision. It is further suggested that if smokers and patients with systemic diseases are solely treated using teledentistry, then it may be challenging to achieve the expected orthodontic results.

**Written informed consent**
In all clinical dental and orthodontic practice and related research, the importance of apriori informed consent cannot be overlooked. In addition, prior IRB approval for original research studies is mandatory to protect patients and participants and ensure the quality of the research projects.\textsuperscript{34} An astounding finding in the present review is that out of the 4 studies\textsuperscript{6,15,35,37} which described the potential application of teledentistry in clinical orthodontics, apriori IRB approval was missing in two\textsuperscript{6,35} of them. Therefore, it is suggested that outcomes shown in Table 1 are probably biased and hence a cautious interpretation of the results is recommended.

**Observation of patient compliance and tooth movement**
Stringent yet routine oral hygiene maintenance plays an important role in the success of orthodontic treatment.\textsuperscript{23} It is well established that an increased plaque index and periodontal probing depth are risk factors for periodontal soft tissue inflammation and marginal bone loss around teeth.\textsuperscript{25} In a systematic review and meta-analysis, Huang et al.\textsuperscript{23} quantitatively and qualitatively assessed studies with refer-
ence to the methods for improving motivation of oral hygiene in patients undergoing fixed orthodontic treatment. In that systematic review, 12 studies of moderate quality were assessed; the results showed that motivational efforts (in terms of oral hygiene maintenance) played a role in the overall success of fixed orthodontic treatment. Those authors concluded that orthodontists should put extra effort into encouraging their patients to practice routine oral hygiene maintenance. The present authors speculate that routine in-person dental visits to orthodontists and dental hygienists is a more reliable method to monitor the oral hygiene status of patients undergoing orthodontic treatment in contrast to sharing photos or videos via teledentistry. In addition, routine face-to-face dental visits may compel patients to regularly follow oral hygiene maintenance procedures. Another advantage of in-office visits over teledentistry is that complications such as oral mucosal lacerations (caused by factors such as broken orthodontic wires and brackets), caries, gingival inflammation and white-spot lesions can be instantly recognised and treated accordingly without compromising the duration and effectiveness of orthodontic treatment. From the authors’ point of view, such goals cannot be achieved via teledentistry.

The use of clear aligner therapy (CAT) is a modernisation in clinical orthodontics primarily because of its aesthetic advantages and relative “invisibility” compared with conventional fixed orthodontic appliances. However, factors such as addition and removal of attachments and interdental enamel reduction contribute towards the overall success of CAT. Thus, without direct supervision by an orthodontist or general dentist certified in CAT, the above-mentioned procedures cannot be done. The present authors suggest that because of such major limitations of teledentistry in clinical orthodontics, individuals opting to receive ‘do-it-yourself orthodontics’ should be cautioned. It is also important to mention that do-it-yourself orthodontics has been seriously criticised by other authors.

### Safeguarding the electronic transfer of patient-related health information

A concern associated with the digital transfer of patient records is breach of patients’ personal and health-related information. Over 20 years ago, the Health Insurance Portability and Accountability Act (HIPAA) was introduced to safeguard the exchange of patient-related health information between health professionals. It is notable that most of the studies which assessed the potential role of teledentistry in orthodontics did not undertake any steps (such as those detailed in HIPAA) to protect the electronic transfer of patient records. It has been recommended that all teledentistry-related efforts should provide sufficient security to meet the HIPAA standards. From the present authors’ perspective, these measures should be scrutinised by an IRB prior to study approval and enrollment of participants.

### Table 1  Characteristics of included studies

<table>
<thead>
<tr>
<th>Authors</th>
<th>Patients</th>
<th>Groups</th>
<th>Results</th>
<th>Informed consent given?</th>
<th>IRB approval?</th>
<th>Was tele-orthodontics useful?</th>
</tr>
</thead>
</table>
| Berndt et al\(^6\) | 126 patients | 1: Patients received interceptive OT by a GD using teleorthodontics \((n = 30)\)  
2: Patients received interceptive OT by postgraduate residents under direct orthodontic faculty supervision \((n = 96)\) | No statistically significant difference in the outcome of OT.                  | Yes                       | Not reported | Yes                           |
| Dunbar et al\(^15\) | 27 patients | 1: Clinical examination-based orthodontic screening  
2: Orthodontic screening based on hard copy or digital records without clinical examination | Intra- and inter-observer agreement varied among groups.                       | Yes                       | Yes          | Unclear                      |
| Mandall et al\(^35\) | 327 patients from 15 dental practices | 1: Referral to an orthodontist after teleorthodontics-based consultation  
2: Direct referral to an orthodontist without prior teleorthodontic-based consultation | Inappropriate referrals were statistically significantly higher in group 2 than group 1.       | Yes                       | Not reported | Yes                           |
| Moylan et al\(^37\) | 12 patients | 1: Assessment of I/C and I/M widths using a dental monitoring software with smartphone  
2: Assessment of I/C and I/M widths on plaster models | No statistically significant difference.                  | Yes                       | Yes          | Yes                           |

GD: general dentist; OT: orthodontic treatment; IRB: institutional review board; I/C: inter-canine; I/M: inter-molar.
CONCLUSION

Teledentistry is a useful tool in initial patient assessments; however, it is not a reliable alternative for in-office clinical orthodontic practice.

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REFERENCES