

# Perspectives of tele-orthodontics in the COVID-19 emergency and as a future tool in daily practice



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## Abstract

**Aim** The aim of our study was to explain how tele-orthodontics represents the only way to perform orthodontics during a period of restriction as the one subsequent to COVID-19 emergencies: To do this, we report a case study and explore the proposal of a model of tele-orthodontics, considering the advantages of this modality in the immediate post-emergency phase and in the future daily practice.

**Materials and methods** Study design: Our study involves 30 patients, who had undergone different orthodontic therapies in a traditional way, and that the clinician continued to follow by means of tele-orthodontics. Given the obvious limitations of tele-practice, a comparison with patients who did not undergo any follow-up or underwent only in-office follow-ups could not be possible. The communication tools used in our study and proposed in our model of tele-orthodontics are videocalls, dedicated applications, intraoral and extraoral photos taken by the patients and instant messaging.

**Results** Tele-orthodontics allowed to perform some orthodontic follow-ups with less chairside time, reduced time spent by the patients in the dental office from up to 45 min, less risk of infection, fewer to no missed appointments, specific troubleshooting solutions, and more follow-ups with odontophobic patients. Overall, tele-orthodontics balanced the disadvantages of less personal contacts and in-office visits.

**Conclusions** The need to respect safety distance and the fears patients have about the risk of infection make tele-orthodontics a fundamental tool during a pandemic lockdown and in its immediate post-emergency phase. Tele-orthodontics demonstrated to be a viable tool to continue at least some orthodontic care in times of emergency, but it may be considered an appropriate solution and addition even in normal times to ease therapy demands for both the orthodontist and the patient, while reducing time and money spent, without an excessive decrease in orthodontic quality.

## Introduction

History shows us that there many pandemics have occurred in recent centuries, and that each one was responsible for a high mortality rate and a serious socio-economic crisis in the countries affected.

In the year 2020, when medicine can cure many diseases, a new pandemic caught everybody by surprise, to the extent that the world was forced to stop all activities to contain the diffusion of the SARS-CoV-2 virus. This virus is a member of the Coronaviridae family, a wide family of respiratory RNA viruses covered by a crown of glycoproteins, hence the name corona (crown in Latin). In December 2019 a new respiratory disease was detected for the first time in China, caused by the virus SARS-CoV-2, and therefore the disease was called COVID-19. The patients affected by this viral infection may present some of these symptoms: fever, fatigue, dry cough (considered the three main symptoms), along with conjunctivitis, intestinal disorders, loss of taste and smell, blood clots and heart failure. In the most complex cases, the patient can sustain significant long term sequelae and death.

The diagnosis is clinical, confirmed by oropharyngeal or nasopharyngeal swab. The affected patients can be divided into three groups: the infected that need hospitalisation, the infected with only few symptoms, and the infected asymptomatic positives to the virus. At the time of this article publication there is no cure, no vaccinations and no immunity (personal or herd) to the virus.

The high virulence and high diffusion of the virus, along with the modalities of diffusion, such as droplets of saliva emitted while talking, coughing or sneezing, pose a higher risk of being infected to some professional categories; dentists especially, who work in close contact with patients and use drills that generate aerosol, have a very high risk for infection. In open spaces the virus can be transmitted through little particles of aerosol, which persist in the air more than heavier droplets, which fall to the ground quicker. Emission of droplets through talking, coughing, sneezing etc. infects surfaces, which can become a means of transmission.

Considering the physio-pathological aspect, the virus attaches the ACE2 cellular receptor, which is not fully developed in children, making them less susceptible to the pathogen. This aspect may explain the lower incidence of the SARS-CoV-2

**KEYWORDS** COVID-19, Tele-orthodontics, Emoji, Malocclusion, Rapid Palatal Expander.

in children and that the infection is always less severe in children. Children most likely benefit from a lower number of comorbidities than adults, along with a lower development of the ACE2 receptors, and a less active and functional immune system due to a higher percentage of T and B lymphocytes [SIOI, 2020].

Currently there are no paediatric standardised protocols for COVID-19, except for during the neonatal period when the mother is SARS-CoV-2 positive. In Italy no child died or underwent intensive care and only 6.8% of the cases of positive children required hospitalisation, as reported in April 2020 by the President of the Italian Society of Pediatrics [Civil Protection, 2020].

In the midst of the COVID-19 emergency, dental offices suspended all deferrable procedures in order to reduce the spread of the pathogen, but what will happen in the future? As of now, dental emergencies are managed via remote triage (phone calls, e-mail or other online modalities). But how digital techniques can help us in the prosecution of our clinical activity during prolonged emergency lockdowns and in the future?

The scientific literature about teledentistry is wide, mainly focused on prevention of dental caries by checking on people living in isolated areas, while literature about the use of teledentistry in orthodontics is quite scarce and limited to diagnosis and the planning phase.

Considering our experience with COVID-19, we propose a model of orthodontic care that combines the traditional way of treatment with tele-orthodontics, dividing the appointments into two different types depending on the possibility of being performed in a telematic way, especially for aligners, palatal expanders and functional appliances, but also for multibracket appliances, considering that there may be phases where progress can be obtained only by the use of elastics, without the direct intervention of the clinician.

Moreover, it can be useful to do an initial general screening of young patients who cannot have a well-timed appointment at the dental office. Video meetings in particular allow us to grossly monitor their respiratory habits (open-mouth breathing vs. nasal breathing), their chewing and swallowing patterns, their overall oral health, to document an evident malocclusion and draw an initial diagnosis.

Considering all these aspects, we can explain to the children in an original and friendly way, the importance of identifying and reducing/eliminating "bad habits" (excessive parafunctions) that can develop into orthodontic problems. This different approach can be more effective, improving the oral situation in some patients who are usually "afraid of the dentist" and therefore have difficulties in listening and following instructions.

Type of treatment	N° of patients	Mean age
Palatal expander	5	8 years
Mobile functional appliance	5	10 years
Invisible aligners	10	13-15 years
Multibracket appliance	10	13-15 years

TABLE 1 The study group.

Instruments of the tele-orthodontics
Video-calls
Dedicated application (Smile Consult, Align Technology Inc.)
Sharing of photos (intraoral and extraoral)
Instant messaging

TABLE 2 The study group.

## Materials and methods

In this study, we evaluated the advantages of using digital techniques in orthodontics to implement therapy at home, along with the cost-benefit assessment of a remote orthodontic approach in daily practice for the near future.

Thirty patients who were already undergoing orthodontic treatment were recruited, randomly selected by a specific software, to test the validity of a tele-orthodontics model: 14 males and 16 females, ranging from 8 to 15 years of age. All the patients filled a questionnaire where they reported their experience with tele-orthodontics, confirming the advantages of this modality.

Among the patients included in the study, 10 were in treatment with aligners, 10 with multibracket devices and 10 with functional therapy, of which 5 had palatal expanders and 5 mobile devices (Table 1).

Every patient was supposed to have their monthly checkup, but an in-person visit with the orthodontist was not permitted during the COVID-19 lockdown, and only non-deferrable healthcare (urgent care) was allowed to be offered. According to the American Dental Association, the substitution of metal wires causing mucous ulcers is the only orthodontic procedure considered non-deferrable.

Our tele-orthodontics protocol included options such as video calls (Zoom Video Communications, Inc.), a dedicated application (Smile Consult by Align Technology Inc.), the sharing

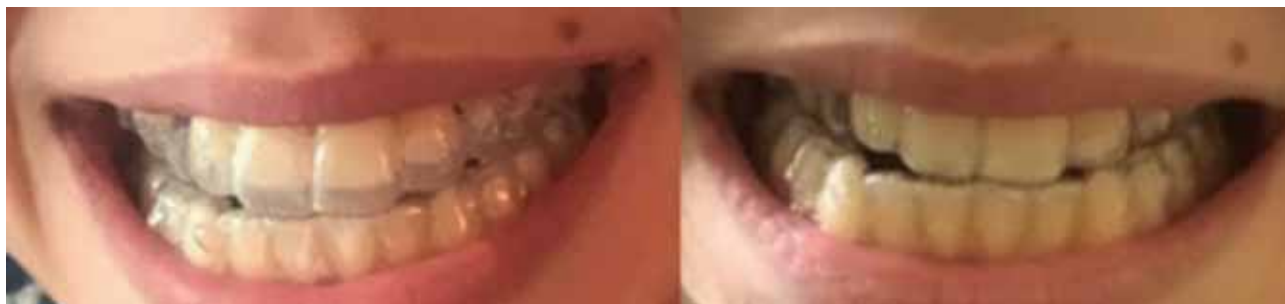


FIG. 1 Tele-orthodontics helped solving problems connected to the application of the aligners, as it was possible to suggest patients to put trays in mild hot water.










Meaning	Emoji
Everything is OK!	
We must schedule an appointment	
The trays aren't fitting well	
The trays are fitting well	
The fixed braces are going well	
The fixed braces aren't going well	
Gingival bleeding	 my gums bleed
Teeth sensitivity to hot or cold	
Teeth pain	

TABLE 3 Some of the emojis created for the study and their meaning.

of intraoral and extraoral photos and instant messaging (Table 2). All patients' guardians were asked to provide a written consent for these treatment modality via e-mail.

In the case of patients with aligners, the app Smile Consult provided by Align Technology Inc. was used to monitor the progress in occlusion and compared it with the ClinCheck simulated progress provided by the company. This app gives the possibility to have online meetings and quick answers to the patients' problems from the orthodontist. It still allows for traditional appointments, in addition to easily schedule appointments online, if and when patients have their own camera to share photos of the mouth and the teeth. Issues such as the difficult fitting of the aligners could be easily solved thanks to tele-orthodontics, by suggesting patients to put them in mild-hot water (Fig. 1).

For fixed therapy with brackets, the photos made it possible to check the progression of the treatment, but all the issues needing a direct intervention of the orthodontist obviously were not possible and required troubleshooting and planning.

For those patients in functional therapy and for those with a palatal expander (Fig. 2), photos and video calls allowed for the continuation of the treatment (for example implementing and monitoring the activations of the expanders). Considering that the COVID-19 is a respiratory pathogen, it is wise to continue the palatal expansion in order to prevent or solve any respiratory



FIG. 2 Teleorthodontics helped managing and avoiding urgent visits such as in this case: the patient sent a photo (WhatsApp) showing a swelling on the palate, therefore a topical NSAID was prescribed and after 24 hours the swelling had subsided, as shown in the following message.

problem caused by a narrow palate [Quinzi et al., 2009; Paolantonio et al., 2019] and tele-orthodontics was the only way to obtain this result during the COVID-19 emergency phase.

In order to prevent discomfort and increase participation in young and shy children, a wide option of emojis was created by the authors in order to improve communication and explain possible issues (Table 3). The use of emoji in instant messaging services and in the dedicated app's chats was very helpful in facilitating the communication with the patients. It proved to be a faster way to interface, allowing for more frequent and time-efficient messages. In particular we designed specific emojis that enabled a faster and clearer communication between orthodontist and patient (Table 3), which include: «Everything is OK! », «We must schedule an appointment», «The trays are fitting well», «Gingival bleeding», «Teeth sensitivity to hot or cold» and «Teeth pain». In the future, the standardisation of the patient-clinician emojis would be an optimal optional way of communication. With more and more text-enabled landlines, this type of communication could be done directly by the office staff through phone calls and using these emojis to facilitate and accelerate the communication flow.

## Results

During lockdown, tele-orthodontics proved to be the only

way to perform some orthodontic tasks, as it offered a modality of communication between dentist and patient, a means to monitor compliance and to troubleshoot issues. Even with the obvious constraints of tele-orthodontics, many advantages became clear and quantifiable (Table 4).

The therapeutic tasks that could be performed both in person or online were: reviewing forms, treatment planning explanation, delivery of the trays by mail, delivery and explanation of elastics use, follow-ups, orthodontic counseling and emergency consultation. Obviously, the appointments that must be done at the office are the first visits and evaluations, dental impressions, bonding and debonding of brackets and bands, stripping and changing of the wires (Table 5).

Even while comparing the average time spent by patients in the office or online, online checkups were more time saving and therefore more appealing economically to both practitioner and patient (Table 6).

One of the benefits found during this study was that the patients' parents were relieved by the possibility to receive attention, trouble shooting and follow up even during the national lockdown, and the patients themselves maintained compliance. Moreover, some economic benefits and time saving were reported by the patients thanks to online meetings (Table 7).

Tele-orthodontics entails reduced personal contact between the clinician and the patient, however the relationship had been built already within traditional appointments. One aspect that was highlighted through tele-orthodontics was that the patients seemed to appreciate the contact with the practitioner more.

## Discussion

In 2018, a systematic review about the use of the teledentistry as a mean to improve the access to clinical care analysed 39 studies, but only 4 of them addressed the application of teledentistry in orthodontics: three came from the UK and one from the USA [Irving et al., 2018]. Also in 2018, a second systematic review about the benefits of teledentistry, included 2 of these 4 articles as well (Table 8) [Estai et al., 2018].

In the UK most orthodontic treatments in underage subjects are covered by the National Health System. However, the number of orthodontists is still very low and 40% of the orthodontic treatments are performed by general dentists. Due to a very long waiting list to schedule an appointment with the orthodontist, teledentistry was developed in order to improve the quality of the British orthodontic care.

The first article [Cook et al., 2001] is a cohort study that included 158 British patients and aimed to implement an advanced system of weekly videoconferences with orthodontic consultants that guided the general dentists in the treatments.

The second article [Stephens et al., 2002] is an observational study that included 163 British patients and experimented the use of the TeleDent system to help general dentists to distinguish between straightforward dental cases from those that necessarily required a specialist care.

The first study [Mandall et al., 2005] is a randomised controlled trial that included 15 dental practices in Greater Manchester (UK), randomly allocated to compare a study and a control group; the aim was to evaluate the advantages of the use of teledentistry in the orthodontic referral from the general dentist to the orthodontist consultants. The test group revealed a high sensitivity, a specificity slightly lower, an inappropriate referral rate reduced to one third ( $p = 0.037$ ) and

no statistically significant difference in first appointment attendance. The authors proposed a questionnaire to the general dental practitioners and 71% of them thought that tele-orthodontics was a good idea, while almost 90% of them agreed or at least did not disagree that patients would benefit from such an option.

The second study [Brendt et al., 2008] on the feasibility of treating disadvantaged children in need of orthodontic treatment focused on a cohort of 30 children treated with interceptive orthodontics by a general dentist supervised by an orthodontist specialist using teledentistry, and 96 children treated by university orthodontic residents supervised directly by members of the orthodontic faculty. The study did not find any statistically significant difference.

Advantages for practitioner	Advantages for patient
Reduced personal contact	Saving time in traveling and office visits
Less risk of contamination	Frequent reminders to maintain oral hygiene
Fewer missed appointments	Possible troubleshooting
More counseling opportunities	Reduced anxiety in phobic patients
Motivation and prevention reinforcement	Shorter appointments
Less chair-side time and relative costs	More time for counseling and prevention

TABLE 4 The advantages of tele-orthodontics.

Telematic appointments	Traditional appointments
Screening	First visit
Treatment planning explanation	Diagnostic testing
Delivery of aligners	Dental impressions
Delivery and explanation of elastics	Bonding and unbonding
Follow up	Stripping
Orthodontic counseling	Changing of wires (fixed brackets)
Emergency consults	

TABLE 5 Conventional orthodontics vs. tele-orthodontics.

Appointments	Office time	Tele-orthodontics
Invisalign control	30 min	15 min
Palatal expander control	15-40 min	5 min
Brackets and wires control	15-20 min	5 min

TABLE 6 Different timing of visits.

Patients' activity	Amount of time
Driving to and from dental office	15-40 min
Parking	5-15 min
Waiting room	15 min

TABLE 7 Time gained by patients.

Author(s)	Type of study
Cook et al., 2001 (UK)	Cohort study
Stephens et al., 2002 (UK)	Observational study
Mandall et al., 2005 (UK)	Randomised controlled trial
Brendt et al., 2008 (USA)	Cohort study

TABLE 8 Literature about the benefits of teledentistry.



Additional costs in post-emergency phase
FFP2 mask
Disposable coat
Disposable headgear
Disposable shoe-covers
Visor
Less patient in one-hour (not more than 2) Coverage of COVID-19 to the insurance policy

**TABLE 9** Additional costs in post-emergency phase.

All of these studies consider tele-orthodontics as a way to help general dentists to correctly evaluate the orthodontic needs, devise a diagnosis and plan the orthodontic treatment (Table 5). However, none of them investigate how tele-orthodontics can be useful to the orthodontists themselves, allowing to follow patients who cannot leave home, but can continue their treatment and receive follow-up, encouragement to stick to the plan, maintain proper oral hygiene, and anything else needed without the direct in-office intervention of the clinician.

Even if the lack of specific literature about an optimal model of tele-orthodontics and a deep-rooted tradition that gives higher importance to the in-office visit, which we can not absolutely deny or minimise, we can also see that an event such as the COVID-19 pandemic forced us to find out new instruments to monitor and follow the progress of our orthodontic treatments.

During the COVID-19 emergency it became evident that that we can not stop following-up orthodontic patients, therefore protection against and prevention of viral infections made the use of teledentistry an attractive solution, although it is not applicable in every case and for long periods of time. This clinical experience showed that only functional appliances and aligners (such as Invisalign) are suitable to be managed for a long time via tele-orthodontics, needing only follow-up to continue therapy. Conversely, the continuation of multibracket treatment is limited in teledentistry, because of its intense hands-on characteristic. Almost all the required follow-ups need the direct intervention of the clinician, except for occasional checkups on oral hygiene or to troubleshoot an issue.

Regarding the COVID-19 immediate post-emergency phase, we have to consider the increase of costs, which can be classified into three categories: the more expensive and personal protective equipment that the dental practitioner will need for COVID-19 infection control; the reduction of the number of patients per hour that can be visited (in order to respect the time/space of 15 min between patients); and the increased cost of insurance policies, covering the COVID-19 risks. Currently (at least in Italy) no professional dental insurance covers the risk of being infected by coronavirus or, in general, covers the risk of a pandemic, but this risk is very real and dentists must both protect themselves and avoid transmitting the disease to the patients (Table 9).

According to the guidelines proposed by the Italian Dental Association (AIO), a temporal distance of 15 minutes between every patient is recommended. Therefore, during an 8-hour daily work schedule only 16 orthodontic checkups can be performed by a single practitioner, while during 6 hours of daily work only 12 orthodontic checkups can be performed. In the case of longer orthodontic procedures, the number of patients for each day would be further decreased (Table 10).

Daily work hours	Number of orthodontic controls
8	16
6	12

**TABLE 10** Modified workflow in the dental office.

Tips about insurance policies in the COVID-19 post-emergency phase
Ask for a contract that is specific
Ask about coverage in case of the COVID-19 infection (or other future viruses) Avoid false statement or reticence
Pay attention to the exceptions

**TABLE 11** Insurance coverage.

Moreover, in planning for the future of our work we suggest to directly consult with insurance companies to explain our professional activity in detail, maybe even fill an insurance questionnaire to evaluate the risks/benefits of signing a specific contract, one that can include the coverage for the risk of an infection (Table 11). In Italy it should be considered that in case of false statement or reticence on the part of the specialist that can influence the evaluation of the risk by the insurance company, coverage and the right of indemnification can be reduced, denied or the contract can be nullified.

The insurance company should have to cover damages (mild or severe) that the specialist might cause to another person.

Clearly every country has its own health insurance and liability insurance systems. We checked and compared several Italian insurance companies' contracts and we noticed that infection caused by a pandemic is not an exception, but a correlation between a pandemic and alleged damage occurred to a patient while in our care should be demonstrated. For these reasons we consider very important the development of a possible app that the Italian government could and should introduce to help limit the pandemic and to localise infected subjects, as this would help us to arrange our dental offices to answer to the need of orthodontic care.

Furthermore, we now know that Italian insurance companies are modifying contracts to specify the kind of coverage that they can offer in this situation according to scientific and economic analyses, but of course all these aspects are going to change based on how the pandemic evolves.

Surely the indications of the government will help us to ensure our safety and that of our patients. Eventually we think the current insurance contracts' conditions and limitation will be altered and updated, considering the change that we are facing and will face in our profession.

The capability to adapt to changes has allowed humans to survive in many situations, and even in this case we will be likely forced to change our personal and professional daily routines and the way we interact with patients.

Thanks to teledentistry, in specific situations like lockdown during a pandemic, which we just briefly illustrated in this article, we will be able to carry on our treatment plans remotely and to check the treatment progress by staying more in touch with our patients.

The American Dental Association has already widely promoted and described the limits of the use of teledentistry in the COVID-19 emergency and in the future it would be useful to debate about the experience of orthodontists of the other nations, in order to develop an optimised model of tele-orthodontics.

A final thought goes to the use of tele-orthodontics which could be an optimal way to perform orthodontic screenings in schools, in order to intercept all the untreated malocclusion in children and adolescents, thus avoiding the need to undergo longer and more demanding orthodontic treatments in adulthood.

### Conclusions

In light of our preliminary study's results, we think that in planning the orthodontist's agenda, some types of orthodontic treatments involving aligners or palatal expanders, can alternate the much-needed dental office appointments with tele-orthodontics for many or most of the follow-ups. Obviously, the first visit, the diagnostic procedures, the dental impressions, oral hygiene, and all the operations requiring a direct access to the mouth of the patients will continue to be scheduled in a traditional way, but all the appointments which can be done remotely, offer an objective benefit to the patient and the clinician.

The American Dental Association (ADA) has widely promoted the use of the teledentistry during the COVID-19 emergency and in the future it would be useful to compare experiences of orthodontists in other nations, in order to develop an optimised model of tele-orthodontics.

In the future, this modality can continue to be helpful to the clinician, especially in the time immediately after the emergency, when only two patients would be able to be visited in one hour and so the indirect cost for every patients will double-up: all the checkups that do not require a direct intervention of the orthodontist can be performed remotely, thus permitting to the orthodontist to perform the required number of checkups and to the patient to save time and reduce the risk of infection (Table 2); tele-orthodontics also allows to save time and money for both the dentist and the patient, reduce the number of missed appointments and to perform more controls in the phobic patients, especially in the younger ones who need to be monitored during the evolution of the physiological occlusion.

In all the emergency phases, tele-orthodontics is fundamental not only for the possibility to continue the orthodontic therapies, but also, from a psychological standpoint, to reassure the patients and his/her parents about the development of their smile.

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All authors declare that all procedures were in accordance with the Helsinki Declaration and informed consent was obtained from all patients for being included in the study.

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