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Challenges, limitations, and solutions for orthodontists during the coronavirus pandemic: A review

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Introduction: Orthodontic patients worldwide missed appointments during the early months of the coronavirus disease 2019 (COVID-19) pandemic. A significant problem with this virus is its high transmission power. Asymptomatic patients can transmit the virus. The aim of this review is to examine orthodontic emergencies and the necessary strategies and measures for emergency and nonemergency treatment during the coronavirus pandemic. **Methods:** The following databases were comprehensively searched: PubMed, MEDLINE, Scopus, and Google Scholar. Up-to-date data released by major health organizations such as the World Health Organization and major orthodontic associations involved in the pandemic were also evaluated. **Results:** Few studies were conducted on managing orthodontic offices or clinics during the pandemic, and most are not of high quality. Appropriate communication is the most important issue in managing orthodontic patients, particularly virtual counseling. Many orthodontic emergencies can be managed in this way by patients themselves. Most studies recommend using the filtering facepiece 2 masks, equivalent to N95 masks for non–COVID-19 patients undergoing aerosol-generating procedures and all suspected or confirmed COVID-19 patients in orthodontic visits. **Conclusions:** At this time, there are no definitive clinical protocols supported by robust evidence for orthodontic practice during the COVID-19 pandemic. Orthodontists should not rush to return to routine orthodontic work and should follow state guidelines. Nonemergency orthodontic visits should be suspended during the severe acute respiratory syndrome coronavirus 2 pandemic in high-risk areas. Resuming orthodontic procedures during the pandemic requires paying special attention to screening, performing maximum efforts to reduce aerosol generation, using appropriate personal protective equipment, having proper ventilation, and fully adhering to sterilization and disinfection principles. (Am J Orthod Dentofacial Orthop 2021;159:e59-e71)

In late December 2019, news broke from Wuhan (China), raising global concerns about a new type of viral pneumonia.[1] The virus spread rapidly to other provinces of China and then to countries worldwide through air travel.[2,3] Some of the clinical symptoms of this novel pneumonia were different from the severe acute respiratory syndrome (SARS) caused by a previous SARS coronavirus.[4,5] After identifying its genetic sequence, a new type of coronavirus was announced. The International Committee on Taxonomy of Virus named it as SARS-CoV-2, and the World Health Organization (WHO) named the novel pneumonia caused by this virus as coronavirus disease (COVID-19).[6,7]

The most important problem is its high transmissibility compared with similar viruses.[8] Although the main source of transmission is symptomatic patients, evidence has suggested that asymptomatic patients and those in the incubation period can also transmit the virus.[9-11]

The cell entry mechanism of SARS-CoV-2 is similar to that of SARS coronavirus (ie, connects to the ACE2 receptors).[12] There are many ACE2-positive cells throughout the respiratory tract. The ACE2-positive epithelial cells of the salivary gland ducts in the oral cavity are among the primary targets of SARS coronavirus. Therefore, the same can be true for the SARS-CoV-2, although there is no evidence to confirm this hypothesis.[13]

Coughing, sneezing, and talking produce droplets or aerosols. Close contact with infected people may result

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in inhalation of droplets or entrance of the virus through mucous membranes of the mouth, nose, and eyes. It seems that these are the main transmission routes of SARS-CoV-2, similar to the other respiratory viruses.[5,14-16] In hospitals and clinic settings, in addition to those above, some medical procedures can also produce aerosols.[17-19] Studies showed that SARS-CoV-2, similar to SARS coronavirus, can go airborne in laboratory settings.[20] If the same be true in nonlaboratory settings, it means that aerosols of the SARS-CoV-2 virus suspend in the air for hours and maybe inhaled before sitting on the surfaces.[21] Touching infected surfaces may also result in indirect transmission.[13] Although ocular manifestations are not common symptoms of COVID-19, evidence suggests that contaminated eye mucosa with infected particles is a possible transmission route.[16,22] Studies confirmed the presence of SARS-CoV-2 in the saliva and blood of infected people.[23] Evidence suggests that SARS-CoV-2 can be transmitted directly or indirectly through saliva.[22-25] Although SARS-CoV-2 can infect the epithelial cells of the salivary ducts and infect the salivary glands, the presence of the virus in salivary specimens may be the result of a mixture of nasopharyngeal and salivary secretions because of the function of the airway covering cilia. Further studies should be conducted to identify the exact origin of the virus in saliva.[22]

People with COVID-19 present a wide range of mild to severe symptoms that may appear 2-14 days after exposure to the virus.[26,27] The symptoms include cough, shortness of breath or difficulty breathing, fever, chills, muscle pain, sore throat, and new loss of taste or smell.[9,28-32] Less common symptoms include gastrointestinal symptoms such as nausea, vomiting, or diarrhea.[33,34] A small percentage of patients experience severe symptoms such as respiratory distress, shock, and cardiac arrhythmias and may die because of the severity of complications.[28,35] COVID-19 mortality rate, which was initially announced at 2%,[36] later changed and now varies in different regions and countries. In addition, there are reasons to under or overestimate the mortality rate.[37,38] According to the WHO, there have been 6,242,974 confirmed cases and 378,485 deaths in 216 countries at the time of writing.[39]

Although all people are susceptible to COVID-19, the elderly, particularly those aged over 60 years and those with comorbidities such as immunodeficiency, asthma, chronic lung disease, cardiovascular disease, diabetes, high blood pressure, liver and kidney disease, and excessive obesity, are at increased risk of infection and mortality.[40-44] Although children mostly experience mild symptoms, severe symptoms and even mortality are also reported among young children and infants, particularly children with immunodeficiency and underlying disease.[26,45,46]

The emergency situation caused by the new coronavirus posed many challenges for governments and countries. Efforts to limit the prevalence and, of course, its socioeconomic and therapeutic costs forced governments to impose temporary regulations to reduce communications and social interactions.[47] The dental field, because of its high potential for transmission, is severely affected by strict regulations imposed by organizations and committees responsible for the new coronavirus.[21,23] In some high-risk areas, routine and nonemergency dental procedures were suspended.[48-50] In some areas, after passing the epidemic's peak and significantly reducing both new cases and mortality, nonemergency dental procedures were gradually allowed. However, because of special precautions and strict rules established to control the infection and gradual reopening, the number of patients seen in a shift has substantially reduced, and special plans are required.

Thousands of orthodontic patients in epidemic areas missed their monthly visits because of the long duration of the orthodontic treatment and its elective nature.[49] This cessation of treatment and possible problems that orthodontic appliance components create over this long period caused great concerns and confusion for both patients and orthodontists. Although orthodontic treatment has esthetic and elective aspects, it does not mean that no emergency condition would occur. This study aimed to manage orthodontic emergencies and to develop strategies and measures for nonemergency care by reviewing the evidence.

MATERIAL AND METHODS

To obtain the maximum information, PubMed, MEDLINE, Scopus, and Google Scholar databases were comprehensively searched using the following keywords: Corona; Coronavirus; 2019-nCoV; COVID; COVID-19; COVID-2019; 2019-nCoV; SARS-CoV-2; oral; mouth; stomatology; dental; dentist; dentistry; orthodontic; orthodontist; emergency; saliva; latency; incubation; symptoms; infection prevention; infection control; outbreak; pandemic; epidemic; contamination; transmission. The title and abstract of articles were scanned to assess their relevance. Duplications were removed. Then, full texts of included articles were obtained. To increase the comprehensiveness of the search, references of articles were also scanned. The final articles were reviewed by 2 authors (M.M. and B.J.), and the findings were collected and summarized. Up-to-date data released by major health organizations such as the WHO and major orthodontic associations in countries involved in the epidemic were also evaluated, and useful information was collected.

LITERATURE OVERVIEW

Due to the rapid and surprising spread of COVID-19, few studies have been conducted on managing orthodontic offices or clinics during the epidemic. We focused more on peer-reviewed studies. However, few studies are available. Although the WHO and major orthodontic associations may provide some guidelines at this time to direct clinical actions, such protocols still require robust evidence, and also such protocols have continuously been updated in the view of the knowledge regarding COVID-19 and SARS-CoV-2. At present, there are no specific studies that can provide real support to orthodontic practice during the COVID-19 pandemic. Orthodontists meet several patients in each shift, which requires face-to-face communication,[21] and observing a distance of 1-2 m is impossible.[51] Contact with the blood and saliva of virus-carrying patients, many of whom may have no clinical symptoms, greatly increases the risk of transmitting SARS-CoV-2 to an orthodontist.[22,23,25] In addition to patient coughing, sneezing and breathing, the bonding and debonding processes, stripping, trimming removable appliances, and air-power polishing before banding or bonding, that requires using high-speed and low-speed handpieces and air-water syringe, are the most important causes of aerosols and airborne viral particles in the orthodontic setting.[52-55] Studies showed that avoiding the formation of aerosols and droplets mixed with the patient's saliva and blood when these devices are working inside the mouth is impossible.[19]

Orthodontists should follow new guidelines provided by provincial and state officials about starting their activities based on the risk assessment.[49] Accordingly, in some high-risk areas, all elective dental procedures are still postponed, and only emergency treatment is allowed,[49,56] including acute infection, abscess, swelling, and severe dentofacial pain.[57] What are the real emergencies in orthodontics? Dipping wires and orthodontic appliance components into the mucous membranes of the lips, cheeks, and gingiva that caused irritation, sores and pain, dental trauma, and other conditions that, if left untreated, can detriment the oral health of the patient.[49,58] In contrast, because of a lower number of new COVID-19 cases and deaths in some areas, by complying with certain rules, nonemergency orthodontic procedures also can be performed.[59]

Orthodontic emergencies

To manage patients during pandemics, orthodontists should prepare plans. One of the most important part of such planning is to provide the possibility of communicating with patients,[49] who may think that their orthodontic treatment is partially abandoned. In addition, prolongation of treatment may cause dissatisfaction, despair, and frustration, particularly if accompanied by mucosal irritation caused by the displacement of orthodontic components. Communication can be conducted through secure e-mail, phone calls, and secure teleconference systems so that the patients can be in contact with their orthodontist, the secretary of the office, or the clinic to express their concerns.[49] This is an important step in reassuring patients. Transmission of orthodontic records (eg, radiograph, image, video) via a secure electronic communication system to the orthodontist to assess a patient's problem can be an option. Patients can take intraoral images of problematic location(s) using their cell phones and send them to the orthodontists via secure e-mail to assess the severity of the problem and decide whether to arrange an emergency appointment (Fig 1).[56]

Through telecommunications systems that support the teleconference by providing video services by one or more means, such as telephone and computer, patients can address their problems at home. Audio-visual communication between orthodontists and their patients by telecommunication technology, such as Skype, Google Duo, Zoom, etc., can be an alternative solution instead of direct face-to-face contact with patients.[60,61]

In the following, a series of emergencies that can be addressed by patients at home in high-risk regions are provided:

Removable appliances.

1. In cases in which the components of the functional appliance broke such that they cannot be used anymore or cause wounds and discomfort: their use should be suspended.[56]
2. If the patient's current aligner is lost or broken: depending on the percentage of usage, the patient can return to the previous aligner or begin to use the next aligner.[56]

Edgewise appliances.

1. Lip and cheek wounds caused by bracket hook and wings can be solved by orthodontic relief wax.[62] If the patient does not have wax, it might be found in pharmacies, drugstores, shops selling dental equipment, or online stores.
2. When the end of ligature wire hurts the lips and cheeks, it can be bent backward by pencil eraser and a cotton swab, and then orthodontic relief wax can be applied.[49]
3. When an elastic O-ring has come loose from the edges of the brackets, it can be placed in the right position by clean eyebrow tweezers or completely removed.

Fig 1. Examples of photographs sent by patients to express their problems and concerns. Although the photographs are not standard and are not high quality, but they are very useful.

4. Detached bracket from tooth surface: If the bracket rotates around the archwire and may fall into the mouth and be swallowed or aspirated, the patient should carefully remove it using a clean tweezer. If the molar tube or the attachment of the last tooth is loosed, it can be carefully pulled out of the end of the wire, or the last segment of the wire, as well as the bracket to which it attaches, can be cut and removed with a nail clipper or stronger cutters.[49] If an object is aspirated and the patient has difficulty breathing or sudden coughing, they must go to the hospital emergency. When an object is unintentionally lost irreversibly into the oropharynx, radiographic examination is necessary to specify if the object has been swallowed, aspirated, or has been lodged in the deep tissues of the oropharyngeal area.[63,64]
5. Protruding distal ends of the archwire that can cause deep and painful sores on the inner surface of the lips and cheeks: If wire slips out from one side, the patient may be able to replace it to the correct position using tweezers. However, if this is not possible, the protruding ends of the thin wires can be cut with a nail clipper, and the ends of the thick wires can be cut with strong cutters. Another way is to use orthodontic wax, as previously described.[49,56,62]
6. A fragmented or loose elastic chain can be removed by a clean eyebrow tweezer or cut by a clean nail clipper.
7. A tightly stretched elastic chain has cut lip or gingival mucosa: it can be cut using a clean nail clipper and removed by a clean tweezer.[49]
8. For long hanging gold chains that are irritating, their free end can be fastened to the bracket with dental floss so that it is no longer annoying. Another person can help the patient at home.[49]
9. Loosed miniscrew and molar bands that have caused pain, discomfort, infection, swelling, and periodontal abscess must be removed by the orthodontist in an emergency visit.[56]
10. Broken bonded retainer: If a small piece of wire is still attached to the teeth, a clean tweezer can be easily used to pull out the entire retainer. If most of the wire is attached to the teeth, the patient can attempt to push the loose retainer wire back toward its tooth as much as possible.[49]

Other fixed appliances. The usage of elastics and appliances, such as headgear, facemasks, and lip bumpers, with fixed intraoral components that patients can activate should be suspended until the next visit to prevent possible emergencies.[56] The fixed intraoral components

Fig 2. The 1-second measurement no-contact temple thermometer (HA500, Rossmax International Ltd, Taipei, Taiwan) without contacting skin (5 cm distance) is an appropriate choice to measure the body temperature and prevent cross-contamination.

should be monitored, and if emergencies such as pain and swelling occur, removing them at an emergency visit is the best action.[56]

Special precautions for regional reopening

If an emergency orthodontic appointment is planned in high-risk regions, special precautions should be taken.[51] It has been suggested that all nonemergency orthodontic treatments should be postponed until the COVID-19 epidemic is effectively controlled.[56,65] In some areas, after crossing the pandemic peak and significantly reducing both new cases and mortality, nonemergency orthodontic procedures can gradually be allowed, but it needs special precautions.[59,66] The standard control measures in former routine orthodontic work may not be adequate to protect both orthodontists and patients from the COVID-19. Strict preventive protocols during orthodontic practice are seriously needed.[21]

Patient evaluation. Before setting a schedule, patients should be evaluated and triaged using the telephone or secure e-mail.[49] The triage should contain clear questions about the history of fever, cough, shortness of breath and difficulty breathing, contact with infected people, and travel to high-risk areas for COVID-19.[57] If the answer to any of these questions is yes, the person is suspected of COVID-19. If the patient is symptomatic (ie, fever, cough, etc.), medical consultation, home quarantine for at least 14 days, and daily follow-up of health status and even referral to special hospital centers for COVID-19, if the symptoms are acute, are recommended.

If the patient is asymptomatic, it is recommended to stay at home for at least 14 days and continuously report the health condition.[21] Only 1 person should accompany the patient.[67] This person should not have medically compromised conditions.[49] When entering the clinic or office, the disinfection of hands and wearing cloth face covering or facemask should be mandatory.[59,67] The patient's body temperature should be measured using a thermometer (Fig 2).[21] The screening questionnaire should be completed by the patient.[21] The completed questionnaire should be consistent with the answers given to the virtual triage.[21] When a fever by dental origin is ruled out, the effective combining of the body temperature measurements and screening questionnaires can develop a general guide for admitting patients to the orthodontic treatment room (Table).[21] However, new items and instructions from reputable references can be added to this guidance. To perform the orthodontic procedures during the pandemic, supplemental informed consent should be taken from the patient and recorded.[68]

Hand hygiene. Hand hygiene is one of the most important steps in preventing fecal–oral transmission.[69]

Table. A general guide for admitting patients to the treatment room and performing procedure

Answer	*Temperature*	*Action*
If the patient replies "no" to all questions	Body temperature >37.3°C	Refer to diagnostic medical centers and self-quarantine are recommended
If the patient replies "no" to all questions	Body temperature <37.3°C	The orthodontist can treat the patient using the personal protective measures
If the patient answers "yes" to any of the questions	Body temperature <37.3°C	Home quarantine and health self-reporting are recommended
If the patient answers "yes" to any of the questions	Body temperature >37.3°C	Immediate quarantine and report to relevant health centers are recommended

Note: Recommendations included in this Table are based on the Guideline for the Diagnosis and Treatment of Novel Coronavirus Pneumonia (the 5th edition) (http://www.nhc.gov.cn/yzygj/s7653p/202002/3b09b894ac9b4204a79db5b8912d4440.shtml) that released by the National Health Commission of the People's Republic of China and also mentioned in Van Doremalen.[20]

Frequent hand washing with soap and water for at least 20 seconds or rubbing hands with ethanol above 60% are the best solutions. Hand hygiene should be performed both before and after touching the patient, after contact with oral fluids, and before attempting to clean and disinfect the equipment used in the mouth.[70,71] Much attention should be paid to avoid touching eyes, nose, and mouth.[21]

Personal protective equipment. Before treating the patient, personal protective equipment (PPE) should be used by the orthodontist. Correct use of PPE without contamination of skin and environment should be taught to the office staff.[72] If the patient has an emergency, the orthodontist, should only deal with true emergencies and avoid actions that cause aerosols, such as using handpieces and unit air-water syringes.[51,73] In particular, patients who are at the end of orthodontic treatment and ready for debonding may be frustrated by the interruption. Therefore, they may have a strong urge to remove the bands and brackets. While reassuring the patient, the orthodontist should prioritize the guidelines, both state and national, for orthodontic services during the COVID-19 pandemic.[49] If nonemergency care is planned, procedures that produce a lot of aerosols should be avoided as much as possible.[59] Alternative treatment protocols, such as application of self-etching primers and glass ionomer cement for bonding that do not require the use of unit air-water syringes, application of etching agents with lower viscosity or even liquid gels that obviously require lower air-water pressure to be washed off, using debonding pliers and scalers for removing residual adhesive rather than rotary instrumentation, if possible, should be considered.[74,75]

One study reported aerosols produced during enamel cleanup might be inhaled irrespective of handpiece speed or the presence or absence of water coolant.[76] Changing the interface between the bracket base and the enamel that may result in cohesive resin fracture on debonding would reduce the amount of remained adhesive and aerosols produced during cleanup consequently. This can be achieved by bracket base mesh or shape or size and adhesive combination modifications.[74,77] Procedures that produce a lot of aerosols, such as debonding, should be performed on certain days on a few patients. Ideally, aerosol-generating procedures should be performed in an airborne infection isolation room.[78] If using the handpiece is mandatory, using an antiretraction dental handpiece with specially designed antiretractive valves should be prioritized.[79] According to the previous studies, these handpieces reduce the backflow of bacteria and the hepatitis B virus from the mouth to the tubes of the handpiece and the dental unit.[80]

High-volume suction is mandatory for aerosol-producing procedures, and the 4-handed or 6-handed cooperation technique should be considered.[49,81] Although there are no unique guidelines about using PPE during dental and orthodontic visits, proper use of PPE, including fit-tested National Institute for Occupational Safety and Health–certified N95 mask or equivalent, gloves, gowns, hair cover, foot cover, face shield, and eye protection, is of crucial importance (Fig 3).[21,49,51] It is advised to wear double layers of latex or nitrile gloves during an orthodontic procedure, especially when sharp instruments are used.[49,82] Surgical masks are loose-fitting, disposable masks that protect from large droplets, splashes, or sprays of hazardous fluids, but do not filter very small particles in the air and, therefore, do not provide full protection against microorganisms and other contaminants.[83] For nongenerating aerosol procedures, surgical facemasks and basic clinical PPE (including eye protection) should be used. If aerosol production is highly likely, the highest-level

Fig 3. Examples of PPE for orthodontic settings. Surgical masks are not recommended for aerosol-generating procedures, of course. If a respirator is not available, a combination of a surgical mask and a facial shield can be an option. In addition, using a 1-piece water resistance gown, which also covers the head and neck areas, is safer for aerosol-generating procedures compared with simple gowns.

personal protections are needed. If aerosol production is unavoidable, these masks are of crucial importance: National Institute for Occupational Safety and Health–certified N95; filtering facepiece (FFP) 2 and FFP3, that have European Standard 149; elastomeric respirators, if available; and powered air-purifying respirator.[36,49,51,57,59,65,84,85]

Most of the studies recommend using the FFP2 masks, equivalent to N95 masks for non–COVID-19 patients undergoing aerosol-generating procedures and all suspected or confirmed COVID-19 patients undergoing any dental procedure.[50] These are tight-fitting masks, therefore need fit test and seal check.[83] The sealing check is a test that should be performed every time a mask is using to assure that it is completely seated to the face.[86] The fit test is used to determine the suitable mask size for any person. If the mask is not fitted well on the face, it will not protect the person against the infection. PortaCount Plus 8038 device (TSI, St. Paul, MN) is a device that quantifies the fitting and helps to achieve full protection.[87] Facial hair-type may affect the fitness of the respirators.[88] Concerns about the counterfeit versions of respirators that are entering the market are escalated.

Unfortunately, rising demand for masks has fueled the market for counterfeit masks. The Center for Diseases Control and Prevention described the signs to identify counterfeit masks.[89] Professional judgment should be used when deciding about using gowns, foot covers, and headcovers. If aerosol production is highly likely, stricter personal protections are needed. For example, use of a 1-piece fluid-resistant gown minimizes skin exposure to contaminations. In addition, wearing eye protection (goggles or glasses) under the face shield may be useful to avoid conjunctival exposure from spray around the shield (Fig 4).[36]

Mouthrinse before orthodontic procedures. Because SARS-CoV-2 is sensitive to oxidation, mouthwash containing 1% hydrogen peroxide or 0.2% povidone-iodine before orthodontic procedures can effectively reduce the microbial load of SARS-CoV-2, although its clinical efficacy requires further investigation.[21,49] Although research showed that chlorhexidine, one of the most common antimicrobial mouthwashes, is

Fig 4. Wearing eye protection (goggles or glasses) under the face shield may help avoid conjunctival exposure from spray around the shield.

effective against hepatitis B, herpes simplex, and HIV, it may not be effective against SARS-CoV-2, and further investigation is needed.[21]

Disinfection and sterilization

Disinfection of the clinic settings. A study reported that SARS-CoV-2 survives in air floating particles for up to 3 hours and has a half-life of 6.8 and 5.6 hours on plastic and stainless steel surfaces, respectively.[20] However, it can be efficiently destroyed by using surface disinfectants. These surface disinfectants contain 62%-95% ethanol, 0.5% hydrogen peroxide, and 0.1% (1 g/L) sodium hypochlorite.[49,70] After each patient visit, all surfaces of the dental unit should be disinfected.[21] A 3-5 minute interval should be considered between 2 successive patients for proper disinfection.[66] The door handles, chairs, desks, etc. should be disinfected with 1000 mg/L chlorine-containing solution in 2-3 hour intervals.[66] Much attention should be paid to cleaning the waterlines of the unit. Flushing water lines for at least 2 minutes at patient intervals or sucking about 1 L of 1% sodium hypochlorite through the suction line at the end of the day controls the dental unit water and reduces infection risks.[90,91]

Removal/filter of contaminated air. Adequate ventilation of the operating and waiting rooms and the establishment of fresh air flow in the orthodontic setting are essential. Ventilation of 15-30 minutes is required after each patient visit.[50] Currently, there is no consensus about using air conditioning, but if it is used, the filters should be changed weekly.[50] The filtration efficiency can be increased to the highest-level that is matched with the air conditioning system.[59] Using high-efficiency particulate air filters can help.[57,59] A portable high-efficiency particulate air filter is a type of mechanical air filter that works by forcing air through a fine mesh that traps harmful particles. When performing procedures that produce aerosols, it is useful and reduces the ventilation time.[59] Upper-room ultraviolet germicidal irradiation (UVGI) can help increase ventilation and air cleaning rates.[92] The UVGI should be turned on after treatment or during the rest time to disinfect the surroundings for 30-60 minutes, twice a day.[66] The following measures are recommended for waiting rooms: social distancing, rearrangement of chairs at least 6 feet apart, patient information posters, wearing of masks, hand disinfectants, removal of magazines, and other unnecessary issues. In addition, installing glass or plastic barriers at reception desks to prevent close contact between personnel and patients and minimizing the number of patients in the waiting room would be useful.[49]

Disinfection of instruments and accessories. The orthodontic photography reflector should not be placed too far back in the mouth because it may evoke a gag reflex leading to the generation of aerosol. Photographic retractors and orthodontic markers can be autoclaved, if autoclavable, or disinfected using glutaraldehyde solution.[93,94] After taking the impressions, remove the saliva or blood on the surface with gently running cool tap water to prevent splattering and then disinfect the impressions.[95] It is recommended that all alginate impressions be disinfected by immersion in 1% sodium hypochlorite solution for a minimum of 10 minutes before they are poured or sent to the laboratory.[96] Packed nickel-titanium and stainless steel archwires are proposed in the fixed orthodontic treatment. All devices near the dental unit and the operating room should be thoroughly cleaned and disinfected. All instruments used in the mouth must be cleaned and sterilized.[97] Orthodontic pliers must be sterilized by steam autoclave sterilization and can be disinfected with 2% glutaraldehyde or 0.25% peroxyacetic acid.[98-103] For orthodontic archwires, the autoclave sterilization process, without adverse effects on surface characteristics of orthodontic wires, is better than cold sterilization.[104-106] When the archwires need to be bent and re-engaged during the fixed orthodontic treatment, such as the torque bending, tip back bending or

the adding of the reversed curve, spray and clean the archwire with 62%-95% ethanol after removing from the mouth.[66] Removable orthodontic appliances, such as clear aligners, acrylic palatal expander, and Hawley retainer are potential transmission routes of viral infection. These appliances should be washed and wiped with 62%-95% ethanol or 1000 mg/L chlorine-containing solutions before the chairside adjustment.[67] Patients should also clean their hands before and after placing and removing appliances or elastics and wipe them frequently with ethanol.[49,67] Frequently used objects such as LED's, etchants, bonding agents, elastomeric chains and modules, should be sprayed with 62%-95% ethanol and wiped with 1000 mg/L chlorine-containing solution.[66] Intraoral scans can be used for the fabrication of orthodontic study models, clear aligners, and other appliances, as well as indirect bonding trays. This strategy can reduce the risk of cross-infection when compared with traditional alginate impressions.[107]

DISCUSSION

Orthodontic treatment in safe conditions requires a thorough understanding of how the pathogen is transmitted in various clinical procedures, such as aerosol-generating procedures and nonaerosol-generating procedures.[108] Studies with standard and high-quality methodology are necessary to understand how the new coronavirus spreads in orthodontic settings and what are the suitable protective measures against it.[109] Clinical trials or studies that simulate the release of airborne pathogens can change our view of protective methods. These studies should be well-designed with a sufficient sample size and clear outcomes. Protective measures, staff training, length of an appointment, different treatment techniques, screening methods, and the nature of patients, especially in orthodontic treatment, should be evaluated.[108]

The emergence of a new coronavirus has posed many challenges to orthodontic treatment. It is unlikely that effective treatment or vaccination against the virus will be achieved soon. This issue requires organizing appropriate and secure communication methods with patients. A review study reported that teleorthodontics could manage most orthodontic emergencies and is very useful and effective for patient reassurance and satisfaction.[61] This article concluded that secure video and telephone communication with patients reduces unnecessary sessions and can maintain regular monitoring of patients.[61] However, the results were based on a review of fair scoring studies with the Mixed Methods Appraisal Tool. Only a limited number of included studies made a controlled comparison between the teleorthodontics and traditional methods. There is also a possibility of publication bias in studies because of the reporting of mostly positive data. Although there is a tendency to reduce the number of face-to-face communications during the pandemic and teleorthodontics is helpful in this regard, it is unlikely to be an alternative method for patients seeking dental and cosmetic treatments. Higher-quality studies are necessary to understand its benefits and disadvantages.

One of the most important challenges for orthodontists and office or clinic staff during the pandemic is the proper use of PPE. The Cochrane group answers frequent questions about COVID-19 and synthesizes useful information from related studies with accurate methodology in a matter of weeks rather than long periods.[110,111] An article was published in April 2020 by Cochrane and has recently been updated to assess the PPE required for health care workers against highly infectious diseases.[109] The included studies were mainly simulation studies and none of them were in the field of orthodontics and dentistry. In the absence of direct evidence for dental settings, we can refer to general evidence and draw similar and related conclusions.[108] However, it should be noted that the level of evidence in this article is low and very low. Most of the included studies simulate exposure to infectious agents rather than real or clinical conditions. Other reasons are small sample size and high or unclear risk of bias and using fluorescent materials and nonpathogenic microbes instead of dangerous microbes and viruses. This article suggests that covering more areas of the body provides higher protection. The review also suggests that PPE made of more breathable material may result in similar contamination as more waterproof materials but have more user satisfaction. Complete coverage of the head and neck area is very important for orthodontists and staff in dental settings. Better fitting PPE in these areas, modified gowns and gloves combinations with a suitable seal to protect the wrists, and using tabs to grab during PPE removal may reduce contamination risk. In general, PPE should provide complete coverage of the body but not be too cumbersome.[108]

There is increased certainty in the evidence regarding disinfection and sterilization. The human coronavirus can remain active for up to 9 days on surfaces.[70] Disinfection with 60%-70% Alcohol and 0.1% hypochlorite can deactivate it on surfaces within a minute. The same effectiveness seems to exist on the new coronavirus.[70] It seems that the policy of sterilization and disinfection of orthodontic instruments and items against the

new coronavirus is not significantly different from the standard protocol of sterilization and disinfection and should be done as carefully as before. The effectiveness of UVGI and ventilation and suction systems against airborne coronavirus particles and the duration of ventilation and the time interval between the admission of patients in the treatment room requires high-quality studies, especially in dental and orthodontic settings.

In the future, prescribing a COVID-19 diagnostic test before admitting patients can be an effective option, particularly if a faster testing method is available. Current testing methods have limitations such as high false-negative results and negative results during the incubation period.[112] In addition, they are not sufficiently available in many societies. To avoid aerosolization in the future, orthodontists may be more eager to select self-etching primers, be more interested in aligners to reduce visits, and pay more attention to communication tools and screening methods. Currently, there is no specific treatment or effective vaccine for COVID-19, and all of these require further investigations.

CONCLUSIONS

Since the emergence of the COVID-19 pandemic, orthodontic treatment has faced many challenges because of its long-term nature. There are no specific studies that can provide real support to clinical conduct. At this time, there are no definitive clinical protocols supported by robust evidence for orthodontic practice during the COVID-19 pandemic. The most important issue in managing patients is proper communication, particularly virtual counseling. Many cases of orthodontic emergencies can be managed at home in this way. Unnecessary and nonemergency orthodontic visits should be suspended during the SARS-CoV-2 pandemic in high-risk areas. Paying special attention to screening, performing maximum efforts to reduce aerosol generation, using appropriate PPE, having proper ventilation, and fully adhering to sterilization and disinfection principles are essential in emergency meetings or to resume routine procedures in orthodontic settings.

CREDIT AUTHOR STATEMENT

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