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Aerosols in Orthodontics – Covid 19

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Abstract

Recent worldwide outbreak of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the causative agent of respiratory coronavirus disease 2019 (COVID-19), is a current, ongoing life-threatening crisis, and international public health emergency. The routes of transmission are through direct contact, and droplet and possible aerosol transmissions. Due to the unique nature of dentistry, most dental procedures generate significant amounts of droplets and aerosols, posing potential risks of infection transmission. Understanding the significance of aerosol transmission and its implications in dentistry can facilitate the identification and correction of negligence in daily dental practice. The practice of social distancing – maintaining a distance of 1 – 2 meters or 6 feet -- between people has been widely recommended to slow or halt the spread. This places orthodontists at high risk of acquiring and transmitting the infection. The objective of this review is to increase awareness, reinforce infection control and prevent cross-transmission within the orthodontic facility.

Keywords: Corona virus disease 2019 (COVID-19); Aerosol; Infection control

Introduction

A novel human coronavirus—now named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)—emerged from Wuhan, China, in late 2019 and is causing a pandemic.[1] Coronaviruses are enveloped RNA viruses that affect animals and humans.[2] Coronavirus particles range from 60 to 140 nanometers (0.06 to 0.14 micrometers), with an average of 0.125 micron, and have distinctive spikes of nine to 12 nanometers that give the appearance of "coronas" around the sun. Cell death is observed 96 hours after inoculation on surface layers of human airway epithelial cells.[2]

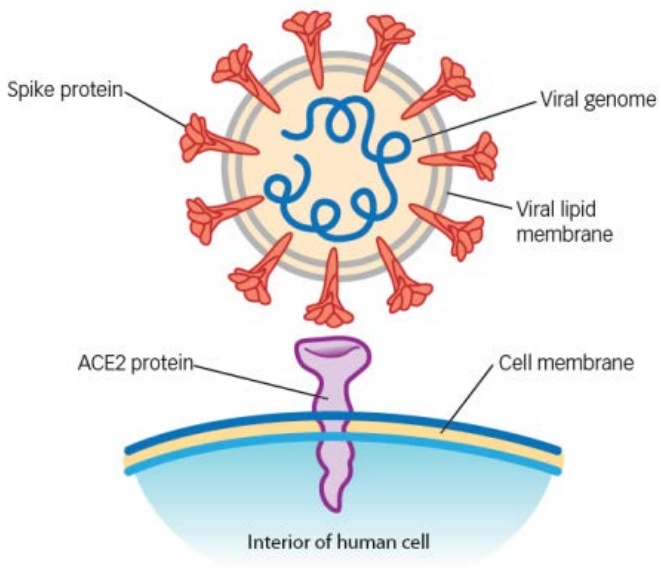
Currently, there are six coronavirus species that cause human disease. Four of them—229E, OC43, NL63, and HKU1—often result in symptoms of the common cold.[3]

The other two strains—severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV)—are zoonotic (originate from animals and cross over to humans), more serious, and sometimes linked to fatal illness.

SARS-CoV-1 was the causal agent of the severe acute respiratory syndrome outbreaks in 2002 and 2003 in Guangdong Province, China.[5] During this outbreak, approximately 8,098 patients were affected with 774 deaths, resulting in a mortality rate of 9%. This rate was much higher in elderly individuals, with mortality rates approaching 50% in those over age 60. Transmission of SARS-CoV-1 was relatively inefficient because it spread only through direct contact with infected individuals; once an individual exhibited symptoms, the virus spread. The outbreak was largely contained because it was easy to identify those individuals who were capable of spreading the disease. A few cases of super-spreading events occurred whereby individuals with higher viral loads and the ability to aerosolize the virus were able to infect multiple people. As a result of the relatively inefficient transmission of SARS-CoV-1, its outbreak was controllable through the means of quarantining individuals in households and health-care centers.

The stability of SARS-CoV-2 is like SARS-CoV-1, with an 80% genetic makeup similarity. Both viruses bind to the human cell via the spike (S) protein to angiotensin-converting enzyme 2 receptor (ACE2) to gain entry, but there are a few differences (figure 1). First, higher viral loads have been detected in nasal passages and the upper respiratory tract of individuals infected with SARS-CoV-2, which mean coughs and sneezes may contain higher viral loads than its predecessor virus. Second, the potential for individuals infected with SARS-CoV-2 to shed and transmit the virus while asymptomatic is much greater, and those in the latent stages of the disease often shed the virus at a higher rate.[7] Third—and most significantly—this new virus strain has been shown to be much more efficient at traveling more considerable distances and becoming aerosolized.

Figure 1: How SARS-CoV-2 binds to the human cell



Several studies have reported cross-transmission of COVID-19 among healthcare workers.

Including 3,387 confirmed cases and 22 reported deaths.[8] The disease can transmit from one healthcare worker to another, from healthcare worker to patient, or from patient to patient within the same facility.[9] Orthodontists may see dozens of patient in a single day. This makes strict infection control measures with the highly transmissible SARS-CoV-2 an area of concern. Children comprise the vast majority of the orthodontic patients. Studies have reported asymptomatic children infected

with COVID-19.[10,11,12] The incubation period of this disease is 14 days up to 24 days.[13,14] The virus is still highly contagious during this latency period.[14] This rings the alarm bell of a potential hazard: treating asymptomatic patients and spreading infection within the orthodontic clinic.

Furthermore, aerosol generation – a routine occurrence in the orthodontic clinic -- is a confirmed route of infection transmission.[15,10]

Aerosol particle transmission

Particles are classified based on size: coarse particles are 2.5–10 microns, fine particles are less than 2.5 microns, and ultrafine particles are less than 0.1 micron. The nose typically filters air particles above 10 microns. If a particle is less than 10 microns, it can enter the respiratory system. If it is less than 2.5 microns, it can enter the alveoli. A particle less than 0.1 micron, or an ultrafine particle like the COVID-19 virus, can enter the bloodstream and target organs such as the heart and brain. The current scientific consensus is that most transmission via respiratory secretions happens in the form of large respiratory droplets rather than small aerosols. Droplets are often heavy enough that they do not travel very far; instead, they fall from the air after traveling up to six feet (figure 2).

The problem occurs when viral particles are aerosolized by a cough, sneeze, or dental care. In these instances, particles can potentially travel across far greater distances, with estimates up to 20 feet, from an infected person and then incite secondary infections elsewhere in the environment. These aerosolized droplet nuclei can remain in an area, suspended in the air, even after the person who emitted them has left and thus can infect health-care workers and contaminate surfaces. Here are some examples of the longevity of COVID-19 in various places[16]:

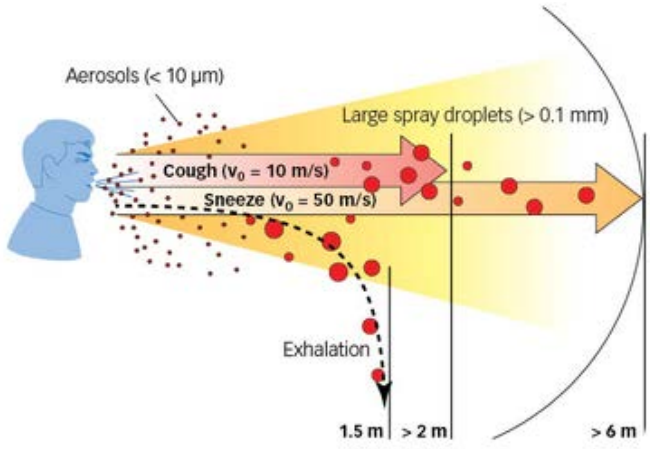
The virus is viable up to 72 hours after application to plastic and stainless steel surfaces.

• The virus is viable up to 24 hours on cardboard surfaces.

• The virus is viable up to nine hours on copper surfaces.

• The virus is viable in suspended aerosols up to three hours.

Figure 2: How COVID-19 is transmitted through aerosol particles



Aerosol Generating Procedures (AGPs)

Aerosol Generating Procedures are defined as any medical and patient care procedure that results in the production of airborne particles (aerosols). These are relevant to COVID-19 transmission, since this may occur via both direct air-borne infection and indirect spread via contact with contaminated surfaces. Restriction of AGPs is, therefore, an important control measure.[18]

Based on the most up to date information available[19-20] dental AGP are produced when using any of the following:

• High speed air rotor drills including surgical drills[19,21,22,23,24,25,26]

• Slow speed drills, run wet and dry, including surgical drills[27,23,28,29,25,20]

• 3 in 1 spray or air/water syringes[21,22,25]

• Ultrasonic and sonic handpieces[21,22,25]

• Air abrasion or intra oral sandblasting[25,30]

For orthodontics this extrapolates for our procedures to include use of high speed air turbine or slow speed rotary drill, 3 in 1 air/water syringe, and enamel preparation using ultrasonic or air abrasion devices.

This will have a direct impact on adhesive removal from enamel, and the use of air/water sprays and rotary handpieces for moisture control and cleaning.

Table of Aerosol Generating Procedures in Orthodontic Practice

Orthodontic Procedure	
Debond With handpiece driven adhesive removal (high speed or slow speed)	AGP
Repair bracket failure With handpiece driven adhesive removal (high speed or slow speed)	AGP
Repair Fixed retainer With handpiece driven adhesive removal (high speed or slow speed)	AGP
Removal of fixed devices eg quad/bands etc With handpiece driven adhesive removal (high speed or slow speed)	AGP
Placement of new Fixed retainer With enamel preparation using either air abrasion/ ultrasonic/ high speed or slow speed handpiece and a 3 in 1 for washing and drying	AGP
Bond up Etch, bond with use of 3 in 1 for wash and dry	AGP
Bond up With handpiece (high speed or slow speed) tooth polish, dry or with pumice Prior to the use of Self-Etch Primer or etch, bond	AGP
Trimming acrylic (worn or tried in) removable appliance/functional/retainer etc With slow or high speed handpiece	AGP
Polishing of teeth With slow or high speed handpiece	AGP
Scale and Polish Use of ultrasonic scaler/air abrasion or high speed or slow speed hand piece	AGP

Even with the use of High Volume Suction (HVE) and/or rubber dam to limit aerosol and the bio impact, these procedures are still considered AGP and appropriate PPE should be worn, along with appropriate decontamination protocols in the surgery.

High and low volume suction themselves are NOT considered AGP.

Alternatives to AGP in the orthodontic setting.

Debond

Removal of brackets and wires alone is not considered the AGP part of a debond. Use of a handpiece, (high speed or slow speed, with or without water coolant) ultrasonic scaler or 3 in 1 air/water spray should be avoided.

For patients with poor oral hygiene where the risk of continuing treatment is high, consideration could be given to removing the brackets alone and hand trimming the adhesive carefully using:

- Band removing pliers,
- Mitchell's trimmers or hand scalers,
- Adhesive removing pliers.

Any small remnants of composite left on the enamel surface are likely to be lost over time with tooth brushing.

There is no more enamel loss when using debanding pliers than with slow speed Tungsten Carbide bur run dry,[31] but take care not to gouge the enamel surface. Pliers should only be used to remove the adhesive on posterior teeth, not the incisors where a Mitchell's trimmer of hand scaler should be used instead. If there are large restorations on the posterior teeth consider placing a cotton wool roll on the occlusal surface before applying any force with the plier.

Repair of brackets mid treatment

As above, if residual composite can be removed by hand, this may enable a new bracket to be placed (using Non AGP bonding technique - see below). Alternative options would be to place a premolar or molar band using GIC, or to bypass the debonded tooth, using dead coil or sleeve on the wire, or using sectional wires mesial to the debonded tooth.

Removal of fixed devices mid treatment

Removal of fixed devices such as Bands, TPA Nance arches, Quad helix and RME devices only becomes AGP if a handpiece is used to remove the residual cement. As above, consider adhesive removal using hand instruments.

Bonding

Conventional acid etch bond up protocols are AGP when using polishing/pumice prior to etching and the 3 in1 air syringe to rinse the enamel after etching. Alternative non AGP options are listed, but it should be recognized that bond strength may be compromised:

Light cured resin modified GIC, can be used without the need for any pre procedural tooth preparation (i.e. pumicing/etching washing/ drying). With these materials there is NO need for a dry field and indeed for successful bonding the enamel surface should remain moist during bonding.[32]

Self etch primers (SEP) can also be used without the need for etching washing and drying the enamel, but they require the pellicle to be removed prior to use, usually with a pre procedural enamel preparation such as pumice/polishing of teeth, which would be an unwanted AGP. Without this stage the bond strength is likely to be reduced. [33,34] To avoid the use of a pumice/polishing of teeth using a handpiece and 3 in 1 syringe with SEP:

• Wipe the bonding surface of the tooth with a cotton roll prior to applying SEP.

• Suction may be used as this is non AGP.

• The Technique for using SEP is also important, with 3-5 seconds rubbing of the SEP to enamel, with re-dip into the SEP reservoir before repeating on each subsequent tooth. Following application of the SEP some manufacturers recommend gentle air drying. This latter stage is potentially an AGP and should be avoided

Bands

Avoid the use of 3 in 1 due to the AGP hazard, but suction may be used. The use of GIC or resin modified GIC doesn't not require a completely dry field on either the tooth or band prior to placement

Fitting and trimming the acrylic on removable appliances

It should be borne in mind that removable appliances may act as a conduit for cross infection, and laboratory protocols should be adhered to in order to minimize this risk. Although new appliances cannot be assumed to be infection free[35], strict adherence to laboratory infection control procedures including processing of impressions, equipment and appliances is crucial in minimizing the risk of any cross infection. Simple fitting and adjustment of a removable appliance is not likely to be an AGP provided no acrylic trimming is required during fitting i.e. after try-in.

In the case of appliances already being worn by the patient that require repair and refitting, they should be decontaminated according to HTM01-05[36] protocol and current PHE cross infection guidance[37], using an appropriate disinfectant before ideally being transferred to the laboratory for repair, where superior high volume suction can be used to minimize the impact of any aerosol generated.[38]

Often removable appliance acrylic trimming would be undertaken at the chair side in the clinical setting, either as part of the fitting procedure for a new appliance, or following the repair of a worn appliance. There is currently a paucity of evidence in the literature on the microbial load on a worn or tried in orthodontic appliance made from acrylic following disinfection, and no evidence that any aerosol generated during trimming is therefore not a biohazard risk. Acrylic trimming of a new but tried in appliance or currently worn appliance in the surgery should therefore be considered an AGP.

Repair of Fixed retainers

Removal of adhesive from the retainer wire can be achieved using Weingart or Birdbeak pliers, and HVE (High Volume Evacuation/Suction).

Adhesive removal from the lingual surface of the incisors may be achieved using hand scalers or Mitchell's trimmers, or the use of adhesive removal pliers.

Aligner Attachments

Placement of aligner attachments can be considered non-AGP if placed using bonding technique as suggested above.

Removal of attachments will be non-AGP if using adhesive removal tool as suggested and will only be considered AGP if a handpiece is used to remove the residual composite.

Taking impressions

An impression in itself is not an AGP, but carries a risk of gag or cough reflex which is a known aerosol risk. Where

accessible, an intra oral scan may be preferable (although this does not eliminate the gag/cough risk).

Any impressions should be sterilised[35] in accordance with HTM01-05 protocol[36] to ensure safe transfer to the laboratory for casting and appliance production.

Retention

Consideration should be given to changing to using a removable retainer regime. This could be made over the remnants of a broken fixed retainer

Minimizing the impact of Aerosol Generation when performed within the clinical environment.

High volume suction (HVE)

The use of high volume suction (HVE) is established as significantly reducing the amount of aerosol in the environment and should be employed if AGP is used, including when trimming appliances outside of the mouth.[39,28-25,42-41]

Rubber dam

The use of rubber dam to reduce the biodiversity of aerosol has been suggested.[39,25,42,41] Studies are very varied in confirming the impact of rubber dam in reducing the biodiversity of aerosol produced.[43-44] It is certainly a technique sensitive procedure and this may account for the variability of results in studies. The practical implications in orthodontics are limited, where multiple teeth are being treated and it is unlikely to be a technique operators are skilled in at present.

Pre-procedural mouth-rinse

Although both Chlorhexidiene and H2O2 mouthwash have been shown to reduce the bacterial load of aerosols Chlorhexidine is not known to be effective against coronavirus.[26] It has been suggested[25,26, 42,45] that since the virus may be vulnerable to oxidation, a pre-procedural mouth-rinse with an oxidising mouthwash such as H2O2, povidone iodine, or Hypochlorus acid may be worthwhile.[41,46]

However, high viral loads have been found in the oropharynx of infected patients, as well as in the asymptomatic subjects.[47] Since Coronavirus is expelled from the lungs at each exhalation there is some limitation to the impact of such pre-procedural mouthwash even if it was effective in reducing the viral load.[48] A previous clinical study examining the bacterial loading of aerosols generated at orthodontic debond found that the use of preprocedural mouthwash (either sterile water or Chlorhexidine) actually increased the biodiversity within the aerosol generated at debond rather than reducing it. This was the case even when using a slow speed handpiece without water coolant to remove the residual adhesive.[20]

A pre-procedural mouth-rinse is therefore not currently seen as a significant step in reducing the risk of aerosol generating procedures.

Face masks

There are 2 main types of face mask; Fluid resistant surgical masks (type IIR) and respirator masks; FFP2 and FFP3 according to filtration rates. Masks have been shown to be effective against nosocomial transmissions of SARS.[49]

Studies have shown[28,29] up to 95% filtration rate with surgical masks, but many studies looking at types of mask and the effect of filtration tend to be laboratory based, and do not correlate with the real world issues of namely exhalation as well as inhalation, the impact of moisture on the efficiency of the mask, the fit of the mask to the individual face and the impact of facial movement on the fit during episodes of wear. The filtering efficiency of a mask is only as good as its fit or the moisture content. Therefore, masks and respirators should be fit tested, checked and always discarded if moist/wet.[50]

Conclusion

Dentists, by nature, are at high risk of exposure to infectious diseases. The emergence of COVID-19 has brought new challenges and responsibilities to dental professionals. A better understanding of aerosol transmission and its implication in dentistry can help us identify and rectify negligence in daily Orthodontic practice. In addition to the standard precautions, implementation of special precautions could prevent disease transmission from asymptomatic carriers. These special precautions would not only help control the spread of COVID-19 but also serve as a guide for managing other respiratory diseases.

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