

Article

COVID-19: Pediatric Oral Health during and after the Pandemics

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Featured Application: this article is a consultation and orientation tool on operative protocols in pediatric dentistry during the COVID-19 pandemics.

Abstract: During the period of health emergency linked to the current COVID-19 pandemic, the management of children's oral health presents specific problems related to the infectious spread of the disease. These problems must be faced on the one hand by acting on the oral health prevention methods, and on the other by implementing specific protocols relating both to the conditions of oral pathologies that normally do not represent an emergency, and to those clinical situations that fall into the category of pediatric dental emergencies. In this perspective, in addition to defining rigorous and highly effective infection control protocols in the dental settings, it is of fundamental importance to work on remote communication and education aimed at maintaining the oral health of the children. This article, after an analysis of the risk factors from COVID-19 associated with pediatric dental treatment, presents a series of considerations on potential oral prevention strategies and on the management of emergency and non-emergency dental procedures in a context of disease transmission control, proposing new approaches and models of treatment based also on remote interaction techniques which will then retain their usefulness even at the end of the current emergency period.

Keywords: COVID-19; pandemics; pediatric dentistry; oral health prevention

1. Introduction

Prevention of oral health in children represents the gold standard towards which health professionals specialized in pediatric dentistry should always be oriented. This is even more true in times of health emergency such as the one we are going through today in which the WHO first declared the COVID-19 epidemic a Public Health Emergency of International Concern [1] and then recognized it as a pandemic [2].

It is precisely during the COVID-19 epidemic period that an adequate management of the oral health of children becomes of crucial importance by implementing specific protocols relating both to the pathologies of the oral cavity that normally do not represent an emergency and to those clinical situations that fall within the category of pediatric dental emergencies.

In both conditions, the main objective is to limit the spread of the epidemic and the onset of cross-infections. Therefore, not only are rigorous and highly effective infection control protocols urgently needed in the dental environments of the regions affected by COVID-19, but it is also

essential to work on remote communication and education aimed at maintaining the oral health of children.

2. COVID-19 Risk Factors Associated with Pediatric Dental Treatment

Genetic and epidemiological research reports that the COVID-19 epidemic started with a single transmission from animal to man, followed by an important human-to-human transmission [3,4]. The human-to-human transmission of COVID-19 occurs mainly through respiratory droplets in air suspension and aerosol and through direct or indirect contact [5,6]. Mother-infant vertical transmission has not yet been confirmed [7,8]. Also, preliminary epidemiological results seem to indicate that pediatric COVID-19 infection is relatively mild when compared to adults, and children are reported to have a better prognosis [9,10].

In dental settings, oral fluids from the patient or contaminated dental instruments or environmental surfaces create a potential way of spreading the virus to the operators and to other patients. Standard dental procedures that include the use of rotating instruments such as the high-speed turbine handpiece and the use of scalers for oral hygiene are associated with the generation of large quantities of aerosols and droplets from the saliva and blood of the patient. These can remain suspended in the air for long periods (hours) before settling on the environmental surfaces and on the medical instruments or before penetrating the respiratory tract through the nose and mouth. Hence, it is clear how the aerosols generated during dental treatment can expose the pediatric dentist, the assistant to the chair and other patients to risk of cross infection.

A recent article [11] reports a review of the main risk factors for COVID-19 associated to pediatric dental treatments. A first way of contagion is represented by direct transmission through the respiratory droplets: the virus can be transmitted between the dentist, the dental assistant and the small patients through the droplets generated by coughing and sneezing or by the dental procedures themselves. An indirect transmission can occur when the droplets containing the virus settle on the surfaces of the instruments with consequent transmission when the pediatric dentist, the assistant in the chair and other patients come into contact with the contaminated surfaces. Similarly, the use of high-speed turbine, ultrasonic scaler and spray gun produce an aerosol of saliva, blood and other fluids that can remain in air suspension for long periods, with an increased risk of transmission.

While the previous transmission pathways are common to the treatment of any dental patient [12], pediatric patients present additional risks of transmission: the use of removable orthodontic appliances or auxiliary elements in fixed orthodontic therapies, such as the use of intermaxillary elastic bands, entails risks of contamination if handling is not carried out with due precautions. Another problem is related to the difficulty for the child to use/endure personal protective equipment (PPE) during medical visits. Finally, the very presence of caregivers, with whom the pediatric dentist must unavoidably interface, will increase the risk of infection.

3. Oral Health Prevention during the COVID-19 Pandemics

3.1 General oral health prevention measures

In general, the prevention of oral health in children is based on the periodicity of the check-ups and on oral hygiene education through adequate information of the parent on orodental diseases. In the COVID-19 epidemic context, even in absence of an international consensus on the provision of dental services, many countries restricted access to, or strongly discouraged non-emergency dental services [13,14], therefore the difficulty of managing regular follow-ups of dental check-ups makes it essential to focus prevention on oral health education interventions that go through adequate remote information. For this purpose, in the recent years much attention was dedicated to the use of "social" digital platforms on which the pediatric dentist can publish and disseminate behavioral guides for the protection of the oral health of children [15,16]. These platforms must be accompanied by more direct forms of interactions between patient/parents and pediatric dentist, such as telephone consultations or, whenever possible, teledentistry [17]. In the current emergency, the main

goal of these guides would be to avoid, or at least minimize, the onset of unfavorable situations for the stomatognathic system, thus improving the oral health of the child and reducing the necessity of immediate interventions.

3.2 Prevention of carious pathology

Prevention against the carious pathology must be based on adequate and effective home oral hygiene measures, on the use of dental floss in the tooth exchange phase associated with the completion of permanent dentition, and on correct alimentary behaviors which limit the intake of fermentable carbohydrates. One of the risks of this epidemic period, in which children are forced to spend most of their time at home, is the acquisition of incorrect alimentary habits. It is important in this sense to inform parents about the carioprotective and cariogenic properties of specific foods [18]. A diet rich in fruit and vegetables not only protects from the onset of caries, thanks to a mechanical protection associated with the stimulation of saliva, but also helps to protect against the onset of gum diseases. Furthermore, it is of fundamental importance to limit the consumption of soft and energy drinks since, in addition to containing high quantities of sugars, their acidic content produces dental erosion and makes the enamel tissue less resistant to the attack of cariogenic bacteria.

Also related to the effects of the COVID-19 is the increased stress level linked to home confinement and infection anxiety, with side effects on children's physical and mental health [19]. For children in the preschool age group, a stress-induced alteration of the sleep patterns may push parents to adopt erroneous expedients to encourage the sleep of the child, such as the administration of bottles filled with fermentable liquids containing carbohydrates, rather than pacifiers dipped in honey or sugar. These behaviors would increase the risk of developing Early Childhood Caries (ECC)[20], which has a rapidly worsening clinical evolution with easy onset of local abscess infectious complications associated with painful symptoms and would require an immediate dental intervention.

Finally, it should not be forgotten that preservation of the oral health of the parents also has a protective effect for the child as the risk of bacterial mother-child transmission is high in the age group between 3 and 5 years and can easily induce severe ECC [21]. Therefore, during the period of confinement, strict oral health prevention measures must also be followed by the parents.

3.3 Other aspects of pediatric dental prevention

The need to spend the whole day in a home setting can stimulate more lively play modes in the children, with an increased risk of traumatic events affecting the dental elements [22] and the consequent need for urgent interventions that increase the risk of contagion from COVID-19. Parents should therefore be instructed on the need for careful supervision of the child's activities, possibly recommending the use of protective mouthguards of the type usually indicated for contact sports.

In general, correct oral health must always be combined with a healthy lifestyle, thus contributing to a good general health. Therefore, physical activity at home, sleeping for an adequate number of hours, and proper nutrition and hydration throughout the day are strongly recommended.

4. Dental Management during the COVID-19 Outbreak

4.1. Management of orodental pathologies that do not represent an emergency

During the COVID-19 epidemic and together with all other medical activities, routine dental work in Italy was suspended and postponed in relation to the progress of the epidemic situation, with the recommendation of limiting dental interventions to emergencies only [23]. Hence, the need to be able to follow the oral health status of children only through adequate remote interaction with parents, who must be properly trained on the recognition of diseases that do not require immediate intervention and which can therefore be managed with palliative measures, waiting to be treated in an outpatient setting at the end of the epidemic emergency.

In agreement with previous literature [11], we list here several clinical situations that can cause concern for the parents but that do not require emergency treatment and can therefore be remotely managed. For each situation we included recommendations which, according to our clinical experience, could help the parents solve the problem or at least mitigate the insurgency of painful symptoms, thus delaying the need for direct professional intervention. These recommendations are also summarized in Table 1.

1. Deciduous or permanent teeth affected by previous carious lesions and treated with temporary dressings: in this case, if the dressings were to decement from the prepared cavity, it is recommended to keep the cavity always free of food debris through careful removal with mechanical brushing after meals to prevent the onset of painful symptoms. It is also recommended to avoid too hot or too cold foods that could trigger the onset of painful symptoms if the original treatment involved the removal of carious dentin-enamel tissue.
2. If the dressing concerns an endodontically treated deciduous or permanent tooth and the spontaneous removal of the dressing paste occurs, home treatment may involve washing the endodontic cavity with water diluted with hydrogen peroxide by means of a special syringe without a needle, followed by application of a cotton pellet during the child's meals.
3. Chronic periapical periodontitis can occur with dental pain when chewing. For temporary control of symptoms, antibiotic therapy with amoxicillin or cephalosporin and pain relievers such as ibuprofen are recommended [24], which are adjuvants to temporarily relieve symptoms and postpone dental treatment.
4. Delays of deciduous teeth exfoliation with their persistence in the arch, in conjunction with the simultaneous eruption of the corresponding permanent tooth are quite common occurrences. In this case, parents should be advised to encourage the child to chew hard consistency foods such as raw fruit and vegetables, that can stimulate the loss of the deciduous tooth by mechanically inducing its complete removal from the alveolar support.
5. Eruptive gingivitis of the permanent first molar is an additional clinical condition, which can be managed during this period. It manifests itself with swelling, edema and redness of the gum in distal position to the erupting first permanent molar. This condition affects school-aged children, on average between 6 and 7 years. The advice to give to the parents is to use cleaning swabs that help the removal of food debris in the gingival bag between tooth and gum, by rinsing with anti-inflammatory mouthwashes alternating during the day with local chlorhexidine antiseptic sprays, in order to reduce the inflammatory state and the painful symptoms.
6. Malocclusions associated with crowding of the dental elements and with overjet and overbite alterations do not represent an emergency. Parents must be instructed to postpone the correction to the end of the epidemic. In case of increased overjet, a condition most frequently associated with the risk of fractures affecting the upper incisors, it is possible to recommend the use of standard mouthguards, easily available in the pharmacy.

Table 1. Recommendations for non-emergency clinical situations.

Clinical Situation	Recommendation
Temporary dressing decementing from a treated carious lesion.	<ul style="list-style-type: none"> • Remove food debris from cavity with brush. • Avoid hot/cold food.
Dressing decementing from endodontically treated tooth.	<ul style="list-style-type: none"> • Wash cavity with water diluted hydrogen peroxide. • Apply cotton pellet during meals.
Pain at chewing from chronic periapical periodontitis.	<ul style="list-style-type: none"> • Antibiotic therapy with amoxicillin or cephalosporin and pain relievers such as ibuprofen.
Delays of deciduous teeth exfoliation with	<ul style="list-style-type: none"> • Chew hard consistency foods to stimulate the

persistence in arch and simultaneous eruption of corresponding permanent tooth.	loss of the deciduous.
Eruptive gingivitis of the permanent first molar.	<ul style="list-style-type: none"> • Use cleaning swabs to remove food debris in the gingival bag between tooth and gum. • Rinse with anti-inflammatory mouthwashes alternating with local chlorhexidine antiseptic sprays.
Malocclusions associated with crowding of the dental elements and with overjet and overbite alterations.	<ul style="list-style-type: none"> • Postpone the correction to the end of the epidemic. • Use of standard mouthguards for increased overjet.

4.2 Management of children undergoing orthodontic treatment

If the child is using a removable orthodontic appliance, the first indication to the parents is linked to the correct hand hygiene measures before inserting the device into the oral cavity. According to recent studies [25], the oral cavity has in fact a high expression of the ACE2 receptor, considered the main host cell receptor for the SARS-CoV-2 virus. This fact also underlines the importance of a correct hygiene associated with the management of orthodontic devices, which must be carefully sanitized before each use and stored in the appropriate box after use.

If Schwarz removable plates are used, a broken retention hook, such as the Adams hook that normally fits on the first permanent molar, is a not unusual occurrence. In this case, if the entire hook breaks from the resin section of the appliance, the child can continue to wear the device as long as the retention is preserved. Alternatively or in case of doubt, it is advisable to limit the use of the device during the daytime hours only, always under parental supervision, postponing the repair of the device at the end of the epidemic.

For fixed orthodontic devices cemented on the palatal arch, such as the rapid palatal expander, it is recommended to temporarily suspend the activations in order to avoid carrying out incongruous maneuvers that can facilitate the detachment of the device from the dental surfaces. Given the current epidemic, it should be forcefully reiterated to the parents that the child must avoid eating viscous foods, such as caramel or chewing gum, or hard foods that can favor the partial detachment of the device, thus triggering an emergency situation that requires an immediate intervention by the pediatric orthodontist.

In the case of fixed multi-bracket therapy, the arch may slide and move distally to the cemented tube on the molars. In this case, especially when light NiTi wires are in use, if the child reports a feeling of discomfort and puncture on the gum, it is possible to advise the parent to manually reposition the arch by sliding it towards the teeth most mesial to the molar using the fingertips of thumb and index. If a bracket decements from the dental surface and rotates by 180° with respect to the tooth while remaining tied to the arch, the parent can reposition it manually, postponing the re-cementation to the end of the epidemic.

4.3 Management of orodental pathologies that represent an emergency

Many pediatric dental emergencies require immediate treatment even during the COVID-19 outbreak. Among these, we can list, e.g., acute pulpitis, acute apical periodontitis, dental trauma and maxillofacial trauma [26,27].

The management of all pediatric dental emergencies during the epidemic must take place by adopting protective measures for healthcare personnel and for the young patient in accordance with the recommendations and guidelines related to the use of effective protocols for the prevention and control of infections referred to by the scientific literature [28-32].

4.3.1 Patient evaluation

In this preliminary triage phase it is necessary to make a recording of the temperature of both the child and their carers and to carry out an anamnestic evaluation to investigate not only trips to geographic areas affected by the epidemic of COVID-19 made in the 14 days preceding the dental visit but also if there is a history of contact with COVID-19 patients or suspected such [6]. The child should be accompanied by a minimum number of people. In addition to measuring the temperature, medical protective masks should be provided to patients and their carers.

4.3.2 Personal protective measures for the pediatric dentist

Since the main route of transmission of COVID-19 is through airborne droplets, during the epidemic period, additional protective measures with personal protective equipment (PPE) are recommended for the pediatric dentist and other healthcare professionals, in particular when performing aerosol generating procedures (AGP). PPE usually include: surgical mask, face shield, protective goggles, gloves, medical cap, and protective suits.

According to the type intervention and on the possible presence of a COVID-19 infected patient, as assessed by the preliminary triage, we can distinguish three levels of protection for the pediatric dentist [33]:

- standard primary protection: disposable work cap, disposable surgical mask, work clothes with white coat, protective goggles or face shields, disposable latex or nitrile gloves. This is the minimal protection for all staff in a clinical context. Can be used by a pediatric dentist when performing dental activities not involving AGP (e.g. first examinations, control visits) on non-COVID-19 patients;
- secondary or advanced protection: disposable work cap, disposable surgical mask, protective goggles, face shield, white work coat with disposable or external surgical insulation clothing, disposable latex gloves. Should be used by the pediatric dentist when performing activities involving AGP (e.g. any activity requiring the use of the high-speed handpiece) on non-COVID-19 patients;
- tertiary or enhanced protection: special full-body protective clothing is required or, if none is available, a lab coat with an external disposable protective suit and, in addition, disposable work cap, disposable surgical masks, protective goggles, face shield, disposable latex gloves, waterproof shoe covers. Although any treatment on a patient with suspected or confirmed infection with COVID-19 should be postponed, if this is not possible and the pediatric dentist cannot avoid close contact, the maximum level of protection should be worn for the whole duration of the intervention.

4.3.3 Hand hygiene

The reinforcement of good hand hygiene of the reception staff, of the patient, and of the medical staff is of fundamental importance especially in the period of transmission of the epidemic from COVID-19. Given the transmission characteristics of the SARS-CoV-2 virus, a bad compliance of hand washing in the dental practice poses a challenge to controlling infection during the epidemic period. A Chinese study [33] recommends the "two before and three after" technique as a standard hand hygiene procedure, emphasizing that oral professionals should wash their hands before examining the patient, before dental procedures, after direct contact with the patient, after touching the environment without previous disinfection, and after touching the patient's oral mucosa and skin or coming into contact with saliva and oral fluids.

4.3.4 Mouthwash rinses

Preliminary results [34,35] indicated that chlorhexidine, the most commonly used mouthwash in dental studies, might have reduced efficiency against the SARS-CoV-2 virus. On the other hand, the virus appears to be vulnerable to several available disinfectants [36,37]. Debate on the best mouthwash to use during the COVID-19 pandemics is still ongoing, also taking into account

dilutions and patient compliance [38]. In any case, it is recommended to let the child rinse with dedicated antiseptic solutions to reduce the oral bacterial load before any treatment.

4.3.5 Management of traumatic orodental injuries

Traumatic pathology has a high prevalence in children [39,40] and can therefore present itself as an emergency to be managed during the COVID-19 epidemic. The standard therapeutic approach to dental traumas should be followed [41-43], always keeping in mind that these often require the use of the high-speed turbine and are at high risk of COVID-19 transmission. Utilization of high level PPE is therefore mandatory.

4.3.6 General recommendations for treatment

Based on previous literature [11,28,30,33,44,45], Table 2 summarizes a set of general recommendations to minimize the risk of cross infection during dental treatment in a pediatric dental setting.

Table 2. General recommendations for treatment in a pediatric dental setting.

1. The environment where the dental treatments are carried out must be properly disinfected and always well ventilated.
2. Get parents to leave the operating room.
3. Always use the appropriate type of PPE.
4. Use four-handed dentistry techniques to optimize the intervention time.
5. Use a high volume aspirator to minimize droplets and aerosol during high-speed turbine operation.
6. Isolate the operating field with the rubber dam in order to minimize the production of aerosols contaminated with blood and saliva, especially during the treatment of the pulpits.
7. Use high-speed turbines with anti-retraction valve, which significantly reduces the return flow of oral bacteria.
8. After any type of treatment, it is necessary to proceed to an adequate disinfection of the environment.

5. Conclusions

In the current context of epidemiological emergency linked to the COVID-19, it is necessary to re-evaluate the pediatric dentist's activities taking into account the challenges in terms of contagion containment. In this sense, the possibility of remote education of parents must be considered both as regards the general prevention measures for oral health, and as regards the home management of milder oral pathologies for which direct intervention of the specialist in pediatric dentistry is not necessary or can be postponed. On the other hand, if, in the presence of dental emergencies, immediate intervention is required, the observance of strict protection protocols of the subjects involved and environmental disinfection becomes crucial in order to minimize the risk of cross infection.

The end of the pandemic will have to mark the beginning of new methods of approach and management in pediatric dentistry. The smart technological systems, that during the pandemic

period blossomed to become the most powerful remote communication tool, could be of great help as standard projection tool for educational material on oral health in children, especially in school age, who are treated in outpatient clinics, boosting and strengthening the approach in pediatric dentistry and the children's motivation for oral health. On the other hand, the specialists in pediatric dentistry will have matured and strengthened their dedication to the practice of this medical specialty in the post-pandemic period, not only by improving and modernizing the approach techniques, but also by proposing new models of treatment that may include the use of remote controls through special platforms, with practical guides dedicated to parents, in order to monitor and preserve the great heritage of general health, of which oral health is an important component.

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