CONTEMPORARY Pediatric DENTISTRY

An online international journal dedicated to all aspects of pediatric dentistry

Editor-in-Chief: Burak Buldur

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Contemporary Pediatric Dentistry aims to serve as a forum for scientifically based information in pediatric dentistry, with the intention of continually expanding the knowledge base in this area. The journal aims to promote the highest standard of education, practice and research in paediatric dentistry world-wide.
The Contemporary Pediatric Dentistry's broad readership consists of pediatric dentists, dentists, and all academicians, researchers, specialists, and general practitioners interested in pediatric dentistry.
This journal provides an open-access forum for the exchange of information about contemporary, new, and significant research in pediatric dentistry throughout the world. The scope is therefore broad, ranging from original research articles, case reports, reviews, editorial comments, and letters to the editor within all aspects of pediatric dentistry including education, practice and research. The journal covers the all aspects of pediatric dentistry. Author Guidelines is declared at its website; https://contemppediatrdent.org/author-guidelines/

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Launch of the Contemporary Pediatric Dentistry: Dream, Vision, Plan, and Reality

"Make things happen! All good things start with a dream.
The dream becomes a vision. The vision becomes a plan. The plan becomes a reality!"

This was my main philosophy of launching the new journal, ***Contemporary Pediatric Dentistry***. I am very honoured and pleased to take the first step of my dream and to celebrate the launch and first issue of ***Contemporary Pediatric Dentistry***, a new international, scientific, open access, online-only publication that aims to serve as a forum for scientifically based information in pediatric dentistry, with the intention of continually expanding the knowledge base in this area. We aim to promote the highest standard of education, practice and research in pediatric dentistry worldwide. This new journal aims to provide an open-access forum for the exchange of information about contemporary, new, and significant research in pediatric dentistry throughout the world. Thus, the ***Contemporary Pediatric Dentistry***'s broad readership consists of pediatric dentists, dentists, and all academicians, researchers, specialists, and general practitioners interested in pediatric dentistry.

The journal will be published in three times in every year (April, August, and December), and its publication language is English. Articles published in this journal are evaluated in an independent and fair, double-blinded peer-reviewed fashion.

I hope that ***Contemporary Pediatric Dentistry*** will become the primary platform for researchers to share findings and discuss all aspects of pediatric dentistry in the development of future innovations that will benefit the international community.

We are now enjoying publishing the First Issue of ***Contemporary Pediatric Dentistry***. Our journal received 24 submissions in just three months since its establishment in 24 August 2020. In our first issue, we have now published a total of 7 articles including original research, review articles and case reports from 5 different countries.

I take this opportunity to thank our Authors, Associate Editors, Reviewers, and all of colleagues who are volunteered to contribute to the success of the journal. On behalf of the Editorial Board, I would also like to extend my warmest welcome to the readers of ***Contemporary Pediatric Dentistry***. I owe a special thank to Dr. Kaan Sağtaş, the Production Editor and a good friend, for his really hardworking and altruistic job during the establishment of this journal.

I feel very excited to see the development of this journal. Together, let's dream and make the ***Contemporary Pediatric Dentistry*** as leading journal in this area!

If you have any questions, support, suggestions or concerns, please feel free to contact to me personally.

Thank you!

Best regards,

Burak Buldur

Editor-in-Chief

Contemporary Pediatric Dentistry

Review
Contemp Pediatr Dent 2020:1(1):2-12

The impact of Covid-19 on the pediatric dentistry clinic: An integrative review

Bruna Eliza De Dea[1] ✉, Grasieli de Oliveira Ramos[2], Lea Maria Franceschi Dallanora[3], Victor Angelo Martins Montalli[4], Danilo Antônio Duarte[5]

Highlights

The COVID-19 pandemic change the dental care protocols, because dental office has a high risk of cross-infection for health professionals.

In pediatric dentistry, dental care has to be reduced to cases of urgency and emergency during the COVID-19 pandemic.

When the dental intervention in pediatric dentistry is necessary, non-invasive or minimally invasive techniques that reduce aerosols should be prioritized.

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Abstract

At the end of 2019, new cases of pneumonia of unknown etiology were identified in China, the cause was attributed to a new type of coronavirus, this infection quickly spread to other countries and gained pandemic status by World Health Organization (WHO) in March 2020. Therefore, containment measures were taken, including social isolation and pause in dental care, since the aerosols generated during this care are classified as high risk for contamination by COVID-19. In this context, children do not seem to be very affected by this infection, since the number of cases is low, but they are considered asymptomatic carriers, contributing to the transmission of the virus to other people. Therefore, the aim of this study was to review the literature in an integrative way, seeking to elucidate the impacts of these factors on the clinical practice of pediatric dentistry. The search resulted in 290 articles, of which 33 were selected for full reading, and 29 articles were included in the integrative review. The COVID-19 pandemic greatly changed the practice in dentistry, new biosafety protocols were established, aiming to minimize viral spread, in pediatric dentistry, dental care was reduced to cases of urgency and emergency, as children are asymptomatic carriers of viruses and when they manifest symptoms, they are less severe when compared to adults. Another recommendation is that whenever dental intervention in pediatric dentistry is necessary, non-invasive or minimally invasive techniques that reduce aerosols should be prioritized.

Keywords: Child; Containment of Biohazards; Coronavirus; Pediatric Dentist

INTRODUCTION

In late 2019, a series of pneumonia events, of unknown etiology, were reported in the city of Wuhan, Hubei province, China. With the spread of new cases in other regions and countries, the cause has been attributed to a new type of coronavirus. In February 2020, this respiratory disease was named COVID-19, or "coronavirus disease 2019" by World Health Organization (WHO) [1], the new coronavirus being called SARS-CoV-2 by the International Virus Taxonomy Committee. In March 2020, WHO classified it as a pandemic, a public health emergency of international interest.[2-4]

In September 2020, the term syndemia is introduced for COVID-19. Syndemia "characterizes the mutually aggravating interaction between health problems in populations in their social and economic context". The biological interactions, linked to social and economic factors, have become important for the prognosis, treatment and development of health policies to control the spread of COVID-19.[5]

The new coronavirus belongs to the Coronaviridae family, being divided into alpha coronavirus and beta coronavirus (infecting the respiratory, gastrointestinal and central nervous systems of humans and mammals) and gamma-choronavirus and betacoronavirus (mainly infecting birds).[6] It is believed that the period of incubation period is approximately 5 to 6 days, ranging from 2 to 14.[2]

The main means of transmission of this disease are droplets of saliva or nasal, oral and ocular secretions from asymptomatic or symptomatic individuals.[4,6,7]

Fever, cough, myalgia, kidney failure and acute respiratory disease stand out as signs and symptoms. In addition, anosmia and ageusia are considered prodomic signs. The clinical course is not yet fully understood, being heterogeneous between adults and children. While symptomatic adults can evolve to a severe condition, children are asymptomatic or mostly mild or moderate symptomatic.[8-10]

Considering the combination of the means of transmission of the disease, the absence of vaccine, the "very high" risk of contamination by the dentist, and of every child being considered asymptomatic carrier, the convenience of an integrative review on the impact of these factors is evident in the practice of pediatric dentistry.

METHODS

Study design

It is an integrative review, which is a study based on bibliographic productions, allowing a theoretical analysis of a subject, filling a knowledge gap, with consequent application of results in practice. Its application in the health area is relevant and has been widely used in order to recap the research available on specific subjects, reorienting practical attitudes.[11]

This research obeys the quality indicators for Integrative Review articles, being elaborated in the phases: definition of the guiding question; literature search; data collect; critical analysis of the included studies; discussion of results and presentation of the integrative review.[11]

Search strategy

The literature review was performed based on the active search for information in the PubMed, Scopus, Lilacs, Bireme, Scielo databases. The searches were performed by the author BEdeD; they were carried out in articles published until October 3, 2020, excluding those published after this date.

The search strategy for each database was developed using the AND and OR combination of free terms and MeSH terms. Terms related to COVID-19 infection ("new coronavirus", "Novel Coronavirus", "Nuevo Coronavirus", "Novo Coronavirus", "Coronavirus disease", "Enfermedad por Coronavirus", "severe acute respiratory syndrome coronavirus 2", "2019-ncov", "ncov 2019", "2019ncov", "covid19", "COVID-19", "covid2019", "covid-2019", "covid 2019", "srag-cov-2", "sars-cov-2", "sars2", "sars 2", "sars cov 2", "cov19", "cov2019", "Coronavirus*", "Severe Acute Respiratory Infections", "Severe Acute Respiratory Infection", "Coronavirus 2", "acute respiratory disease", "Betacoronavirus", "Coronavirus infections",

"sars vírus", "Wuhan market vírus", "virus mercado Wuhan", "Wuhan Coronavirus", "Coronavirus de Wuhan)" AND "pediatric dentistry" were combined with each other in all database searches.

The intention of this integrative review is to locate, interpret and synthesize the volume of evidence produced in this pandemic period and incorporate it in the decisions of control, treatment and pediatric procedures.

Article eligibility criteria

The articles identified by the initial search strategy were selected according to the following inclusion criteria: articles whose themes referred to the management and dental care of pediatric patients, or which dealt with biosafety in dentistry during the COVID-19 pandemic; published until October 3, 2020, abstract and / or articles available online for full reading. Articles that did not answer the guiding question; published as of October 4, 2020, abstracts and / or articles that were not available online for reading in full and duplicate articles in the databases were excluded.

Selection of publications and data extraction

The titles resulting from the search in all databases were arranged in a Microsoft Excel® spreadsheet so that repeated titles could be verified; reading the titles and excluding those that did not fit the inclusion criteria, the resulting abstracts were read in sequence and, subsequently, the pre-selected articles were read in full to determine the review sample.

The selection was made by the author BEdeD1, under the supervision of the author DD², the articles were chosen by consensus.

The data tabulated and presented in a table support the construction of the biosafety protocol and care for infant patients ".

RESULTS

The search in the databases resulted in 277 articles and 13 more from other sources, with 290 articles pre-selected. After removing duplicates (52) and reading the titles and abstracts, 33 articles were selected for full reading, of which 29 articles were included in the integrative review, 209 studies were excluded because they did not fit the study subject (Flowchart 1).

All of the 29 selected articles were published in the year 2020, the majority being published in the months of April, May and June. Most of the selected articles were published in English, only two were published in Spanish, one in Portuguese and one in Chinese (Table 1). Most of the selected articles are letters to the editor, editorials, and literature reviews, this shows the scarcity of publications on the topic. The guiding question of the research seeks to emphasize the influence of the pandemic in the clinical practice of pediatric dentistry, as well as to evaluate and synthesize protocols implemented in the post-pandemic.

Flowchart 1. Search strategy and selection of articles

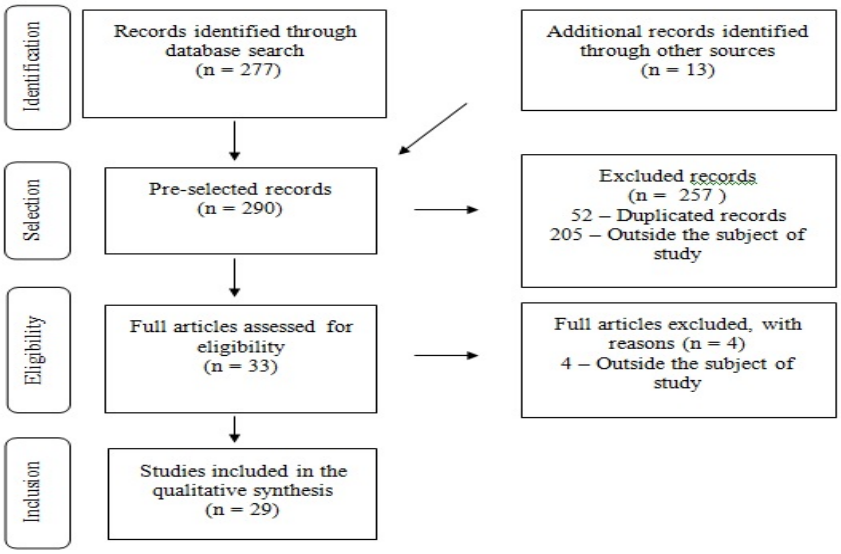


Table 1. Selected articles

Author	*Title*	*Main subject studied*	*Magazine*	*Language*	*Month/Year*
Jayaraman, et al. [17]	Impact of COVID-19 on Pediatric Dental Practice in the United States	Guidelines on care in pediatric dentistry	Pediatric dentistry	English	May/20
LAAPD *[16]	Ruta de atención para procedimientos de Odontología Pediátrica urante la etapa de confinamiento o cuarentena de la pandemia COVID-19	Guidelines on care in pediatric dentistry	Revista de Odontopediatría Latinoamericana	Spanish	April/20
Ferrazzano, et al.,[6]	COVID-19 Disease in Children: What Dentists Should Know and Do to Prevent Viral Spread. The Italian Point of View	Guidelines on care in pediatric dentistry, symptoms in children	International journal of environmental research and public health	English	April/20
Al- Halabi et al.[7]	Assessment of paediatric dental guidelines and caries management alternatives in the post COVID- 19 period. A critical review and clinical recommendations	Guidelines on care in pediatric dentistry	European Archives of Paediatric Dentistry	English	April/20
Mantovani et al.[8]	Coronavirus disease 2019 (COVID-19) in children and/or adolescents: a meta-analysis	Symptoms observed in children	Pediatric research	English	June/20
Ilyas et al.[19]	COVID-19 pandemic: the first wave – an audit and guidance for paediatric dentistry	Guidelines on care in pediatric dentistry	British Dental Journal	English	June /20
Carlotti, et al.[14]	COVID-19 Diagnostic and Management Protocol for Pediatric Patients	Symptoms observed in children and therapeutic protocols	Clinics	English	March/20
Sun, et al.[15]	Clinical features of severe pediatric patients with coronavirus disease 2019 in Wuhan: a single center's observational study	Symptoms observed in children	World Journal of Pediatrics	English	Feb/20
LAAPD *[21]	Teleodontología: Aplicación a la Odontopediatría durante la pandemia COVID-19	Use of Teledentistry in pediatric dentistry	Revista de Odontopediatría Latinoamericana	Spanish	May/20
Sahu et al.[2]	Coronavirus disease (COVID-19): Characteristics in children and considerations for dentists providing their care	Guidelines on pediatric care and symptoms found in children	International journal of paediatric dentistry	English	April/20
Dong, et al.[12]	Epidemiology of COVID-19 Among Children in China	Clinical characteristics in children and epidemiological aspects	Pediatrics	English	June/20
Peditto et al.[4]	Dentistry during the COVID-19 Epidemic: An Italian Workflow for the Management of Dental Practice	Guidelines on care in pediatric dentistry	International journal of environmental research and public health	English	May/20
Casamassimo, et al.[22]	Pediatric Dentistry During and After COVID-19	Guidelines on care in pediatric dentistry	Pediatric dentistry	English	April/20
LAAPD *[23]	Tratamento da doença cárie em época de COVID-19: Protocolos clínicos para controle dos aerossóis.	Guidelines on care in pediatric dentistry	Revista de Odontopediatría	Portuguese	April /20

Table 1. Selected articles (continued)

Author	*Title*	*Main subject studied*	*Magazine*	*Language*	*Month/Year*
Lu, et al., [9]	SARS-CoV-2 Infection in Children	Symptoms observed in children	The new England Journal of medicine	English	April /20
Martins-Júnior, et al.,[20]	Implications for dental professionals when caring for paediatric patients	Guidelines on care in pediatric dentistry	Evidence-Based Dentistry	English	June/20
Pecoraro, et al, [27]	The psychophysical impact that COVID-19 has on children must not be underestimated	Psychological impacts on children post social isolation	Acta Paediatrica	English	May/20
Wang, et al., [31]	Oral health management of children during the epidemic period of coronavirus disease 2019	Guidelines on care in pediatric dentistry	Sichuan Da Xue Xue Bao Yi Xue Ban	Chinese	March/20
Amorin, et al.,[24]	New Post-COVID-19 Biosafety Protocols in Pediatric Dentistry	Biosafety protocols in pediatric dentistry after COVID-19	Pesquisa Brasileira em Odontopediatria e Clínica Integrada	English	June/20
Sun, et al.,[3]	Knowledge of and attitudes toward COVID-19 among parents of child dental patients during the outbreak	Parental knowledge level during the social isolation of the COVID-19 pandemic	Braz. Oral Res.	English	May/20
Brodim , P[11]	Why is COVID-19 so mild in children?	Symptoms observed in children	Acta Paediatrica	English	April /2020
BaniHani, A., et al,[33]	Could COVID-19 change the way we manage caries in primary teeth? Current implications on Paediatric Dentistry	Guidelines on care in pediatric dentistry	Int J Paediatr Dent	English	June/2020
Acharya S. et al,[25]	How to deal and learn from the threat of COVID-19 in paediatric dentistry	Guidelines on care in pediatric dentistry	Eur J Paediatr Dent	English	September/2020
Saleha Shah[26]	COVID-19 and paediatric dentistry- traversing the challenges. A narrative review	Guidelines on care in pediatric dentistry	Annals of Medicine and Surgery	English	October/2020
Dellagiulia A. et al,[28]	Early impact of COVID-19 lockdown on children sleep: a four-week longitudinal study	Impact of social isolation by COVID-19 on children's sleep.	J Clin Sleep Med	English	September /2020
Baptista, AS et al,[30]	Can children's oral hygiene and sleep routines be compromised during the COVID-19 pandemic?	Guidelines on care in pediatric dentistry	Int J of Paed Dent	English	September /2020
Bahramian H. et al.,[18]	COVID-19 Considerations in Pediatric Dentistry	Guidelines on care in pediatric dentistry	JDR Clinical & Translational Research	English	July/2020
Campagnaro R et al,[29]	COVID-19 pandemic and pediatric dentistry: Fear, eating habits and parent's oral health perceptions	Guidelines on care in pediatric dentistry	Child Youth Serv Rev	English	November/2020
Cianetti S. et al,[32]	Model for Taking Care of Patients with Early Childhood Caries during the SARS-Cov-2 Pandemic	Guidelines on care in pediatric dentistry	Int. J. Environ. Res. Public Health	English	May/2020

Key: * LAAPD = Latin American Association of Pediatric Dentistry

DISCUSSION

The pandemic established by COVID-19 forced healthcare professionals to change their care. Dentistry has significantly changed the routine of clinical practice, in the context of private practice and public services.

However, the absence of official guidance from health agencies and agents, challenged a search for worldwide bibliography, in order to systematize guiding recommendations for a safe clinical practice for infant patients and their family nucleus, dental surgeon and staff involved in the care.

The discussion of this research is based on the identification, evaluation and synthesis of the elected articles, didactically presented in the following subtitles: Systemic signs and symptoms; Determinants of service needs; Care in procedures and procedures to be prioritized.

Systemic signs and symptoms

The signs and symptoms in children, when compared to adult individuals, appear to be less severe, with a better prognosis and a very low mortality rate. It is advocated that the child has an innate and more active immune response, fewer ACE-2 receptors and/or acquired cross-immunity from previous contact with other coronaviruses and enteroviruses.[12] Add to that less base comorbidities and a weaker acute inflammatory response to the COVID-19.[7,8,10,12-14]

Fever and cough are common, and pharyngeal erythema, diarrhea, nasal congestion, dyspnoea, abdominal pain and skin rash may also be present. Polypnea, sputum, nausea, vomiting, headache, fatigue, constipation are exacerbations of signs and symptoms when COVID-19 is associated with comorbidities such as leukemia and hydronephrosis.[7-10,14,15]

Radiographically, unilateral or bilateral pneumonia can be seen with signs of peripheral opacity. In more critical situations, ground glass opacity, pleural effusion and "white lung type" changes are detected.[7,9,10,15,16]

Hematological tests show normality or with a reduction in white blood cells, eventually presenting leukopenia and lymphocytopenia. Levels of C-reactive protein may be normal or elevated. In more severe situations, they may be accompanied by an increase in liver enzymes.[10,15]

Determinants of service needs

We must assume that all children and their parents and / or guardians are potentially carriers of the virus, increasing the risk of cross-infection for health professionals[8,17,18], so it is important to determine when it is necessary to perform a child's face-to-face care. In this pandemic period, it is essential to define what is urgency and emergency in pediatric dentistry.[17,19]

By definition, emergency is any situation where the patient's life is at risk and needs immediate care, dental emergencies must be treated exclusively in a hospital environment, as urgency is the management of complications that require immediate treatment for pain relief and control of infection.[17] Dental emergencies must be handled within an hour, whereas emergencies can be handled within the first 24 hours.[4] In Table 2, we present the main dental conditions that are characterized as emergencies and urgencies.

Table 2. Procedures classified as urgent and emergency in pediatric dentistry

Emergency	Urgency
Excessive bleeding [4,8,17]	Severe irreversible pulpitis [4,17] Pericoronitis [4,17]
Facial cellulitis with intra and extra oral edema that compromises the airways or deep planes [4,8,17]	Dentoalveolar abscess [4,8,17] Painful dental fracture [4,8,17] Alveolite [4,17] Dental trauma with avulsion or dislocation [4,8,17]
Dentofacial trauma that can compromise the airways [8,17]	Bleeding [8,17] Biopsy or dental preparation prior to medical procedures [4,8,17]

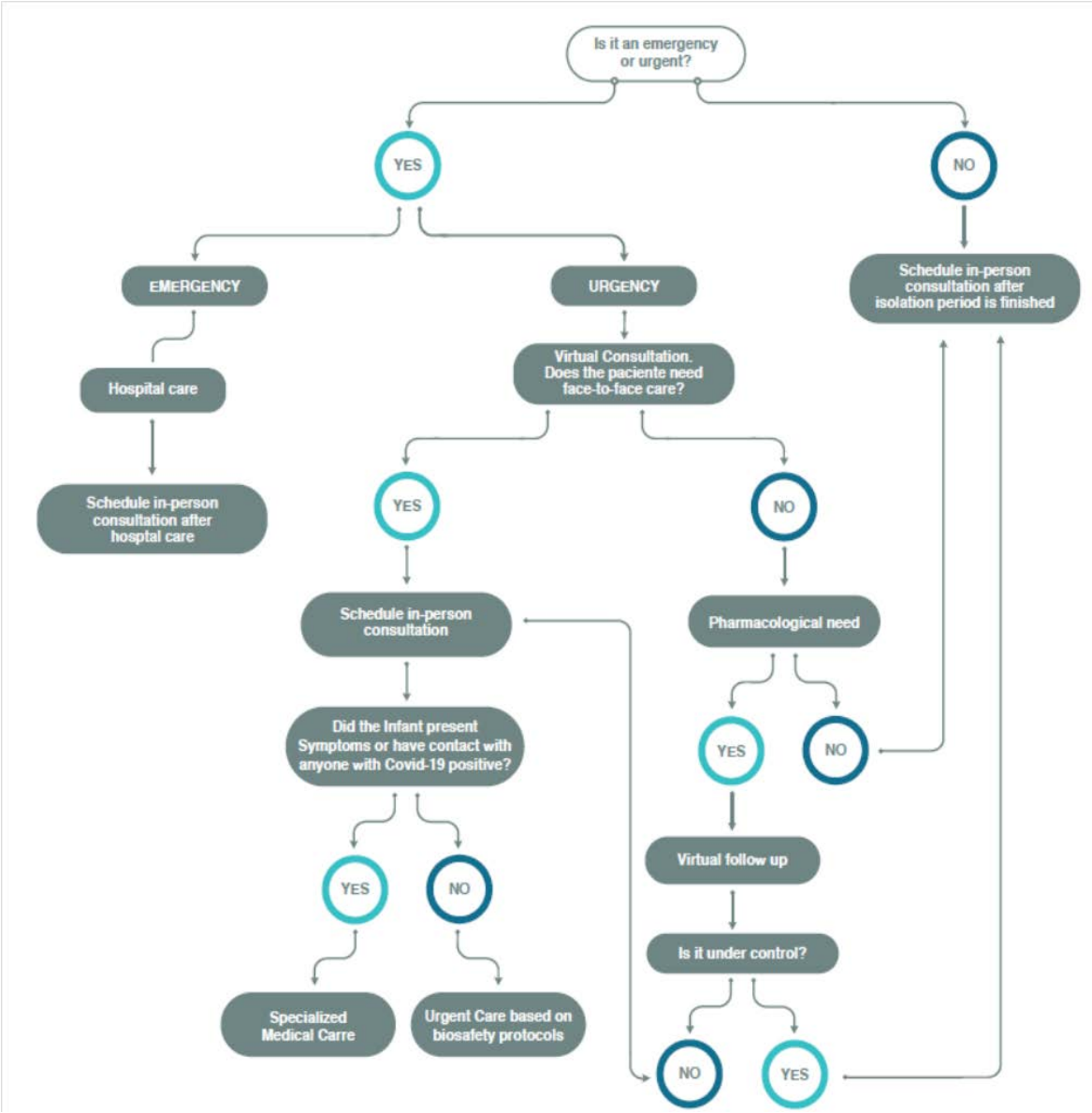
Standard Precautions during patient care

The Latin American Association of Pediatric Dentists recommends that during the period of social isolation dental care should be performed only in patients with cases of emergency and urgency, postponing elective treatment.[17]

Even treating only cases of emergency and urgency, it is essential that some care is performed, the screening of these cases must be performed through remote care (Teledentistry) in order to identify the situations that require face-to-face care, and to manage the elective cases.

After identifying the cases that require dental care during this period, appropriate biosafety measures must be taken, in addition, the use of techniques that reduce the generation of aerosols should be prioritized, thus reducing the risk of cross-contamination by COVID-19. [4, 7, 8, 12, 15-24] In flowchart 2 we present a suggested care protocol for pediatric pediatric patients in the period of social isolation due to COVID-19.

Flowchart 2. Suggested care protocol for pediatric patients in the period of social isolation due to Covid-19



Teledentistry in pediatric dentistry

Teledentistry is an indispensable modification in care in the face of a public health crisis, especially when face-to-face contact between patient and health professional is not possible, due to geographic or sanitary restrictions.[19] Teledentistry can be implemented through telephone resources, platforms tools and digital means that allow diagnosis, therapeutic guidance, patient control, in addition to defining the need or not for face-to-face care.[12, 17, 25]

Three types of teleconsultations are defined: asynchronous consultation, generally used when the patient or caregiver seeks the professional to consult their point of view, requires a waiting time between sending the question or request and the specialist's response; synchronous consultation, when the virtual consultation is in real time through telephone calls or preferably by video conference; mixed query is when using both synchronous and asynchronous queries.[22]

When conducting screening using this model, it is important to ask about signs and symptoms, pain and its characteristics, the presence of edema and fever. In situations of facial trauma, affected structures, active bleeding and involved teeth are investigated. The request for images assists in defining the need or not for face-to-face assistance.[17, 22]

It is recommended that the virtual consultation is preceded by a questionnaire and the communication, like a face-to-face consultation, should be administered safely, with a soft and calm voice, in order to convey confidence to the patient. The clarification to the patient and / or caregiver regarding the benefits and limitations of this type of consultation must be emphasized.[22]

The virtual consultation allows anamnestic recording, however, as there is no possibility of the physical-clinical examination, a presumptive diagnosis is made and, if necessary, therapeutic recommendations. Particularly in pediatric dentistry, therapeutic recommendations must obey the concepts of pharmacological prescriptions, providing textual guidance to parents or guardians.[22]

It is necessary to emphasize that if the virtual consultation indicates the need for face-to-face assistance, this must be authorized with the signature of the Informed Consent Form by the family nucleus and evidently respect all biosafety rules.[22]

Biosafety in pediatric dentistry in times of COVID-19 pandemic

The literature presents experiences in pediatric dentistry, where it was possible to diagnose caries lesions and make treatment decisions by means of intraoral cameras or images obtained through smart phones with the support of dental or personal assistants. The high transmissibility standard of COVID-19 can cause contamination in dentists and the dental environment favors cross-contamination. As a result, some biosafety protocols have been devised. In general, they encourage the avoidance of crowding, avoid the use of books / magazines, toys and plush toys in the waiting room, limit the number of daily appointments, use of masks for the patient and companion, disposable shoe protectors, hats, strict washing of clothes. hands.[26, 27]

Regarding the professional using PPE and providing measures to reduce contamination: physical barriers in the clinical environment, cleaning and disinfecting surfaces / objects / environments with sanitizing products, goggles and face protectors, disposable aprons, respiratory masks with particulate filter, gloves and hats. Technically, aerosol-producing procedures should be avoided, and when produced, if possible, use physical barriers and / or dental aerosol vacuuming (high-power suction) and rubber dam.[4,17,18,25,26]

Procedures to be prioritized

The strategy recommended by WHO is the temporary suspension of elective procedures during the pandemic, which is controversial in relation to the recommendations of entities in the pediatric class. It is essential that each clinical situation is determined through its specificities and that associations of techniques can be performed during this period. Another important

point to be considered is the psychological issue involved in this moment of isolation.[17,28- 31]

Emotional disorders, depression, irritability, insomnia, stress, emotional exhaustion are examples of the symptoms reported in situations of quarantine and social isolation. These factors can influence the routine of eating, sleeping, oral hygiene and explain the difficulties that families have been facing due to the need for adaptations in this period.[30,31]

At the time of social isolation, where we do not yet have a vaccine and since dental care is considered to be at high risk of infection by COVID-19, we must prioritize urgent care and give preference to procedures that do not generate aerosols, especially minimally invasive, which are based on modern concepts for treatment and control of caries disease through a conservative approach.[8,17-19,32,33]

The emergency care services listed in Table 2, which require immediate treatment, must be performed following all the rules of the proposed biosafety protocols and the regulations defined by the health regulatory agency of each country.

In the treatment of caries disease, priority is given to techniques that do not generate aerosols, such as supervised tooth brushing, the use of low rotation, fluoride varnish, sealants, atraumatic restoration, selective removal of decayed dentin, application of silver fluoride diamine, non-control cavity restorer and hall technique.[8,17,18,21,34]

Final Considerations

Unquestionably the COVID-19 pandemic changed the behavior of the dental surgeon and their team, as well as the patient. This change is most strongly noticed in Pediatric Dentistry, given that the child alone, demonstrates a relative degree of anxiety in the face of medical and dental procedures. In addition, it always requires an escort. Social distancing itself has contributed negatively to the child's behavior, from a psychological point of view.

These factors associated with the risk of contamination by the new coronavirus in the dental environment, require strict compliance with biosafety rules and the care protocol, restricting the risks of contamination for the population and oral health professionals.

It is important to reinforce the strategies of dressing and de-dressing, waste disposal, surface disinfection and use of PPE.

We underline the importance of differentiating emergency and urgent interventions, and in mandatory face-to-face interventions, prioritize non-invasive or minimally invasive techniques that do not generate aerosols.

Considering that, still, we do not have consensus and strong scientific evidence on all measures and protocols, they are subject to change.

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Contemporary Pediatric Dentistry

Review

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Behavior management in Pediatric Dentistry during and after Corona pandemic

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Highlights

The current paper mainly focuses on how the things have changed and what are the specific changes that we can incorporate in our clinics so that we can make it less fearful to the children in present scenario.

The present pandemic situation has brought about significant changes within the dental clinics and their environment. Each and everything had undergone transformation that has become a "new normal".

Pediatric dentists must adopt all the required behavior management skills and be cautious about the whole procedure.

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Abstract

Children are not miniature adults. They should be treated as different entity and not just as adults who are shortened. Children have their own apprehensions and fear. The most commonly encountered is the fear of the unknown. Fear is something which is innate and inborn. Fear of dentistry is there in every individual, whether young or old. This is mostly subjective in nature. Children show exaggerated fear for dentistry as this is something new to them. The pediatric dentists are trained in behavior management for reducing fear. There have been many methods, both pharmacological and non-pharmacological for behavior management in children. The pediatric dentists were able to apply one or the other behavior management techniques till now. Sudden appearance of a pandemic caused by nCOV-2 (coronavirus) changed everything. The change in practice pattern is bound to effect all the dental patients, more so the children. Here we will discuss how the behavior management techniques will change for children and how we can get some newer methods to reduce the fear.

Keywords: Behavior Management; Coronavirus; COVID-19; Pediatric Dentistry

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INTRODUCTION

Pediatric dentists are expected to identify and effectively treat dental diseases of children that are within the knowledge and scope acquired during their professional studies. Effective and efficient treatment has to be provided to the child and for that, the parents also have to understand their roles.[1] Behavior guidance should be done and this means that inappropriate behavior has to be converted to appropriate behavior within the societal norms with the help of empathy and learning.[2] The main idea behind behavior management by pediatric dentist is to gain the confidence of the parents and the child. It's always better to know the scientific basis of implementation of any behavior management technique and also to look into cultural sensitivities, tolerance level and flexibility in a child, and the parents before applying any of these methods.[3] Children are not miniature adults. They should be treated as different entity and must be dealt with carefully. Children have their own apprehensions and fear. Behavior management should never be used as a punishment or assertiveness for a child. All the methods which are to be used to tame the child should be age and gender appropriate. The pediatric dentists have to realize the potential of the child and then try to implement any behavior management technique for that particular child. In short, it has to be customized in accordance to the child in the present scenario.[4] The present scenario has suddenly changed, with the world being affected by COVID-19.COVID-19, known as the Coronavirus Disease 19, is the viral infectious disease which rapidly developed as a pandemic. COVID-19 has an etiologic agent, i.e., severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). SARS-CoV-2 was first discovered in 2019 in Wuhan, China. Then it unfortunately spread globally, resulting in the 2019–2020 pandemic, as declared by the World Health Organization (WHO).[5] There are more than 342 millions affected and almost 10 million deaths worldwide.[6] This virus has affected all the people showing no such predilection, but elderly people and immunocompromised people are affected more severely. Most of the countries are under lockdown for more than a month, some even more. All the offices, industries, and workplaces have been closed to maintain social distancing. The healthcare professionals, especially the dentists, are at the highest risk of coming in contact with this virus when working.[7]But it has also to be seen that sooner or later the lockdowns will end, and the dentists will definitely have to start their consultations and work in a routine manner. But their routine will not be a normal routine anymore in this pandemic. The dentists have to take extra precautions, both for themselves as well as their patients and clinical staffs. The standard operating protocols have to be in place while working in the clinic so that the dentists are not infected from this virus.[8] In this scenario, the child patients will be affected more, because of the changing surroundings and clinic environment.

The impact of the current pandemic situation on children and their parents

The impact of COVID-19 on children

The children have lesser immunity and weaker awareness of self-prevention and therefore should be the main focus during this pandemic.[9] During any epidemic/pandemic, the psychological changes should be monitored for children in a proper manner. Previous studies state that children's psychological behavior is easily affected by their surroundings.[10] At this point of time, children aren't able to attend schools and meet with their peers face-to-face. Such long-term negative events affect children and they tend to react negatively. Many haphazardness occurs such as increased use of electronic gadgets, reduced learning times, and changes in sleep patterns too.[11] Apart from that, parents' stressful conditions during these times will also influence a child's behavior.[12] A Child's bad behavior can impact their overall development. A single child will have less negative behavior than multiple children in a family setting as the children only have more awareness regarding the stress caused by surrounding environment. The pandemic situation in cities is relatively more serious than rural areas increasing the bad mood of parents which in turn can result in bad behavior in children.[13]

The impact of COVID-19 on parents

In the peak of the pandemic, parents also will have serious negative emotions which can include anxiety, depression, frustration, anger, and so on.[14] The manifestations of these emotions may be revealed as excessive attention on the progression of pandemic, excessive attention to the health of themselves and their families and unreal suspicion of them being infected without any reason. In addition, parent's excessive attention on their child again will have an impact on the children's behaviour.[15] Higher education levels of parents will mean that they will have deeper understanding of the situation, which can lead to psychological panic situations and these in turn again will affect the children at home.[16]

All these scenarios have to be taken into consideration in knowing what kind of behavior we are going to experience as a child enters the clinic along with the parents.

During the COVID-19 pandemic and together with all other medical activities, routine dental work in most countries was suspended and postponed in relation to the progress of the epidemic situation, with the recommendation of limiting dental interventions to emergency situations. Hence, there is the need to be able to follow the oral health status of children only through adequate remote interaction with parents via virtual meets, 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. As far as possible, we, as pediatric dentists, should take up only emergency cases and try to defer elective cases like delays of deciduous teeth exfoliation, eruptive gingivitis and chronic periapical periodontitis which can be managed with antibiotics and analgesics. In case of emergencies, we have to advise the parents to get the child to the clinic; but we also have to make them aware of the changes in the clinic and the standard operating protocols in this current pandemic situation.

The changed clinic environment and child behavior management

Behavior management is the means by which the dental health team effectively and efficiently provides treatment and thus building a positive dental attitude.[17] The pediatric dentists are in a position to provide treatment to the children, cooperative or uncooperative with the behavior management techniques available both pharmacologically and non-pharmacologically. The present situation of COVID-19 has bound the pediatric dentists to think their behavior management strategies in a different way. The COVID-19 not only seriously threatens the physical and mental health of patients and their parents but also effects the mental health of the public.[18] The methods used prior to this pandemic will have to be modified and also newer methods have to be adopted. Here in this research, we will outline few situations which will change in a pediatric dental clinic setup and will also discuss how we can manage the anxieties and fears in children.

The pediatric dental clinic setup

The pediatric dental clinics are used to having lot of attractions which are child-specific and also for the parents to be kept engaged.[19]

The reception area

The reception section is the first space that the patients enter, so it is of great importance. The patients (and their parents too) judge and view details of the entire clinic the moment they enter the reception area. The design of this space such that it attracts the children and the parents. Now with the changed scenario due to the pandemic, the reception will have a changed look for the child as he/she enters the clinic. This is because the child has to undergo temperature checks with infrared thermometer, use of pulse oximeter for oxygen saturation as children are mostly asymptomatic, use of sanitizers, use of shoe covers along with the attire of the receptionist, who will be mostly covered up in a PPE. This itself will be an overwhelming situation for a child dental patient. The receptions will not have many decorative pieces to attract children as it can again lead to virus being settled on them.[20]

What can be done to reduce fears?

Dental practitioner should always talk on phone and have a proper telephone triage with parents or guardians to obtain all the possible information about the child patient's health status as well as oral symptoms. Being informed will make one able to understand if dental procedure represents an urgent need or it can be postponed without any harm. Also the parents have to be informed that they have to prepare their children for the situation. They can show them various videos in which the healthcare professionals have worn PPEs and are using infrared thermometers. Hence pre-appointment calls and letters will be an effective behavior management tool which will aid in reducing fear in a child. To make sure that no more than one pediatric patient and an accompanying person should wait in the pre-operative room at a time, proper dental emergency appointments must be organized.

The waiting area

The waiting areas are designed in such a way that it will keep both the children and the parents engaged while they wait for their turn. The waiting area has number of magazines for parents, comics and even color books for children. Some clinics also have aquariums to keep the children entertained. Here both the children and parents wait for their turn inside the operatory. Unfortunately the waiting area will not have these in the recent pandemic scenario. Previously the waiting areas were so lively that children became friends with other children. Simultaneously, their fears were reduced too. But now, when social distancing is the most important norm, child patients will not be allowed by their parents to mingle with other children as they will be worried about the transmission of this virus.[21]

What can be done?

This pandemic has induced bad habits when it increased almost every child's screen time. Most children are glued to televisions or smart phones. Hence, all the clinics must provide free Wi-Fi so that the children could be kept engaged while patiently waiting for their turns to come. Here the dentists can utilize some useful tricks. The television set can be made to show treatment being done on a child who is cooperative, so that the children know what to expect inside. Here the audiovisual aids will be helpful for behavior management. Another important thing to be kept in minds is to keep the waiting time as short as possible. This is again keeping in mind that attention span of children is short as well as in these pandemic times they are already irritated staying at home.[22]

The play area

The play area is an integral part in any pediatric dental clinic and an added attraction for child patients. Larger clinics (larger areas) having a lot of space use to keep lot of play items for children, e.g., slides, gaming consoles, items for paintings etc. Even for smaller clinics this was normal to keep play items in play room.[23]But again this is bound to change with social-distancing norms and to reduce the transmission of coronavirus very few items can be kept in this area. All the items have to be cleaned properly every time a child touches it so most clinics will do away with lot of play items. It must always be kept in mind that the toys provided for children may be a potential source of drastic cross-infection. It is observed that soft toys are most contaminated among all, are difficult to disinfect, and may re-contaminate rapidly when compared to toys that are hard in nature. Then there is the fear of virus settling on these items if many children play with these items; and mostly we now know that children may be asymptomatic carriers of this deadly virus.[24]

What can be done?

Always allow only one child at a time inside the play area. Be careful in sanitizing the area as soon as the child comes out and wait for some time (at least 30 minutes).Then you can allow another child to go inside the play area.

The treatment room

This is the room where the child will have a lot of fear about. The dental chair in the treatment room is a device in which the patient undergoes treatment while at the same time tolerates dental

panic and anxiety. A dental unit with a variety of instruments, such as the turbine, handpieces, suction, lamp, etc. may be extremely fear-promoting for the children, especially for those who are going to the dental office for the very first time. This room is one of the most significant parts of the clinic for a pediatric dental clinic. This room is a place where the child should not get anxious and stressed when arriving.

Therefore, it must be designed and made in such a way that the child feels comfortable. The atmosphere inside the treatment room should be cheerful and child-friendly. Dental units with pediatric designs should be replaced by the conventional units. For the distracting the children, music could be played with the help of headphones or television can be set with cartoon serials.[24]

But now with this pandemic scenario, the dentist and the dental assistant will be wearing PPEs along with face shields which can be overwhelming for the child on a first visit. The attire itself may scare the child immensely. The pediatric dentists will more often be using conventional designs of dental chair as pediatric designs might not allow them to work free with all standard protocols in place. The basic behavior management techniques of communication, tell-show-do assumes an important role in this scenario.

The pharmacological means of behavior management, i.e., nitrous oxide sedation may not be feasible in these times as they will again increase the work load on the dentist and the assistant for disinfecting the entire unit. If aerosol generating procedures (AGP) are to be done, the use of high evacuation suction is a must which again can promote fear in the child. There are suggestions to minimize the use of these tools; if this is not possible, the last appointment of the day should be intended for those patients who need dental treatments requiring the use of high-speed rotating instruments.[25] The parent may not be allowed inside the operatory to maintain social distancing and keeping in mind that all patients might be carriers of this virus. The situation might become daunting for the child and fear may increase to a greater extent.[26]

What can be done?

The most fear-promoting thing inside the operatory will be the fear from unknown as the child would have sensed the changes in the clinic setup the moment he walked in. Here it is the parents' responsibility to reassure the child about the environment. The next challenge for the child to face would be the pediatric dentist and the assistant's attires as they will be in PPEs. The PEs can be made little child friendly. The face masks can have the designs of a cartoon mouth; the face shields can also incorporate interesting designs to make them less fearful for the patient. The child has to be explained each procedure slowly. The communication (verbal and nonverbal) has to be minimized in this pandemic. It is advisable for the pediatric dentists to record and show all the procedures to the child patients on the television which can be placed inside the operatory. The parents should be allowed inside the operatory irrespective of the age of the child as most children will be emotionally unstable in these testing times where they are not allowed to play with their friends. The parents also should follow the standard operating protocol of the clinics. The parents should be given the option of general anesthesia in hospital setups if the child does not cooperate. The use of sedation in this pandemic in clinics is not much advisable. The children lacking cooperative ability can be managed with physical restraints. Furthermore, restraining devices used to control movements of pediatric patients such as Velcro Fasteners may also be contaminated and should be disinfected accordingly.[27] Thepediatric dentists also have to treat the special children under general anesthesia in hospital care with prior COVID-19 tests. Furthermore, pediatric dentists must take up all the responsibilities of safeguarding children with compromised systemic health no matter what, as these child patients areaways at greater risk of complications that may arise from any dental infection and specially-abled children (e.g., autistic pediatric patients).This is because many a times such patients' behavior may become impossible to control properly in case of severe dental pain.[28]

Discussion and Conclusions

COVID-19 has now spread throughout the world like wildfire. While there is currently no

vaccine to prevent COVID-19, doctors and researchers are learning more about it every day. Symptoms of COVID-19 range from mild to severe. These generally begin 2–14 days after being exposed to the virus and often include coughing and shortness of breath. At least two of these symptoms can also suggest a person has COVID-19 such as follows: fever, chills, repeated shaking with chills, muscle pain, headache, sore throat, and a new loss of taste or smell.[29] Early research suggests that fewer children than adults with COVID-19 get a fever, coughing, or shortness of breath. It is also observed that some children attacked with COVID-19 had to be hospitalized as well. However, severe illness has been reported in children, most often in infants less than a year.[30] In the recent times, the outbreak of the coronavirus in dentistry is one of the greatest challenges that the many of the parents are facing. The pandemic caused due to Coronavirus seems to have a major impact on the parents. If there is a need for the emergency dental treatment, they prefer to stay at home and use a home remedy or give pain killers to relieve children's dental pain instead of referring to dental offices or clinics.[31] However, with the application of standard precautions and protocols consistently; there is not much to be afraid of. Before the pediatric dentist can start practicing, they should be aware of the local guidelines of their states and countries. Healthcare updates are changing at a rapid pace, and it's really confusing and alarming to start practice normally. The dentists and the attendants in the clinic should be aware of standard operating protocols. Initially the preference should be given to those children who have dental emergencies. The next preference is to be given for preventive protocols like pit and fissure sealants, silver diamine fluoride application, fluorides, Hall Technique, atraumatic restorative treatment.[32,33,34] All these are non-AGP. The role of parents during these times for behavior management will be more as they are spending more time with their children; thus they can understand the psychology of the child better than the pediatric dentists. The pediatric dentists now have to be more dependent on technology. The first consultation and communication with the child must be made virtually so that the child becomes acquainted with the pediatric dentist. Here the pediatric dentist can give them oral hygiene ,hand hygiene, sneeze etiquettes, and also tell them a little about this viral disease including the changes he/she will witness in the clinic. All these have to re-enforced by the parents until the time arrives for visiting the clinic again. The pandemic has and will continue to change the way pediatric dentists practice. It becomes essential that in these testing times, we do not leave our little patients to suffer. The ongoing COVID-19 spread is a public health emergency and global threat. Governments all around the world have ordered citizens to stay at home as an emergency measure and implemented school closures to prevent further spread of the infection. More than 250 million children and adolescents in 165 countries are affected by the closures.[35] Under such situations, physical and mental health problems are significant concerns. Particularly, children and adolescents' lifestyle behaviors, such as physical activity and sedentary behavior, may have been drastically impacted due to the prolonged school closures and home confinement during the COVID-19 pandemic.[36] This has led to an increased negative behavior being observed in children trapped in their homes. Pediatric dentists have to keep in view the situation and manage the children accordingly.[37]

The COVID-19 has changed the way we used to practice with our little patients; but we, as pediatric dentists, have to overcome the barriers and give the best possible treatment to them while maintaining all the protocols. Till now no published data has given any importance to the behavior and the behavior management techniques to be followed by pediatric dentists.

The pediatric dentists should keep in mind the complete mental picture of the child before undertaking any treatment in this pandemic. As mentioned previously, preventive measures against COVID-19 in dental practice mostly include clinical or telephonic triage supported by an elaborate questionnaire on the present movements and symptoms, oral rinses with 1% hydrogen peroxide, body temperature measurement, and the use of specific PPEs.[38,39] It must be made sure that preventive measures are properly employed for child patients as much as possible. Along with parents and dental staffs in the clinic, the behavioral changes which have

been identified in children have to be managed with appropriate management skills. In this process, the parents can be of great help. Moreover, they have to be informed over telephone. Some points are as follows:[40,41]

1) They must be creative in their home-based fun activities. They must know how to encourage and support their children to be active in innovative but safe ways. Suggestions include trying new leisure hobbies, co-participation in activities, using online physical and health activity apps, and, last but not least, getting outdoors more frequently (while maintaining proper public safety advises).

2) Parents must be responsible in setting routines for their children, including regular sleeping and waking times, supervised time for screens, and proper time for quality family moments.

Children facing unexpected events usually exhibit various stress reactions, as confirmed in the study performed in China during the COVID-19 epidemic. [42] Resilience, the personal attributes that help children manage everything from little disappointments to big life traumas, should be nurtured and implemented by public health programs in children. This should be properly supported by healthcare personnel, families, and friends—so that they can easily overcome these stresses.

In helping the child psychologically, these small but effective approaches definitely come in handy. It will be much easier for us to manage the children in the clinics once they are emotionally strong enough to understand the present scenario.

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Original Research

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Assessment of trait and state anxiety in 3-6-year old children during sequential phases of dental treatment

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Highlights

- Dental anxiety influences children's behavior in the operatory. An introductory dental visit is important for children, parents and the dental team.
- Recording a child's anxiety and behavior during successive appointments can assist in behavior management.
- Scheduling initial appointments for preventive procedures reduces children's anxiety and gains their cooperation at future dental visits.

Abstract

Aim: To assess changes in trait and state anxiety of children during sequential phases of dental treatment. **Methods:** Three hundred children, aged between 3 to < 6 years, who reported for their first dental visit were included. Both parents and children were evaluated over five sequential phases of dental treatment. Children's Fear Survey Schedule-Dental Subscale (CFSS-DS) and Modified Dental Anxiety Scale (MDAS) were used to assess child's trait anxiety. Children's Emotional Manifestation Scale (CEMS) and Facial Image Scale (FIS) were used to assess child's state anxiety. Child's behavior was rated using Frankl's Behavior Rating Scale (FBRS). Paired sample t-test, Pearson's Correlation coefficient and Spearman's Rank Correlation coefficient was performed. **Results:** Mean CFSS-DS and CEMS scores decreased significantly from the first (26.55; 10.25) to the fifth visit (24.74; 8.1) ($p<0.05$). A significant decrease in the mean FIS (state anxiety) score from the first (2.70) to fifth (2.48) visit was seen ($p<0.05$) Children's behavior differed significantly between the dental visits.($p<0.001$) There was a significant inverse correlation between behavior and both trait and state anxiety ($p<0.05$). **Conclusions:** Sequential phases of dental treatment significantly reduced trait and state anxiety.

Keywords: Behavior Rating Scale; Child; Dental Anxiety; Dental Care

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INTRODUCTION

Pediatric dentists frequently experience anxiety and fear-related responses among children. Dental fear and anxiety are main reasons for avoiding dentists. They represent different progressive degrees of the same psychological condition.[1] Anxiety is defined as a nonspecific feeling of apprehension towards a concrete situation that does not necessarily require previous experience, and is not proportional to the response that is triggered in the individual.[2] It is not attached to an object; rather it is a generalized response to an unknown threat or internal conflict and is associated with more abnormal conditions.[3] Dental anxiety denotes a state of apprehension that something dreadful would happen in relation to dental treatment, coupled with a sense of losing control.[4]

Most dentists readily recognize children with disruptive behavior during dental treatment, whereas dental fear and anxiety (DFA) may be more subtle. It is therefore necessary to assess dental anxiety at initial appointments, so that the dental team can adequately prepare children for a positive treatment experience. There are three methods to measure dental anxiety: (a) "behavioral assessment", in which the dental team rates both emotional and behavioral reactions shown by children during treatment; (b) "psychometric assessment" in which children or one of their parents complete a questionnaire, usually prior to treatment and; (c) "physiological response analysis" in which variations of parameters linked to anxiety are measured.[5] Psychometric assessment is the most common and easy method to measure childhood and adolescent DFA.[5] Pediatric dentists should select appropriate behavior management interventions in order to minimize DFA and help children develop a positive attitude towards dental health and treatment.[6]

Dental treatment frequently involves restorative and invasive procedures that are scheduled over several visits. A gradual exposure to the dental environment and to dental procedures has been shown to successfully minimize dental anxiety in children.[7-9] The reasons for dental anxiety cannot be solely attributed to the dental setting. Other personality traits can play a fundamental role in the onset of dental anxiety. These include general anxiety, mood, temperament, emotional status, parental dental fear and family social status. [1,10] Two distinct anxiety factors have been identified and labeled as state anxiety and trait anxiety. State anxiety is a transitory emotional condition in response to a perceived threat. However, trait anxiety is interpreted as measuring stable differences between individuals in their response to an anticipated threat. Trait anxiety is a relatively permanent personality characteristic.[11] It is important to differentiate a state condition (dental anxiety) from perception of fear (generalized anxiety or trait anxiety).[3]

Studies to assess dental anxiety among children have considered general anxiety itself as dental anxiety.[12-14] However, individual assessment of trait and state anxiety is lacking. Evaluation of children's anxiety and behavior at successive dental visits during different dental procedures could be useful to the dental practitioner. Therefore, the present prospective longitudinal study was carried out to determine whether gradual exposure of children to the dental environment would reduce their levels of state and trait anxiety.

METHODS

The present prospective longitudinal study was carried out at the Department of Pedodontics and Preventive Dentistry. The ethical standards of experiments of this study were in accordance with the guidelines provided by World Medical Association Declaration of Helsinki on Ethical Principles for Medical Research. Ethical clearance to conduct the study was obtained from institutional ethical review board

[Ref.No.430/2015-16]. Prior to the study, nature of the study was explained to the parents and their written consent was taken for participation of both parents and children in the study. The sample size was estimated using the following formula:

$$n = \frac{[Z_{\alpha/2} + Z_{1-\beta}]^2}{d^2}$$

where n = estimated sample size, $Z_{\alpha/2}$ = 1.96 (for 5% significance level), $Z_{1-\beta}$ = 1.28 (for 90% power), d = 0.2 (minimum detectable difference). Therefore n =262 (rounded off to 300).

Three hundred children, aged between three to six years, who reported for their first dental visit were selected for the study. Only those children who had never accompanied their parent or any other family members to a dental clinic were included. Children exhibiting high anxiety due to medical or psychological factors were excluded. Children requiring to be treated under general anesthesia were not included. Children with special health care needs or requiring emergency treatment and extraction of teeth were excluded from the study.

The relationship between socio economic status and child's behavior has been well documented.[9,14] Socio demographic details were recorded during the first visit. All the children belonged to the upper middle class according to the Kuppuswamy's Socioeconomic Status Scale.[15] Treatment that required multiple visits necessitated the patients to attend the dental clinic for five sequential phases of dental treatment. The five sequential phases of dental treatment were as follows: 1) Introductory phase- Children were introduced to the dental chair and no operatory procedure was carried out; 2) Preventive phase - Preventive procedures including oral prophylaxis, pit and fissure sealants and fluoride application were carried out; 3) Restorative phase- Teeth were restored using glass ionomer cement and composite was done; 4) Invasive phase- Treatment that required administration of local anesthesia, including extraction and pulp therapy; 5) Recall phase- Patients were recalled within one week following the invasive phase. First to third visits were considered as 'non-invasive' phases, and the fourth visit was considered as 'invasive'.

On the first visit, parents were asked to give their response regarding their child's fear in the reception area using the parental version of Children's Fear Survey Schedule – Dental Subscale (CFSS-DS).[16] Parents answered the same questions instead of their children in the way how they assume that the children would feel in that situation.

Fifteen items that were related to the treatment and dental setting were answered by parents. Each item was scored on a 5-point response scale ranging from 1 (not afraid at all) to 5 (very afraid). The total score thus obtained fell within a range of 15 to 75 points. Scores equal to or over 45 points indicated higher levels of trait anxiety. Similarly, child's perception regarding his own trait anxiety was assessed using Modified Dental Anxiety Scale (MDAS).[17] It is a brief questionnaire consisting of five questions, which were answered with the help of the parent if the child was very young, or by the child if he or she was able to comprehend. Each item was scored on a 5-point response scale ranging from 1 (not anxious) to 5 (extremely anxious). The total score thus obtained fell within a range of 5 to 25 points. Trait anxiety was assessed on the day of the dental visit and was done before carrying out the dental procedure.

During the dental procedure, the child's state anxiety was assessed by the dentist (investigator) using Children's Emotional Manifestation Scale (CEMS).[18] It consists of five categories that are valid indicators of children's emotional behavior: facial expression, vocalization, activity, interaction and level of cooperation. Each category has five levels of intensity and is scored from 1 to 5. Thus,

on addition of scores in each category, the total ranged from 5 (positive emotional behavior) to 25 (negative emotional behavior). Higher scores indicated the manifestation of more negative emotional behavior. Facial Image Scale (FIS) was used to assess child's state anxiety during the dental procedure.[19] This scale uses faces as an indicator of children's dental anxiety and includes one item with a response set of five faces, ranging from a very happy face at one end to a very unhappy face at the other end. Children were asked to indicate which of the faces they felt most associated with at that moment.Behavior of the child during the dental procedure was rated using Frankl - Behavior Rating Scale.[20] The scale divides observed behavior into four categories, ranging from Rating 1: definitely negative, Rating 2: Negative, Rating 3: positive and Rating 4: definitely positive. Since it has four categorizations, numerical values can be assigned to the observed behavior.[20] The proportion of children showing Frankl behavior rating was calculated at different appointments. The children's behavior was considered to be either negative (ratings 1 and 2) or positive (ratings 3 and 4).Following assessment of trait anxiety, the child was taken into the dental operatory for clinical examination and if indicated, radiographs were taken. No treatment was carried out on this first dental visit. Parents were then presented with a dental treatment plan for their child and the procedures to be carried out at the subsequent visits was briefly explained, beginning with preventive procedures, followed by restorative work and finally the procedures involving administration of local anesthesia. At the end of each visit, the parent was told of the procedure to be carried out at the next appointment.

Further, four sequential appointments were scheduled with an interval of 4-6 days between each appointment, for various phases of dental treatment. Anxiety (trait and state) and behavior were assessed at each of the dental visits in a similar manner. During the treatment procedures, the child was guided using communication and tell-show-do technique. Restoration of occlusal caries involving outer and middle third of dentin (d1 and d2 lesions, respectively)[21] that did not require to be done under local anesthetic administration were initially carried out. For caries involving the inner third of dentin (d3 lesions)[21], local anesthetic was administered only if the parent of the child requested for it. The supraperiosteal (local infiltration) technique and/ or inferior alveolar nerve block was administered as indicated for extraction and pulp therapy in the upper and /or lower primary teeth.[22]

Statistical Analysis

Paired sample T-test was applied to compare the difference in the anxiety (CFSS-DS, MDAS and CEMS) levels relative to the dental visits. Chi square test was used to compare the FBRS at different dental visits. Wilcoxon Matched Pairs test was used to assess the same for state anxiety (FIS) and behavior (FBRS) levels, respectively. Karl Pearson Coefficient of Correlation was used to assess the correlation between trait (child and parent) and state (child and dentist) anxiety levels individually at different dental visits. Spearman Rank Correlation Coefficient test was used to find out the correlation between anxiety and behavior of the child. Data obtained was tabulated and subjected to statistical analysis using Statistical Package for Social Sciences [SPSS] for Windows (version 22.0 Released 2013, Armonk, New York, IBM Corp.). Level of significance was considered to be 5% ($p<0.05$).

RESULTS

The perception of child's trait anxiety (CFSS-DS) was found to have a highest mean score of 26.55±12.52 at the first dental visit and the child's own perception of trait anxiety (MDAS) mean score was highest at the restorative phase (11.70±4.44). The lowest mean MDAS score was observed at the recall phase (10.51±5.01)(Table1).

Table 1. Mean trait anxiety and state anxiety scores at different dental visits

Dental visit	Trait Anxiety		State Anxiety	
	CFSS-DS Mean ± SD	MDAS Mean ± SD	CEMS Mean ± SD	FIS Mean ± SD
Introductory	26.55± 12.52	11.15± 5.02	10.25± 4.56	2.70± 0.91
Preventive	26.13± 11.59	11.18± 3.97	11.10± 4.25	2.72± 0.87
Restorative	25.35± 10.97	11.70± 4.44	11.35± 4.16	2.81± 0.79
Invasive	25.99± 11.75	11.63± 4.38	13.95± 4.48	2.96± 0.90
Recall	24.74± 12.65	10.51± 5.01	8.10± 3.03	2.48± 0.84

The mean CEMS score (state anxiety) was highest at the invasive phase (13.95±4.48) and was lowest at the recall phase (8.10±3.03). The state anxiety projected by the child during the dental treatment showed a highest mean FIS score of 2.96±0.90 at the invasive phase, which gradually decreased to 2.48±0.84 at the recall phase (Table 1).

A significantly higher proportion of children (>70%) showed positive behavior at the introductory and preventive dental visits. There was a 10% reduction in children who showed positive behavior at the restorative visit. Whereas, negative behavior was seen in a higher number of children during the 4th visit (invasive). At the 5th (recall) visit, nearly 99% of children showed positive behavior. Overall, a significant difference was observed in behavior of the children between dental visits ($p<0.001$) (Tables 2a & 2b).

Table 2a: Proportion of children showing positive ratings and negative ratings according to Frankl behavior rating scale

Dental visit	No. of children with positive behavior		Chi-square	p value	No. of children with negative behavior		Chi square	p value
	Rating				Rating			
	+3 n (%)	++4 n(%)			-1 n(%)	--2 n(%)		
Introductory	59 (19.67)	162 (54)			63	16		
Preventive	26 (8.67)	188 (62.67)			71	15		
Restorative	17 (5.67)	171 (57)	103.856	<0.001*	98	14	12.881	<0.011*
Invasive	1 (0.33)	91 (30.33)			148	60		
Recall	113 (37.67)	183 (61)			3	1		

*statistically significant values (p-value <0.05)

Table 2b: Proportion of children showing positive and negative behavior according to Frankl behavior rating scale

	Children with positive behavior Rating + and ++		Children with negative behavior Rating - and - -		Chi square	p value
Dental visit	N	%	N	%		
Introductory	221	73.67	79	26.33	328.242	<0.001*
Preventive	214	71.33	86	28.67		
Restorative	188	62.67	112	37.33		
Invasive	92	30.67	208	69.33		
Recall	296	98.67	4	1.33		

*statistically significant values (p-value <0.05)

On comparison of trait anxiety observed at different visits, the mean CFSS-DS score at recall phase was found to be significantly lower than the first and fourth visits (p<0.05). The child's trait anxiety (MDAS score) was significantly lower during the preventive phase in comparison to that of the restorative phase (p=0.019) and invasive phase (p=0.045). At the recall visit, it was significantly lower than that observed during the 2nd, 3rd and 4th visits (p<0.05) (Table 3).

The mean CEMS score (state anxiety) at the fourth visit (invasive phase) was found to be significantly higher than that of the previous visits (p<0.05). It was lowest at the recall phase (p=0.0001) (Table 4).

Table 3: Comparison of trait anxiety between dental visits

Dental visit		Trait anxiety			
		CFSS-DS		MDAS	
		Paired t	p value	Paired t	p value
1st Introductory	2nd	0.7464	0.4560	-0.1171	0.9068
	3rd	1.8634	0.0634	-1.8922	0.0594
	4th	0.7639	0.4455	-1.5517	0.1218
	5th Recall	2.0515	0.0411*	1.7225	0.0860
2nd Preventive	3rd	1.6357	0.1029	-2.3659	0.0186*
	4th	0.2409	0.8098	-2.0150	0.0448*
	5th	1.9189	0.0559	2.1847	0.0297*
3rd Restorative	4th	-1.4429	0.1501	0.2999	0.7644
	5th	1.0992	0.2725	4.0600	0.0001*
4th Invasive	5th	2.1934	0.0290*	4.3013	0.0001*

*statistically significant values (p-value <0.05)

Table 4. Comparison of state anxiety between dental visits

Dental visit		CEMS	
		Paired t	p value
1st Introductory	2nd	-3.9238	0.0001*
	3rd	-4.0481	0.0001*
	4th	-10.6107	0.0001*
	5th Recall	8.165	0.0001*
2nd Preventive	3rd	-1.1682	0.2437
	4th	-9.2891	0.0001*
	5th	11.8842	0.0001*
3rd Restorative	4th	-9.3113	0.0001*
	5th	12.8924	0.0001*
4th Invasive	5th	21.9210	0.0001*

*statistically significant values (p-value <0.05)

The mean FIS score at the fourth visit (invasive phase) was found to be significantly higher than that of the previous visits ($p<0.05$). At both introductory and recall visits, the mean FBRS score was significantly higher than that of the other visits ($p<0.05$) (Table 5). There was a significant correlation between CFSS-DS and MDAS at all the visits ($p<0.05$). Also, a significant correlation was also observed between CEMS and FIS at all the visits ($p<0.05$) (Table 6).

Table 5: Comparison of state anxiety and behavior between dental visits using Wilcoxon Matched Pairs test

Dental visit		State anxiety FIS		Behavior FBRS	
		Z-value	p value	Z-value	p value
1st Introductory	2nd	0.1470	0.8831	2.8402	0.0045*
	3rd	1.7727	0.0763	4.3155	0.0001*
	4th	3.6103	0.0003*	9.6749	0.0001*
	5th Recall	2.8277	0.0047*	8.3502	0.0001*
2nd Preventive	3rd	1.4911	0.1360	2.4926	0.0127*
	4th	3.5870	0.0003*	8.7229	0.0001*
	5th	3.4769	0.0005*	10.2011	0.0001*
3rd Restorative	4th	2.3347	0.0196*	7.9821	0.0001*
	5th	5.0855	0.0001*	11.0252	0.0001*
4th Invasive	5th	7.2759	0.0001*	13.7272	0.0001*

*statistically significant values (p-value <0.05)

Table 6. Correlation between scales used to assess trait anxiety and state anxiety

Dental visit	Trait anxiety CFSS-DS and MDAS		State anxiety CEMS and FIS	
	r value	p value	r value	p value
Introductory	0.5438	0.0001*	0.3765	0.0001*
Preventive	0.5378	0.0001*	0.3844	0.0001*
Restorative	0.4809	0.0001*	0.3080	0.0001*
Invasive	0.5099	0.0001*	0.3320	0.0001*
Recall	0.5050	0.0001*	0.1942	0.0007*

*statistically significant values (p-value <0.05)

Spearman's rank correlation coefficient showed a significant inverse correlation between child's behavior and both trait and state anxiety at each of the dental visits ($p<0.05$). Trait anxiety and FIS showed a weak inverse correlation with FBRS. A strong inverse correlation was observed only between CEMS and FBRS (Tables 7 and 8).

Table 7:Correlation of behavior (FBRS) with trait anxiety

Dental visit	CFSS-DS and FBRS		MDAS and FBRS	
	rho value	p value	rho value	p value
Introductory	-0.434	0.0001*	-0.440	0.0001*
Preventive	-0.476	0.0001*	-0.449	0.0001*
Restorative	-0.307	0.0001*	-0.297	0.0001*
Invasive	-0.242	0.0001*	-0.250	0.0001*
Recall	-0.135	0.0196*	-0.221	0.0001*

*statistically significant values (p-value <0.05)

Table 8: Correlation of behavior (FBRS) with state anxiety

Dental visit	CEMS and FBRS		FIS and FBRS	
	rho value	p value	rho value	p value
Introductory	-0.797	0.0001*	-0.466	0.0001*
Preventive	-0.729	0.0001*	-0.329	0.0001*
Restorative	-0.663	0.0001*	-0.312	0.0001*
Invasive	-0.726	0.0001*	-0.293	0.0001*
Recall	-0.737	0.0001*	-0.174	0.0025*

*statistically significant values (p-value <0.05)

DISCUSSION

General anxiety which includes dental anxiety could be the reason for increased anxiety expressed by children to their parents prior to a dental visit. According to the "Latent Inhibition" theory, children tend to become less anxious if they have had more neutral visits (e.g., check-up, cleaning) before exposure to invasive dental treatments (e.g., restorations, extractions).[10,23] Therefore, this study was conducted, to assess how acquired experiences can influence dental anxiety and behavior in a child, when various phases of dental treatment are carried out in a sequential manner.

The most frequently used measuring instrument for determination of dental fear and anxiety in children is the CFSS-DS.[24,25] This scale has a high reliability, a simple and fast application, and represents a cost-effective way for evaluation. In younger children who cannot read or answer a questionnaire, it is necessary to rely on a proxy report, preferably given by their parents. In most studies, parental version of CFSS-DS has been used to assess dental fear in young children and has shown satisfactory reliability and validity.[25]

In the present study, a second scale (MDAS) was also used to measure trait anxiety prior to the procedure. MDAS has reasonable psychometric properties, low instrumental effects and can be integrated into dental practice as a clinical tool to screen for dental anxiety.[26] Trait anxiety (MDAS) was seen to increase for procedures requiring administration of local anesthesia. However, on completion of the treatment procedure at the end of each visit, the children appeared to be more relaxed and the same could have been conveyed to their parents. Therefore, the trait anxiety was seen to reduce prior to each of the successive visits, and was significantly less at the fifth appointment (recall visit). Successive dental appointments following an initial introductory visit, could have allowed parents and their children to prepare for and respond to subsequent stressful dental procedures. This is in

accordance with previous studies [7,8,23] that have recommended the need for scheduling invasive treatment procedures at latter appointments.

Age, general fears and maternal dental fear, have been found to have a significant impact on the variance of CFSS-DS.[27] Majority of parents of younger children are reasonably able to rate their child's dental fear accurately. However, parents tend to estimate the dental fear of their children slightly higher than their children.[24] In the present study, a significant correlation was observed between MDAS and the parental rating (CFSS-DS).

Familiarization with the dental environment and treatment provided has been shown to decrease negative behavior in children.[7] In this study, state anxiety was highest during the administration of local anesthesia and significantly reduced at the recall visit. At each visit, the children's behavioral response was seen to change and was influenced by the treatment procedure that was carried out. A child's response to stressful procedures can be varied. The emotional responses of children in the dental operatory need to be understood as a multidimensional phenomenon with behavioral, subjective, and physiological components.[28] The CEMS scale used in this study is an objective tool to document children's emotional responses during stressful medical procedures.[18] It is known to have a relationship with the projective technique (FIS).[29] Therefore, at each dental visit, direct observation of child's behavioral response by the investigator was found to be consistent with that of the child's choices on the Facial Image Scale (FIS). The FIS is a valid means of assessing child dental anxiety status in a clinical context.

The Frankl behavior rating scale is a functional notation method that is quantifiable, reliable and communicates patient's behavioral information in some way.[30] In this study, behavior of the children was seen to change according to the procedures performed at each dental visit.

Negative behavior was seen in a significantly higher proportion of children only during procedures involving administration of local anesthesia. It reflected the trait and state anxiety levels as assessed by the parent, child and the investigator. The investigator's rating of state anxiety (CEMS) was strongly associated with the child's behavior at all dental visits. It may be because the CEMS is an objective tool that accurately assesses the child's emotions towards various dental procedures.[18] In this age group of children, trait anxiety may be influenced by their general fears and their inability to distinguish it from dental fears.[27] Although a behavioral rating scale does not have a prognostic value, it records the child's actual performance during a dental procedure. Therefore, it prepares a clinician for the child's behavior on future visits and to guide the behavior during treatment.[30]

In the present study, physiological parameters of the children were not recorded. The timing of dental appointments was not the same for all children and it could have influenced the outcome of the study. The effect of different non-pharmacological management techniques including distraction therapy on anxiety levels and behavior in children could be investigated. Anxious parents tend to estimate the dental fear of their children significantly higher than non-anxious parents.[24] Maternal dental fears were not assessed in this study. Further, all clinicians do not perceive behavior in precisely the same manner and they tolerate children's behavior differently.[30]

The results of this study indicate the need for assessment of trait and state anxiety of a child by both parents and the dental team in order to predict the child's behavioral response and apply appropriate behavior management techniques. Based on this study, only an introductory visit for parents and children is not able to reduce dental anxiety in young children. Scheduling successive

appointments to perform dental treatment from relatively painless to more invasive procedures can improve a child's behavior in the dental office.

CONCLUSIONS

Trait anxiety (CFSS-DS and MDAS) and state anxiety (CEMS and FIS) of children were related to their behavior. Sequential phases of dental treatment reduced trait and state anxiety in 3 to 6-year-old children and resulted in their cooperative behavior. An introductory dental visit is important for children and parents. Recording a child's anxiety and behavior during successive appointments can assist the dental team in behavior management.

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Original Research
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Comparison of two vital pulp therapies in β-Thalassemic children

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Highlights

- This study compared two vital pulp therapy techniques: mineral trioxide aggregate pulpotomy and indirect pulp capping in children with β-thalassemia major who cannot withstand the stress of the dental chair for long.
- Both techniques had high success rates with no statistically significant difference between them. However, patient satisfaction was higher with indirect pulp capping than pulpotomy.
- Both types of vital pulp therapies may be applied to β-thalassemic children with higher success rate.

Abstract

Aim: Beta-thalassemia (β-thalassemia) major is one of the most common inherited genetic blood disorders and is characterized by many systemic manifestations and skeletal problems. Children with β-thalassemia have a high caries index and must receive proper dental treatment to achieve better oral health. The aim of study is to compare two types of vital pulp therapies in children with β-thalassemia major. **Methods:** Sixty-five children with β-thalassemia major having carious primary molars were selected from the Hereditary Blood Disorders Clinic at the National Research Centre to be treated at Ain Shams University and Oro-dental Genetics Department, National Research Centre. Patients received one of both types of vital pulp therapies: mineral trioxide aggregate (MTA) pulpotomy and indirect pulp capping. The children were divided into two groups as follow: Group I (n=30) received MTA pulpotomy and Group II (n=35) received indirect pulp capping using high viscosity glass ionomer cement. Clinical and radiographic follow-ups were done at the baseline, six months, and after one year. Patient preferences for types of vital pulp therapies were evaluated at the end of treatment. Comparison of the groups with qualitative data was done using Chi-square test. Comparison of the groups with quantitative data and a parametric distribution was done using an independent t-test at significance level 0.05. **Results:** The findings revealed success rates of 90% in Group I and 100% in Group II. There was 10% clinical and radiographic failure in Group I and 0% in Group II but the difference between the two groups when compared to each other was statistically not significant (p= 0.055). **Conclusions:** Both types of vital pulp therapies showed high success rates in children with β-thalassemia major and thus can be used safely in these patients. However, minimally invasive types of dental treatment may be preferred in children with β-thalassemia major as indirect pulp capping for being less invasive and requires less effort, fatigue and time.

Keywords: Calcium Silicate; Dental Pulp Capping; Pulpotomy; Thalassemia

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INTRODUCTION

Thalassemia is a single gene disorder that is caused by any of more than 200 mutations that affect beta-globin gene expression within the hemoglobin molecule, and it is one of the most common forms of congenital hemolytic anemia manifesting just after the first few months of life.[1] It is usually characterized by an overall reduction in hemoglobin synthesis with ineffective erythropoiesis and hemolysis of mature cells and a massive decrease in mature red blood cell production. Ineffective erythropoiesis leads to skeletal and non-skeletal manifestations[2,3] with extramedullary hematopoiesis and extreme expansion of marrow spaces in the long bones, spine, skull, ribs and facial bones[2-4] resulting in the characteristic oro-facial features of prominent maxilla, retruded mandible, class II malocclusion, wide overjet and deep overbite leading to the so-called chipmunk facies.[5,6]

Caries index is high in β-thalassemia major children and their oral health is poor as low priority is given to their oral health which in turn leads to further deterioration of systemic health due to poor masticatory function and the inability to eat and chew food properly.[7] Poor oral health also affects the quality of life of children with β-thalassemia major. They experience mental fatigue, and decreased self-esteem, learning and social relationships.[8-11] Over the past 20 years, the medical management of β-thalassemia major patients has improved enough to expect almost normal life expectancy, so the provision of integral rather than palliative dental treatment should be considered[12]. Many studies[4-7] have described the prevalence, orofacial features and caries prevalence in children with β-thalassemia major but few have evaluated success and failure of dental intervention or compared types of dental interventions in these patients.

The null hypothesis of this study was that there is no difference in the success rate between MTA pulpotomy and indirect pulp capping in children with β-thalassemia major. The aim of the study was to compare between both types of vital pulp therapy in these children.

METHODS

Study Design and Ethics

Ethics approval was obtained from the Ethical Committee of the Faculty of Dentistry, Ain Shams University and Medical Research Ethics Committee of the National Research Centre. The proposal has the ethical approval ID number (PED)-17-3D meeting ID 68 at Faculty of Dentistry, Ain Shams University. Informed consent and assent were obtained from all patients and their parents. This randomized clinical trial study adhered to the Consolidated Standards of Reporting Trials (CONSORT) guidelines. The confidentiality of all data was preserved.

Power analysis was designed to have adequate power to apply a two-sided statistical test of the null hypothesis that there is no difference between the tested groups. By adopting an alpha level of (0.05) a beta of (0.2) i.e., power=80% and an effect size (h) of (0.746) the predicted sample size (n) was a total of 60. Sample size calculation was performed using G*Power version 3.1.9.7. Therefore, sixty-five children with β-thalassemia major with having carious primary molars were randomly selected. Randomization was done using statistical analysis software (SPSS, Inc.; Chicago, IL) where patients were assigned to a number starting from (1) to (65) and randomly allocated to the studied groups (i.e. 30 in group (I) and 35 in group (II)) following a simple randomization procedure.

Medical history and medical consultation from the hematologist before treatment, proper coagulation profile (bleeding time) and hemoglobin levels were checked before starting any dental procedure. In children receiving blood transfusions, the dental treatment was carried out after 2-3 weeks of blood transfusion (when blood test results were optimal). Dental histories were also taken before treatment. Clinical photographs and periapical radiographs (Skydent, E-speed film, 2×3cm, size 0, 7/8×1 3/8 in) using the paralleling technique were also taken prior to and after treatment. Eligibility criteria of patients were as follows: (i) Children with β-thalassemia majör, (ii) age range of 4-7 years, (iii) clinically fit and well to receive dental treatment (with optimum blood test

results), (iv) no associated or other superimposed systemic disorders.

Inclusion criteria

The inclusion and exclusion criteria were based on the American Academy of Pediatric Dentistry (AAPD) guidelines for vital pulp therapy in primary and young permanent teeth.[13]

*Clinical inclusion criteria were as follow: (i) d*eep carious teeth, (ii) teeth diagnosed from clinical history as reversible pulpitis, (iii) absence of soft tissue swellings, (iv) absence of sinus or fistula, (v) restorable with filling or crown.

*Radiographic inclusion criteria were as follow: (i) a*bsence of periapical or furcation involvement, (ii) absence of widening of periodontal ligament space, (iii) no internal or external resorption.

*Exclusion criteria of teeth were as follow: (i) n*on-vital teeth, (ii) symtomatic teeth with preoperative spontaneous pain, (iii) persistent pain and bleeding after hemostasis in cases of selected teeth for pulpotomy, (iv) children who could not continue the treatment or follow up.

All the dental procedures were carried out using a rubber dam (Sanctuary Dental Dam, medium, 5"×5", plain blue, Malaysia) to guarantee the success of vital pulp therapy following the American Academy of Endodontists.[14] The children (patients) were divided into two groups: Group I (n=30) received mineral trioxide aggregate pulpotomy (MTA plus, Cerkamed, Stalowa Wola, Poland) and Group II (n=35) received indirect pulp capping (IPC) with high viscosity glass ionomer cement (Equia fil, GC, Tokyo, Japan)

Study Protocol

Group I: MTA pulpotomy

Preoperative clinical photos and radiographs were taken prior to treatment and local anesthesia was administered. Rubber dam (Sanctuary Dental Dam, medium, 5×5, plain blue, Malaysia) was placed for isolation and moisture control. Caries removal and de-roofing of the pulp chamber was done using round diamond burs (W&H Diamond Burs, Australia). Bleeding was stopped using cotton pellets until there was no bleeding form the orifices of the pulp chamber. On a sterile glass slab, the contents of one bottle of MTA (MTA plus, plus, Cerkamed, Stalowa Wola, Poland) and one drop of distilled water were applied with a standard powder to distilled water ratio 3:1 as per manufacturer's instructions. A spatula was used to mix MTA as the powder and distilled water were mixed for 30 seconds to achieve a homogeneous consistency similar to wet sand. The mixture was then applied with an amalgam carrier and condensed to the cavity with a suitable sized condenser. The cavity was finally sealed with a final restoration as stainless steel crowns.

Group II: Indirect pulp capping

Preoperative clinical photos and radiographs were taken prior to treatment and local anesthesia was administered. Rubber dam was placed for isolation and moisture control. Selective dentin caries removal was conducted, removing infected dentin from the pulp wall and total removal from the surrounding walls using excavator (Zeffiro #1, stainless steel excavator, Lascod, Italy) compatible with cavity size. Preconditioning of the surface with polyacrylic acid (Dentin Conditioner, GC corporation, Tokyo Japan) for ten seconds followed by washing and drying of the cavity. High viscosity glass ionomer cement (Equea; GC, Tokyo, Japan) was used and mixed according to manufacturer's instructions and then inserted into the cavity. Superficial protection of the restoration with a coat (Equia coat, GC corporation, Tokyo, Japan) that was cured for ten seconds for surface protection of the restoration

Clinical and radiographic follow ups were done at baseline and after 6 months and after one year. The clinical and radiographic evaluation criteria complied with the guidelines of the AAPD on vital pulp therapy in primary and young permanent teeth[13] and the timing of the radiographic follow up complied with the guidelines of the AAPD on radiographic prescription for children, adolescents and individuals with special health care needs[15] where failure is satisfying the criteria and success is not.

Clinical Successful Evaluation Criteria

Clinical success criteria included: asymptomatic teeth (absence of pain), absence of soft tissue swelling, absence of sinus or fistula and absence of tooth mobility.

Radiographic Successful Evaluation Criteria

Radiographic success criteria included: the absence of periapical or furcation involvement,

the absence of widening of periodontal ligament space, and the absence of internal or external resorption. At the end of the study, the patients who had received both types of treatment were selected to provide their preferences of treatment type.

Statistical Analysis

Data were collected, revised, coded and entered into the Statistical Package for Social Science (SPSS, Inc.; Chicago, IL) version 23. The quantitative data were presented as mean, standard deviations and ranges when parametric and qualitative variables were presented as numbers and percentages. The comparison between the groups with qualitative data was done using a Chi-square test. Success (0) was the absence of the aforementioned criteria and failure (1) was their presence. The comparison between groups with quantitative data and a parametric distribution used an independent t-test.

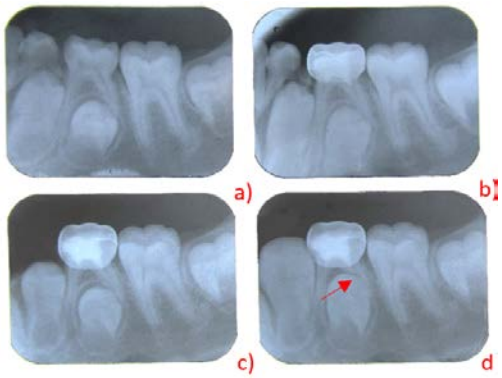

Figure 1. Radiographic follow up in MTA pulpotomy Group. a) preoperative; b) postoperative at baseline; b) after 6 months and d) after 1year with the red arrow showing normal physiological root resorption

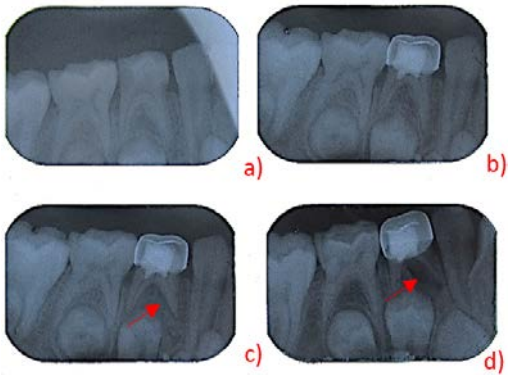

Figure 2. Radiographic follow up in MTA pulpotomy Group. a) preoperative; b) postoperative at baseline; c) after 6 months with red arrow showing wideninng of periodontal ligament space the beginning of root resorption and d) after 1year with the red arrow space and external root resorption radiographically

The confidence interval was set to 95% and the margin of error accepted was 5% and p-value <0.05 considered significant.

RESULTS

The study included 65 children with β-Thalassemia major with a mean age range of 5.77± 0.96. While Figure 1 shows a representative radiographical follow-up and normal physiological root resorption in a tooth after one year in Group I, MTA pulpotomy, Figure 2 shows increased widening of periodontal ligament space and external root resorption in one year follow-up. While Figure 3 and 4 show representative radiographical follow-up and normal physiological root resorption after one year in Group II, IDP. Tables 1 and 2, and Figure 5 show the success and failure comparative rates. Figure 6 shows patients' preference of type of treatment received.

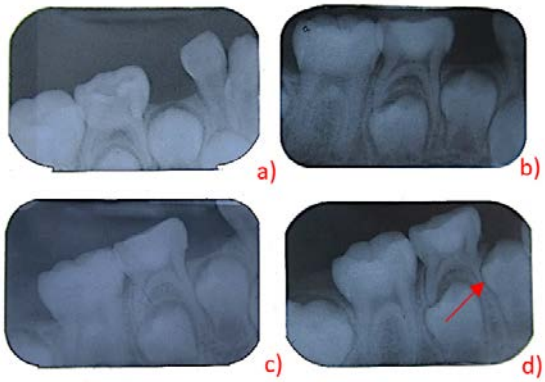

Figure 3. Radiographic follow up in indirect pulp capping (Group II): a) preoperative; b) at baseline; b) after 6 months; and d) after 1 year with red arrow showing normal physiological root resorption and the beginning of eruption of lower permanent first premolar

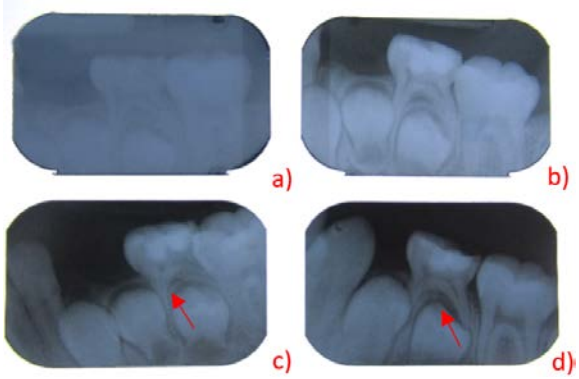

Figure 4. Radiographic follow up in indirect pulp capping (Group II): a) preoperative; b) postoperative at baseline; b) after 6 months and d) after 1 year also with red arrows showing normal physiological resorption

Table 1. Clinical success rates in mineral trioxide aggregate pulpotomy (Group I) and indirect pulp capping (Group II)

	Group I (n=30)				Group II (n=35)				p-value
	Success		Failure		Success		Failure		
	n	%	n	%	n	%	n	%	
Baseline	30	100	0	0	35	100	0	0	-
6 months	27	90	3	10	35	100	0	0	0.055
1 year	27	90	3	10	35	100	0	0	0.055

Table 2. Radiographic success rates in Mineral Trioxide Aggregate Pulpotmy (Group I) and Indirect Pulp Capping (Group II)

	Group I (n=30)				Group II (n=35)				p-value
	Success		Failure		Success		Failure		
	n	%	n	%	n	%	n	%	
Baseline	30	100	0	0	35	100	0	0	-
6 months	27	90	3	10	35	100	0	0	0.055
1 year	27	90	3	10	35	100	0	0	0.055

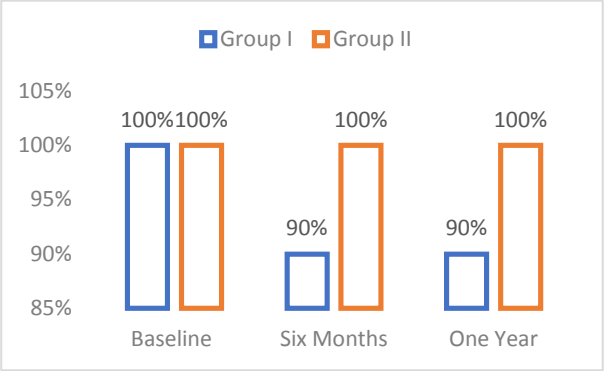

Figure 5. Radiographic success rates in Group I and II

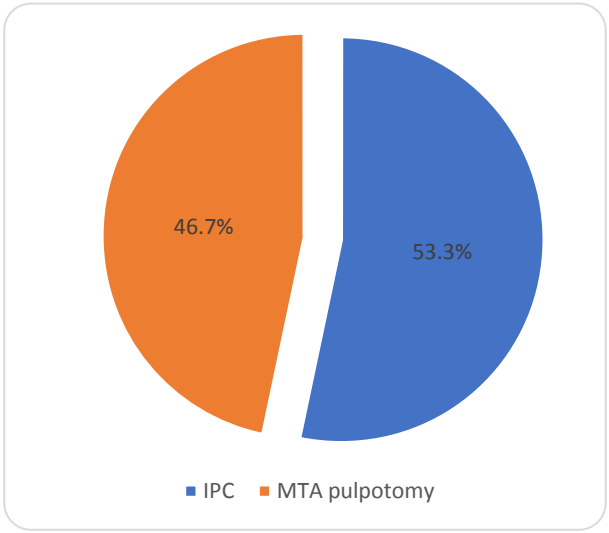

Figure 6. Percentage of patient preferences

DISCUSSION

Managing carious primary teeth is a challenge for the pediatric dentist.[13,16,17] In children with β-thalassemia major, successful management and outcome depend on evaluating each patient's medical and dental history to determine the best treatment for their age[12] and accurately diagnosing the status of the pulp prior to therapy.[16] If the dental pulp is vital or reversibly inflamed, vital pulp therapy techniques are appropriate.[17-19]

In deciduous dentition, pulpotomy is the procedure of choice to remove infected, inflamed pulp tissue, and it is usually performed after a pulpal exposure whether carious or mechanical. It allows the preservation of teeth that otherwise would be planned for extraction and it helps maintain the arch integrity.[13,18,19]

Formocresol has been the most popular pulp dressing material for pulpotomized primary molars for many years. However, its use has decreased considerably worldwide.[20,21]The long-term evaluation of MTA when used as the primary molar medication in pulpotomies, has a high success rate.[22] MTA also has no systemic or local toxic side effects.[20,21] and has proven therapeutic properties in various endodontic procedures in primary teeth.[20,21,23]

In this study, the clinical and radiographic success rates were both 90% after six months and after one year in cases treated with MTA pulpotomy in Group I without further clinical or

radiological pathological complications. Other studies[20,24,25] have had similar clinical and radiographic MTA success rates of 94-100%. This may be due to dentinal bridge formation at the orifice entrance and the preservation of the vitality of the remaining pulp tissue due to its biocompatibility.[20]

In this study the treated teeth with MTA pulpotomy were free of any pathological clinical symptoms or radiographic pathology except for 10% of the treated teeth which showed radiographical alterations as external root resorption. These findings were the same as in a previous study[22] which reported radiographical internal resorption due to undiagnosed chronic inflammation within the radicular pulp prior to pulp therapy.

Pulpotomy accompanies presence of alterations as faster root resorption and early loss.[26-28] Therefore, primary tooth pulpotomies should be radiographically evaluated at least annually because the success rate of pulpotomies diminishes over time.[15,21,24]

IPC is best in the case of deep carious lesion without pulp involvement. Two possible treatment options for IPC exist: total and the selective caries removal techniques. The latter avoids greater damage to the tooth and avoids pulp exposure.[2930] IPC is more conservative than pulpotomy because it preserves the vitality of coronal and radicular pulp.[31]

IPC relies on the selective removal of caries.[31-33] The dentin left in place is thereafter covered with a medicament followed by a final restoration. After sealing the cavity, the remaining dentine is capable of remineralization due to changes in the microenvironment caused by the lack of substrates for the bacteria and the caries process is arrested. [34, 35] This technique which is based on minimally invasive procedures is favored in current practice for caries treatment, [35,36] and it is time-saving and requires less discomfort particularly in β-thalassemic patients.

In this study, the success rate of IPC was 100% after six months and after one year. The teeth treated with IPC were free of any clinical or radiographic signs or symptoms. Similarly, a study by Vidya et al.[22] reported a 100% success rate in cases treated with IPT.[22] Other studies[37,38,39] reported a success rate greater than 90% IPC success rate and considered it a required pulp therapy procedure.

The current study showed that both MTA pulpotomy and IPC are effective pulp therapy techniques for primary teeth in β-thalassemic patients. Vidya et al.[22] also studied the success rates of IPC and pulpotomy in the treatment of deep carious lesions in primary molars, and they reported high success rates in both groups with statistically non-significant difference. [22] Faugeron et al[31] reported greater long-term success (three years) with IPC than pulpotomy for treating deep carious lesions in primary teeth.

At the end of the study, patients who had received both types of treatment were asked to provide their overall satisfaction and preference of the treatment type on a scale of satisfaction from 1-5. The patient preference was higher for IPC (53.3%) than vital pulpotomy (46.6%) considering the treatment duration, comfort, cost, and postoperative satisfaction. Ricketts et al[39] concluded that IPC is a more conservative, time saving approach the requires less discomfort to the patient. Likewise, Vidya et al[22]found that IPC required less chair side time, increased child cooperation and was more cost effective

One of the limitations of this study is the transfusion schedule of the patients which increased the time taken to finish the study. The present study has also the limitations of the far destinations, non-compliance and patient drop outs due to the medical condition. Another limitation is related to the cost of material taking into account the time of survival of the primary tooth in the oral cavity.

In children with in β-thalassemia major, both vital pulp therapy techniques (MTA pulpotomy and IPC) are applicable but IPC is preferred and more conservative requiring less effort and time by both the patient and dentist.

CONCLUSIONS

Children with β-thalassemia major have a higher caries index than healthy children which is attributable to inadequate dental care and the poor accessibility of dental health services due to their medical condition. MTA placed on

amputated pulpal tissue preserves the pulp vitality and promotes the regeneration of hard tissues, and IPC is a conservative procedure that treats deep carious lesions on teeth with no signs of pulp exposure or symptoms of pulp degeneration. Both techniques are equally successful in treating primary carious molars in β-thalassemic children but IPC is more preferred because it is the less invasive and involves less effort, fatigue, and time.

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Evaluation of bioactive glass and hydroxyapatite crystals as pulpotomy agents in primary molars: A clinical study

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Highlights

- The pulp in the primary teeth has immense potential for repair because of a high degree of cellularity and vascularity in this tissue.
- Bioactive Glass and Hydroxyapatite crystals exhibit pulpal biocompatibility, antibacterial property, osteogenic property and good bonding to tooth structure.
- Bioactive Glass and Hydroxyapatite Crystals were found to be promising regenerative materials for pulpotomy in primary teeth.

Abstract

Aim: To clinically and radiographically evaluate the potential of bioactive glass and hydroxyapatite crystals as pulpotomy agents in primary molars. **Methods:** A total of fifty teeth were selected from 25 children (14 boys and 11 girls) aged 4 to 9 years, who had no medical condition that would contraindicate pulp therapy. Each child had at least two primary molars (first and/or second primary molar) requiring pulpotomy. A conventional pulpotomy procedure was performed on the selected teeth using bioactive glass and hydroxyapatite crystals. All molars were evaluated clinically and radiographically at regular intervals over 12 months. The results were subjected to statistical analysis using Fischer exact test. **Results:** One hundred percent clinical success and 84% radiographic success was observed in both the groups at the end of the study period. **Conclusions:** The study concluded that both bioactive glass and hydroxyapatite crystals can be used as pulpotomy agents in primary molars.

Keywords: Bioactive Glass; Deciduous Teeth; Hydroxyapatite; Pulpotomy

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INTRODUCTION

Pediatric endodontics focuses on keeping the pulp of primary teeth vital until their physiological resorption in order to maintain the space between teeth, prevent detrimental tongue and speech habits, preserve esthetics, and maintain chewing function.[1,2] Pulpotomy in primary dentition is a common therapeutic procedure which involves surgical amputation of the coronal infected portion of the vital pulp followed by the application of a medicament over the residual radicular pulp tissue to promote healing. Successful pulpotomy procedure depends not only on the correct diagnosis of the inflamed dental pulp, but also on the selection of an effective and biocompatible medicament.[1,3] The ideal pulpotomy material should be bactericidal and harmless to cells and surrounding structures, promote healing of the pulp tissue and not interfere with the physiologic root resorption.[5-6]

Regeneration is a procedure to stimulate dentinal bridge or reparative dentin formation. There are various regenerative agents for pulpotomy such as calcium hydroxide, Mineral Trioxide Aggregate (MTA), bone morphogenic protein, enamel matrix derivative, lyophilized freeze dried platelet derived proteins and calcium enriched mixture.[7-12]

A material is said to be bioactive if it gives an appropriate biologic response and results in the formation of bond between material and the tissue. Bioactive glass is silicate based, containing calcium and phosphate. It is currently regarded as the most biocompatible material in the field of bone regeneration due to its bioactivity, osteoconductivity, osteoinductivity, hemostasis and its antibacterial property.[13] Hydroxyapatite is the main inorganic component found in human hard tissues, i.e. tooth and bone. It is similar in crystallography and chemical composition to that of human hard tissue and has other properties like biocompatibility, bioactivity and steoconductivity. It is non-toxic and is non-inflammatory in nature.[14]

Both BAG and HA crystals are regenerative materials which have been extensively used for bone repair and bone grafting procedures, repair of mechanical bifurcation perforations, apical barrier formation, fillers for reinforcing restorative glass ionomer cement and composite resin. They have been effective as desensitizing agent post bleaching; for treating early carious lesions and as a remineralizing agent in toothpastes. Despite the ostensible abilities of hydroxyapatite crystals and bioactive glass to be osteoconductive, osteogenic and dentinogenic little research has been done on their application as pulpotomy agents.[15] The null hypothesis was to test whether two materials with remineralizing properties (Bioactive glass and Hydroxyapatie crystals) would be successful as pulptomy agents in primary molars. Hence, the purpose of this clinical study was to assess the potential of bioactive glass and hydroxyapatite crystals as pulpotomy agents in primary molars.

METHODS

A randomized, split-mouth clinical trial was performed. Ethical clearance to conduct the study was obtained from the institutional review board of The Oxford Dental College, Hospital and Research Centre, Bangalore, Karnataka, India (Institutional Ethical Review Board: IERB), (315/2012-2013). Written informed consent was obtained from the patients and parents. The present prospective study was carried on normal, healthy and cooperative children from the patients attending the Department of Pedodontics and Preventive Dentistry of The Oxford Dental College, Hospital and Research Centre, Bommanhalli, Bangalore, India. The trial adhered to the Consolidated Standards of Reporting Trials (CONSORT) guidelines.

Estimation of sample size

The sample size was estimated based on assumption with 90% improvement. Hence, it is estimated with 5% significance level, 80% power and 20 % allowable error of 80%. The following formula provided the required sample size as follow:

$$n = \frac{[Z_{\alpha} + Z_{1-\beta}]^2 pq}{E^2},$$

where n = Estimated sample size, Z = 1.96 for 5% significance level, Z1- β = 0.841 for 80% power, p = 90, q = 10, E = 18, by substituting this value n = 22, assuming 10% dropout, the sample size will be n = 22+ 3 = 25. So, a total of

fifty teeth were selected from 25 children (14 boys and 11 girls) aged 4 to 9 years, who had no medical condition that would contraindicate pulp therapy. Each child had at least two primary molars (first and/or second primary molar) requiring pulpotomy. The parents/guardians were informed about the condition of the child's dentition and the nature of the study was briefly explained. A brief history was recorded and the teeth were subjected to clinical examination and radiographic evaluation prior to the study. Participation in the study was voluntary and prior written informed consent was taken.

The clinical inclusion criteria selected for the study were as follows:

- Vital primary molars with probable carious pulp exposure
- Absence of spontaneous pain or persistent pain or nocturnal pain
- No clinical symptoms or evidence of pulp degeneration such as pain on percussion,
- No history of swelling or sinus tracts;
- Restorable tooth structure should be present
- Hemorrhage from the amputation site is bright red and easy to control

Radiographic inclusion criteria were as follows:

- Radiographic evidence of not more than one-third of physiologic root resorption
- Absence of furcal and/or periapical radiolucency
- Absence of radiographic evidence of internal or external root resorption
- Absence of pathologic root resorption

Exclusion criteria were as follow:

- Any of the above clinical or radiographic inclusion criteria are not met
- Remaining radicular tissue of the tooth was non-vital (suppuration/purulent necrosis)
- Hemostasis could not be achieved within 5 minutes by direct contact with a wet cotton pellet, prior to material placement.

In this split mouth study design, allocation of the primary molars to either bioactive glass (25 teeth) or hydroxyapatite crystals (25 teeth) group was randomized by the toss of a coin. In each child, one molar was treated with BAG and the other molar with HA crystals and divided in two groups; in Group I- pulpotomy was done using BAG and in Group II- pulpotomy was done using HA crystals.

A conventional pulpotomy procedure was performed on the selected teeth. Following administration of local anesthesia, rubber dam isolation was carried out. All dental caries and overhanging enamel was removed with a No. 330 high speed bur (Dentsply, USA) with water spray. Removal of all carious dentin was carried out with the use of a sterile No. 4 or 8 round slow speed bur (Dentsply, USA) and access to coronal pulp was gained and the entire roof of the pulp chamber was removed. A spoon excavator, large enough to extend across the entrance of the individual root canals was used to amputate the coronal pulp. The pulp stumps were cleanly excised until the root canal orifices could be seen, with no tags remaining on the pulpal floor. Gentle wash out of the debris was carried out with the water syringe. After completion of the amputation, hemorrhage was controlled using slightly moistened cotton pellets placed against the pulp stumps at the orifices of the root canals.

BAG (PerioglasR Bioactive Synthetic Bone Graft Particulate 45S5, Average particle size: 90-700 microns, Unit size (Cup): 0.3 cm, Novabone Perioglass Florida, USA) is usually available in either cup or syringe form. In the present study, according to the manufacturer instructions, 2-3 drops of sterile saline was added into the cup containing 0.5cc of BAG with the particle size measuring 90-700μm. Once all the particles were wet with saline, the excess solution was blotted with sterile cotton. The mix was transferred to the root canal orifices using an amalgam carrier in order to standardize the quantity of the material placed. The material was condensed lightly using cylindrical condenser to confine the material placement at the root canal orifices. Bioactive glass was easy to place because of its cohesiveness.

HA crystals (G- Bone, SHAG 21, Synthetic Hydroxyapatite Granules, Average particle size: 0.4-0.9 mm, Hydroxyapatite crystal- Surgiwear G bone, Shahjahanpur, India) are available either in the syringe or cubes form. In the present study, the HA crystals dispensed in the syringe form

measuring 1cc in quantity with the average particle size of 400-900µm was used. Due to its larger particle size, the material was grounded to small particles using a mortar and pestle.

After the placement of the regenerative agents, the pulp chamber was filled to about half its volume with a thick mixture of zinc oxide eugenol cement and access cavity was restored with miracle mix (GC Corporation, Tokyo, Japan). Following rubber dam removal, the occlusion was checked for high points using articulating paper. Immediate post-operative intra-oral periapical radiographs were taken. In both the groups, final restoration with stainless steel crown (3M, ESPE, USA) was done within 1 week following the pulpotomy procedure.

The patients were recalled for clinical and radiographic evaluation after 1, 3, 6 and 12 month intervals. They were also instructed to report to the hospital on the development of any symptoms regarding the treated teeth, during the intervening 1-year period.

The pulpotomized teeth were judged as clinically successful when they met the following criteria:

- Absence of pain, sensitivity or swelling.
- No tenderness to percussion
- Absence of an abscess or fistulation
- No pathologic mobility or premature exfoliation

Radiographic success criteria included the presence of a normal periodontal ligament space, absence of periapical/ furcal radiolucency, and absence of internal or external root resorption.

Statistical Analysis

Data was collected, tabulated and statistically analyzed. Data analysis was performed using SPSS (Statistical Package for the Social Sciences) Statistics for Windows, Version 18.0. Chicago: SPSS Inc. Fischer exact test was used for statistical analysis.

RESULTS

All 50 teeth were available till the end of the study (Table 1). One hundred percent success was observed clinically at all evaluation periods in both the groups (Table 2).

Table 1. Distribution of pulpotomized primary molars

Primary molars	Group I (BAG) n (%)	Group II (HA) n (%)	Total N (%)
Mandibular 1st molar	15(60)	16(64)	31(62)
Mandibular 2nd molar	5(20)	6(24)	11(22)
Maxillary 1st molar	4(16)	3(12)	7(14)
Maxillary 2nd molar	1(4)	0	1(2)
Total	25(100)	25(100)	50(100)

Table 2. Clinical evaluation of both groups at 1,3,6 and 12 months

Evaluation Criteria	Period of evaluation (months)				Period of evaluation (months)			
	1 n(%)	3 n(%)	6 n(%)	12 n(%)	1 n(%)	3 n(%)	6 n(%)	12 n(%)
History of pain	0	0	0	0	0	0	0	0
Tenderness on percussion	0	0	0	0	0	0	0	0
Swelling	0	0	0	0	0	0	0	0
Fistulation	0	0	0	0	0	0	0	0
Pathologic mobility	0	0	0	0	0	0	0	0
Premature exfoliation	0	0	0	0	0	0	0	0

Radiographically 100% success was seen at one month evaluation in both the groups (Table 3). At three month evaluation, periodontal ligament space widening was seen in two teeth (8%) and furcal radiolucency was seen with regard to three teeth (12%) in group I. In the Group II, two teeth (8%) showed periodontal ligament space widening and one tooth (4%) showed furcal radiolucency. At the six month of evaluation, furcal radiolucency was seen in four teeth (16%) and external root resorption was observed in two teeth (8%) in group I. In Group II, periodontal ligament space widening was seen in one tooth.

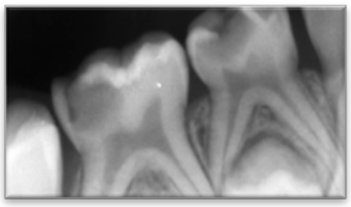

Figure 1. Preoperative intra oral periapical radiograph showing extensive carious lesions in mandibular primary molars, with more than two thirds of root length, and absence of furcal/ periapical radiolucency

At the end of study period, furcal radiolucency was seen in two teeth (8%) and external root resorption in two teeth (8%) in the Group I. In the Group II, periodontal ligament space widening in one tooth (4%), furcal radiolucency in one tooth (4%) and external root resorption in two teeth (8%) was observed.

Overall, one hundred percent radiographic success was seen at one month follow up in both the groups. At the third month 80% success was observed in group I and group II revealed 88% success. At the sixth month follow up, in Group Iand Group II, 76% and 84% success was seen respectively. At twelfth month follow up, similar success of 84% was observed in both the groups; $p > 0.05$ was not significant. Figure 1 shows a representative picture of preoperative intra oral periapical radiograph showing extensive carious lesions in mandibular primary molars, with more than two thirds of root length, and absence of furcal/ periapical radiolucency. Figure 2, 3, 4, and 5 represents the follow-up radiographs of a pulpotomized 2nd molar teeth after 1, 3, 6, and 12 months, respectively.

Table 3. Radiographic evaluation of both groups at 1,3,6 and 12 months

RADIOGRAPHIC CRITERIA	GROUP - I (n=25)				GROUP – II (n=25)				
	1month	3month	6month	12month	1month	3month	6month	12month	p value
Periodontal ligament space widening	0(0%)	2(8%)	0 (%)	0(0%)	0(0%)	2 (8%)	1 (4%)	1 (4%)	0.25
Furcal radiolucency	0(0%)	3(12%)	4(16%)	2(8%)	0(0%)	1 (4%)	3(12%)	1(4%)	0.30
Periapical radiolucency	0(0%)	0(0%)	0 (0%)	0(0%)	0(0%)	0 (0%)	0 (0%)	0 (0%)	1.0
External root resorption	0(0%)	0(0%)	2 (8%)	2(8%)	0(0%)	0 (0%)	0 (0%)	2 (8%)	0.50
Internal root resorption	0(0%)	0(0%)	0 (0%)	0(0%)	0(0%)	0 (0%)	0 (0%)	0 (0%)	1.0

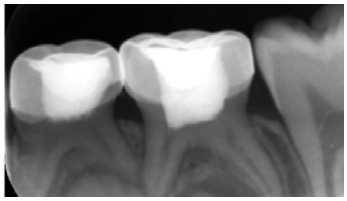

Figure 2. 1-month follow-up periapical radiograph showing the pulpotomized teeth

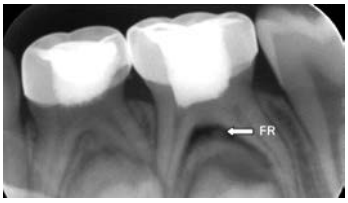

Figure 4. 6-month follow-up periapical radiograph suggesting of furcal radiolucency (FR) in 2nd molar

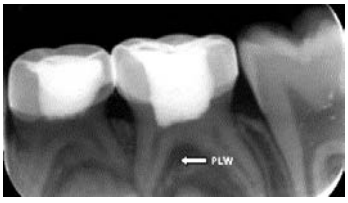

Figure 3. 3-month follow-up periapical radiograph suggesting widening of periodontal ligament (PLW) in 2nd molar

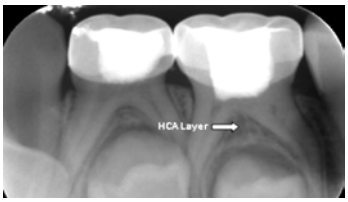

Figure 5. 12-month follow-up periapical radiograph showing radiopacity in 2nd molar

DISCUSSION

Recent research into endodontic materials has focused on what is called the "biological era". With greater understanding of the pulp biology, pathophysiology and its power of healing, the emphasis has shifted to the regeneration of pulp. Several agents such as calcium hydroxide, MTA, bone morphogenic protein have been successfully used as regenerative pulpotomy agents.[8,12,16] Though these materials have been used extensively, they have their inherent drawbacks. Calcium hydroxide does not adhere to dentin, cause internal root resorption and dissolves over a period of time. On the other hand, MTA has long setting time and tends to cause discoloration of dental tissues.

Amongst various regenerative agents, BAG and HA crystals have been assessed due to their biocompatibility, bioinductivity, antibacterial property, osteogenicity, and the ability to stimulate hard tissue formation in the field of medicine and dentistry.[17] Studies on their application in pediatric dentistry is limited because of the economic, commercial reasons and also taking into account the time of survival of the primary tooth in the oral cavity.[18,19] Therefore, in the present study, BAG and HA crystals were selected for use as regenerative pulpotomy agents in primary molars.

In order to make comparison of the two materials possible, the selected children had to have at least two primary molars requiring pulpotomy. For ethical reasons, every child had one primary molar each, treated with BAG and HA crystals. Hence, no child was withheld from the benefits of either of the two pulpotomy agents. It also ensured direct comparison of both the medicaments within the same mouth.

Beyond the pulpotomy material properties, the biological sealing after pulpotomy is fundamental for the pulp treatment success.[18] Therefore, in this study all the pulpotomized teeth were initially restored using zinc oxide eugenol cement as a sub base immediately following application of both the regenerative agents due to its lack of mechanical strength, followed by miracle mix (GC Corporation: Tokyo, Japan) because of its good compressive strength and direct bond to tooth structure.[17,20]

However, it is imperative that a permanent restoration be placed as soon as possible for the overall success of the treatment. In order to achieve an enhanced seal and to compensate for potential marginal leakage of the restoration, all the molars were restored with stainless steel crowns (3M ESPE, USA) within one week post operatively. Stainless steel crowns (SSCs) were most suitable since all these primary molars had sufficient longevity with considerable time for exfoliation to occur. SSCs are always considered superior to multisurface restorations in primary molars. Failure in other types of permanent restorations include fractures, ditches and secondary caries, that require re-treatment

whereas, with stainless steel crowns there could only be a need for re-cementation of crowns.[21,22]

The treatment outcome of any study is largely determined by the criteria used to evaluate whether, any treatment procedure has been "successful". In the present study, pulpotomy was regarded as a success in the absence of clinical signs and symptoms such as pain, swelling, fistula and/or radiographic evidence including periapical or furcal radiolucency and external or internal root resorption.[12,22]

Throughout the entire evaluation period none of the primary molars treated with BAG showed any clinical signs and symptoms. BAG has shown to provide enhanced seal over the vital pulp as it does not deteriorate, disintegrate and resorb with time.[23] The mechanism underlying the binding of BAG to collagen fibers may be the result of a rapid surface reaction that takes place on the glass when exposed to physiological solutions. There will be rapid exchange and release of ions that attack the silica glass network which leads to formation of silanols at the glass solution interface. The continuous condensation of silanols will form SiO_2 rich gel layer. The ions released from the BAG to the surface through the SiO_2 rich layer binds with the reactive groups of the collagen structure resulting in the formation of HCA layer (Hydroxyapatite Carbonate Layer). As dentin matrix comprises of 90% collagen fibers, the adherence of the reacted surface of the bioactive glass particle to underlying tissue forms stronger chemical bond.[24,25] This bonding provides matrix for mineralization and hermetic seal to prevent microleakage. This could be one of the reasons for clinical success observed in group I, wherein BAG was used as a pulpotomy agent.

BAG also has an antibacterial potential due to its ability to raise the pH in an aqueous suspension which is not well tolerated by bacterial cells.[26] Silica levels are also reported to be responsible for the antibacterial nature of the bioactive glass.[27]

All the teeth in group I were evaluated as radiographically successful at one month postoperative evaluation. This result is in accordance with earlier in-vivo studies. [22,28]

Radiographically, at three months in Group I (BAG), two primary molars (8%) showed periodontal ligament space widening and furcal radiolucency was observed in three additional primary molars (12%). This could be due to a protective inflammatory response of the body to BAG which is a foreign material.[23,29] This initial inflammatory response may also be due to the high alkalinity at the site of application. When BAG is exposed to physiological solutions or body fluids, it rapidly releases ions such as Na^+, K^+, Mg^{+2} and Ca^{+2}. There will be cation exchange processes which will increase the concentration of hydroxyl ions at the BAG/solution interface, thereby raising the pH to around 10.5.[24,25,30]

In fact, the inflammatory process continued to be evident even at 6 months, the periodontal ligament space widening seen with one of the primary molars progressed to involve the furcation area. External root resorption seen in two teeth could have also been due to the inflammatory reaction of tissue to BAG.

In group II (HA), all teeth were clinically successful throughout the evaluation period. Hydroxyapatite crystals are more biocompatible as their stoichiometry is similar to tooth structure.[31] They are compatible with fibroblasts, osteoclasts, osteoblasts and periodontal ligament cells. Apart from two primary molars with periodontal ligament space widening, furcal radiolucency was observed in one primary molar (4%) at three months evaluation. In the present study, the initially larger sized crystals of HA were ground to fine particle size in order to improve its handling characteristics and for convenient placement of the material at the application site. Higashi et al.[32] reported that tissue inflammatory response was seen more with usage of smaller particle size in comparison to larger particle size. Similarly, the placement of smaller sized HA crystals could have triggered an inflammatory response that manifested as furcal radiolucency in three primary molars at the end of 6 months evaluation. These results were in accordance with a previous study. [33]

At the twelfht month of evaluation, external root resorption was visible in two of the furcally involved teeth. It could be a result of smaller particle size and irregular shape of the hydroxyapatite crystals. The other reason could be

due to inflammation that could not be diagnosed clinically or due to individual immunological response of patients to the regenerative agent. [34]

As per the clinical criteria used in the present study, all the fifty pulpotomized primary molars treated in both the groups were evaluated as successful. In both groups, furcation radiolucency and external root resorption were observed to occur more frequently in first primary molars, probably due to their smaller crown size and highly situated pulpal horns. This is in accordance with that of previous studies, which showed a higher prevalence of pulpotomy failures in first primary molars.[35-36]

During the initial period of evaluation, a higher percentage of radiographic success was seen with teeth treated with HA. However, at the end of 12 months, with bioactive glass, healing and regeneration of tissue resulted in success (84%) that was comparable with HA crystals. The statistical analysis showed $p>0.05$ which was not significant.

Based on the observations of this study, both BAG and HA crystals appear to be successful pulpotomy agents in primary molars. Presently one of the factors limiting the routine use of these materials is the high cost of these materials. Since they are difficult to store, it is recommended to discard any material remaining after its usage. Moreover, in primary molars the quantity of the material used is minimal. Both materials are considered to be technique sensitive. Therefore, economic usage of both materials is not feasible. With growing concerns regarding the use of formocresol, BAG and HA crystals can be the preferred choice for pulpotomy agents in primary molars due to their biocompatibility and regenerative properties. Longitudinal studies for more than a year including histologic evaluation of these teeth following exfoliation should be done to study the pulpal response towards these agents. Their effect on development and eruption of the underlying succedaneous tooth is also a potential topic for research.

Given their high success rate, BAG and HA can be considered as suitable regenerative agents for pulpotomy procedure in primary teeth.

CONCLUSIONS

One hundred percent clinical success was observed throughout the evaluation period in both the groups. The radiographic evaluation revealed 100%, 80%, 76% and 84% success at 1, 3, 6, and 12 months respectively with BAG as pulpotomy agent. In Group II, radiographically 100% and 88% success were seen at 1 and 3 months respectively. A similar success of 84% was observed at both 6 and 12 months radiographic evaluation with HA crystals. There was no statistically significant difference between the two materials on both clinical and radiographic evaluation at the end of the study period.

This observation advocates further clinical, radiographic and histological studies with longer follow- up till the period of tooth exfoliation to ascertain the efficacy of these novel regenerative pulpotomy agents.

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Contemporary Pediatric Dentistry

Case Report
Contemp Pediatr Dent 2020:1(1):57-62

Polyethylene fiber post modification with vital pulp therapy in a traumatized immature incisor using Biodentine: A four year follow-up case report

Alem Cosgun[1] ✉, Halenur Altan[2]

Highlights

- It is quite difficult to determine the correct treatment procedure to success in the treatment of dental trauma cases in the form of crown fractures in teeth with immature root formation.
- This case report presents the treatment of the complicated crown fracture with the open apex of the tooth of a delayed admitted patient, with modified polyethylene fiber post.
- This novel treatment type may promise favorable outcome and can be used in such cases.

Abstract

In this case, it was aimed to restore a traumatized permanent incisor with open apex using a modified polyethylene fiber post after amputation as well as to present a four-year long term follow-up. A healthy 10-year-old boy was referred with a complaint of pain caused by tooth number 11. The patient fell and broke his upper incisor ten days ago and no treatment was done before. Total amputation was carried out after clinical and radiological examination. The exposed root pulp was covered with Biodentine™ (Septodent, Saint-Maur-Fosses Codex, France). Glass-ionomer cement (Fuji IX extra, GC Corp., Tokyo, Japan) was placed on the Biodentine™, and after a 3-month follow-up, polyethylene fiber post (Ribbond, Seattle, WA, USA) was placed in the crown since healing was observed in the relevant tooth. The restoration was completed with composite resin (Clearfil Majesty Esthetic Kuraray, Osaka, Japan). Four years later, radiographic examination revealed completed root formation and complete root obliteration. Clinical examination revealed favorable esthetic and functional outcome. Traditional treatments can be modified in order to obtain long term clinical success. Polyethylene fiber post can be used as an alternative method to root canal therapy in complicated crown fractures in teeth with immature root formation due to the advantages such as the possibility of modification according to the crown, aesthetics, easy application, and supporting the vitality of the tooth.

Keywords: Biodentine; Pulpotomy; Ribbond; Tooth Fractures

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INTRODUCTION

It is quite difficult to determine the correct treatment procedure to succeed in the treatment of dental trauma cases in the form of crown fractures in teeth with immature root formation.[1,2] Generally, treatment options may vary depending on the fracture line level, amount of remaining dental tissue, pulpal conditions, the extent of tooth eruption, the presence of a tooth piece compatible with the remaining tooth structure, root length, and morphology, status of the aesthetic region and patient's aesthetic expectation.[3-5] In teeth with immature root formation, trauma-related exposed pulp responds well to proven vital pulp treatments by preserving pulp vitality and enabling the continuity of root formation.[3,6-8] The success of vital pulp treatments depends on the selection of the correct treatment method as well as the pulp capping material selected. The pulp capping material should be capable of sustaining the pulp vitality, preventing bacterial leakage, resisting the forces during the insertion of restoration and function, enabling the formation of dentin bridge, and should be biocompatible.[9-12]

A total pulpotomy is a treatment method that aims to sustain the vitality of radicular pulp remaining as a result of the complete removal of the coronal pulp tissue.[13] It is indicated in the presence of pathologic change in the pulp within the exposed area of the primary and young permanent teeth with exposed pulp due to decay or trauma, with vital pulp, hemorrhage that can be controlled during the procedure without any existing pathology.[14, 15] This treatment is usually preferred in cases where inflammation in pulp tissue progresses deep into a coronal pulp and perforation area is too large or multiple.[16]

This case report presents a restored traumatized permanent incisor with open apex using a modified polyethylene fiber post (Ribbond) after amputation and four-year long term follow-up.

CASE REPORT

Written informed consent was obtained from the patients and their parents for publication (including all accompanying images). Informed consent was obtained in Turkish, which is the native language of the patients and their parents.

A healthy 10-year-old boy was admitted to our clinic with a complaint of pain caused by tooth number 11. The patient fell and broke his upper incisor ten days ago and no treatment was performed. Clinical evaluation revealed a complicated crown fracture in tooth number 11 with sensitivity in percussion, and palpation. There was no mobility and periodontal damage (Figures 1 and 2). In the radiographic examination, in addition to immature root form, it was observed that the periapical tissues were healthy (Figure 3).

Figure 1. Pre-treatment intraoral view

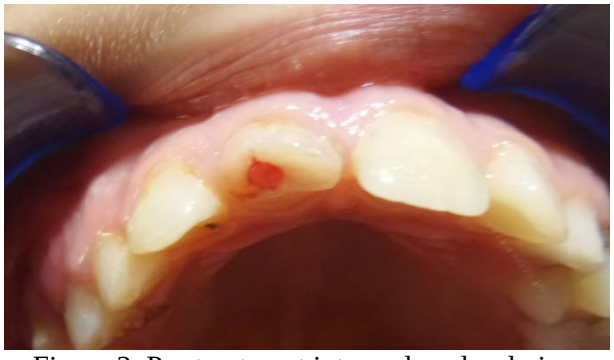

Figure 2. Pre-treatment intraoral occlusal view

Figure 3. Diagnostic periapical radiograph

Local anaesthesia with articaine hydrochloride (2 ml) and adrenaline (0.005 mg/ml) (Maxicaine, VEM, Ankara, Turkey) was applied to the traumatized tooth. The tooth surface was disinfected by wiping with a cotton roll impregnated with 2.5% sodium hypochlorite (NaOCl). The crown pulp was amputated with a high-speed sterile diamond drill (Meisinger, Germany) under water cooling, and then the root pulp at a depth of 3 mm from the root canal orifice was amputated. Hemorrhage was controlled with saline impregnated cotton pellets. After achieving a complete hemorrhage control, Biodentine™ (Septodent, Saint-Maur-Fosses Codex, France) was condensed over the remaining root pulp without applying pressure. After the setting of Biodentine™, it was temporarily covered with glass-ionomer cement (Fuji IX extra, GC Corp., Tokyo, Japan) (Figure 4).

Figure 4. Post amputation periapical radiograph

Healing was observed in the relevant tooth at the end of a three-month follow-up. The glass-ionomer cement was removed, and a cavity where the polyethylene fiber post could be placed was opened (Figure 5). The length of the cavity where the post would be placed was measured with the help of periodontal sond. Polyethylene fiber post (Ribbond, Seattle, WA, USA) with a length of twice the measured length was cut. Since wet resin provides more bonding surface and strength, Ribbond that was cut was wetted with a bond (Clearfil Se Bond, Kuraray, Osaka, Japan) and kept in a light-proof environment until usage in order to avoid polymerization. 37% phosphoric acid (Minitip Etching Gel, 3M ESPE, USA) was applied to the prepared cavity, and then washed and dried. Primer and bond (Clearfil Se Bond, Kuraray, Osaka, Japan) were applied on the cavity surface, respectively, and then polymerized. The fluid composite was applied to the cavity where the post would be placed. The polyethylene fiber post, which became soft and comfortable to form in the bond, was folded in half, and one end was placed in the fluid composite contacting the cavity base with the help of a mouth spatula. The core was created, forming with the aid of a mouth spatula and then polymerized (Figure 6).

Figure 5. View of the cavity before the polyethylene fiber post application

Figure 6. Intraoral view during the polyethylene fiber post application

The restoration was completed using composite resin (Clearfil Majesty Esthetic Kuraray, Osaka, Japan). In the follow-up appointment, the relevant tooth was found to be clinically and radiographically asymptomatic. In the radiographic evaluation performed after four years, it was observed that the root development was completed, and the root canal was completely obliterated, and no problem was observed in the restoration as a result of the clinical evaluation (Figures 7 and 8).

Figure 7. Intraoral view after 4 years

Figure 8. Periapical radiograph after 4 years

DISCUSSION

In crown fractures with exposed pulp sustaining the vitality of pulp enables the continuity of root formation.[17] In this case report, the treatment of the complicated crown fracture with the open apex of the tooth of a delayed admitted patient, with modified polyethylene fiber post and the long term follow-up, were presented.

The time elapsed after the trauma is very crucial in the selection of treatment.[18] In our case, the pulp remained exposed for ten days. There were three critical issues to be considered in the selection of the treatment; first was the delayed admission of the patient, the second was the insufficient remaining coronal dental tissue, and the third was the exposed root. Due to the increased contamination risk and infection depth of the pulp in delayed admissions, root canal therapy, or coronal pulpotomy is applied.[18] Cvek et al.[19] reported limited inflammation in a mechanically exposed and untreated pulp at a depth of 2-3 mm at the end of 7 days. Considering the diagnostic data, pulpotomy was applied to involve the coronal pulpotomy in order to deepen the coronal third of root canal to enable the continuation of root formation.

A structure to support the tooth is formed with posts applied to the root canal system in extensive, complicated crown fractures treated with canal therapy.[20] However, in this case, a modified method was applied since vital endodontic treatment was applied, and it was not possible to insert a post in the root. Plasma-reinforced polyethylene fiber post was used for coronal restoration. Polyethylene fiber post was easily inserted in the crown since it was easy to shape when soft. There was no problem in the restoration part since it bonded with the composite resin. Color stability was right in the long-term follow-up.

Pulp canal obliteration is more common in extrusion, intrusion, and lateral luxation injuries.[21] Pulp canal obliteration is rare than other injuries of permanent teeth with exposed apex, which is considered as a sign of pulp vitality. Pulp canal obliteration is associated with both the type of injury and the patient's age at the moment of trauma since it mainly affects the teeth with immature root formation at the time of injury.[21-24] Since pulp canal obliteration is affected by both loss and reestablishment of the neurovascular supply, the interface between vital periodontal tissues becomes larger as the apical diameter of immature teeth increases from where new nerves and vessels can grow into traumatized pulp eventually increasing the possibility of pulp revascularization.[25]

As dentin thickness increases in teeth with pulp canal obliteration, translucency decreases; thus, they become darker than the adjacent teeth. The colour of crown can turn into yellow or gray.[26] In this case report, potential aesthetic problem was avoided thanks to the modified vital pulp treatment preventing the reflection of potential coloring on the crown as a result of pulp canal obliteration.

CONCLUSIONS

Polyethylene fiber post can be used as an alternative method to root canal therapy in complicated crown fractures in teeth with immature root formation due to the advantages such as the possibility of modification according

to the crown, aesthetics, easy application and supporting the vitality of the tooth.

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Case Report
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Conservative management of mandibular fracture with maxillomandibular fixation using orthodontic brackets and elastics: A case report

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Highlights

- This case report enlightens the novel closed fracture reduction technique of mandibular fracture management with maxillomandibular fixation using orthodontic brackets and elastics.
- Conservative management is the mainstay management of fracture in children. Orthodontic brackets and elastics are non-invasive and cost effective.
- This method shows a promising result and can be used in some selective cases.

Abstract

Mandibular fracture is the most common facial skeletal injury in pediatric population seen in hospital setting. Fracture management is complicated by the developing permanent tooth buds and continuous mandibular growth. However, healing capacity in children is faster. Hence, conservative management is most often the treatment of choice for bone fractures in children. This case report is about a 6-year-old female child who sustained mandibular fracture after a road traffic accident (RTA) which was conservatively managed with maxillomandibular fixation using brackets and elastics. Orthodontic brackets were placed on facial aspect of posterior teeth of both the arches and elastics were used for traction leading to immobilization and stabilization of fracture. Healing was uneventful with complete bony union as evident by three months follow up orthopantomogram. Maxillomandibular fixation using brackets and elastics is a simple and non-invasive closed fracture reduction technique giving excellent result. The present case report showed successful outcome of mandibular fracture management.

Keywords: Closed Fracture Reduction; Maxillomandibular Fixation; Mandibular Fractures

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INTRODUCTION

Mandible is largest, strongest facial bone and also the most commonly involved bone in pediatric facial fractures seen in hospital setting.[1] Most common sites of mandibular fracture are condyle followed by angle, symphysis and body[2] with the main cause being road traffic accidents (RTA).[3]

Mandibular fracture should be managed early since delay in treatment can result in facial asymmetry, malocclusion and temporomandibular dysfunction.[4] Treatment option varies from that of adult.[5] Minimally invasive procedures are adopted in pediatric mandibular fracture to avoid post operative functional or growth related complications.[6] Various available options for moderately displaced fracture include closed fracture reduction by maxillomandibular fixation with eyelet wiring and arch bars, acrylic splinting,[7] orthodontic vacuum-formed thermoplastic splint,[8] orthodontic brackets and elastics.[9] Open reduction internal fixation is recommended for severely displaced fracture.[10]

This case report is about the conservative management of mandibular fracture in a child with maxillomandibular fixation using orthodontic brackets and elastics which can be utilized for such cases in future.

CASE REPORT

A 6-year-old female child patient accompanied by her parents visited the Department of Pedodontics and Preventive Dentistry 24 hours following road traffic accident. Patient was well oriented. Medical or dental history was not significant. Procedure was explained to the parents and written consent was obtained for the treatment and publication of the case report.

Extra oral examination revealed diffuse swelling and tenderness in the right mandibular body region. Mouth opening was adequate with intact temporomandibular joint. Intraoral examination revealed gingival inflammation distal to 85. The occlusion was within normal limit.

Orthopantomogram (OPG) revealed fracture of right body of mandible with displacement (Figure 1). According to the Dingman and Natvig classification,[11] it was diagnosed as unfavorable fracture of the right body of the mandible.

Figure 1: Fracture of the right body of mandible with displacement

Closed fracture reduction by maxillomandibular fixation using orthodontic brackets and elastics was planned. Stainless steel orthodontic brackets with hooks were bonded using composite on the facial surfaces of 53 54 55 63 64 65 73 74 75 83 84 and ¼" blue color elastics were placed from the upper hook to the lower hook in figure of 8 (Figure 2) under local anesthesia. Finally, the occlusion was verified.

Patient was discharged with antibiotics, analgesics and chlorhexidine mouthwash. Patient had already received a dose of tetanus toxoid injection in the emergency. Patient's parents were advised to change the elastics every day and to provide only liquid diet. She was instructed to limit the mandibular movements and also the outdoor activities.

On recall visit after a week, extra oral swelling had significantly subsided and the intraoral healing was uneventful. Two brackets from 84 and 75 had debonded which was rebonded using composite. On the fourth week, the brackets were debonded (Figure 3). There was no pain or swelling. On three months follow up, intra oral examination revealed erupting 46 and OPG showed complete bony union (Figure 4).

Figure 2: Maxillomandibular fixation with brackets and elastics

Figure 3: After debonding of brackets

Figure 4: Healing of fracture with proper alignment

DISCUSSION

More than 50% of the pediatric facial fractures are seen in the mandible and their management depends upon the dental age as well as the type of fracture.[12] In case of children, minimal manipulation of jaw is required. Children have higher bone remodeling potential and rapid healing rate. Hence early management with shorter immobilization period than adults (2-3 weeks vs 4-6 weeks in adult) result in excellent healing.[10]

In case of greenstick fracture or non displaced fracture, conservative management is suggested. Close observation, soft diet and analgesics will suffice. In case of displaced fracture, close or open reduction with fixation is indicated. In case of moderately displaced fracture, closed fracture reduction technique is the ideal treatment. This technique involves acrylic splints with circummandibular wiring, maxillomandibular fixation with arch bars and eyelet wiring and vacuum formed thermoplastic splint. Open reduction is indicated in older children and with severely displaced fractures or fracture of angle of mandible.[10]

In this case, since fracture was distal to the last clinical tooth i.e. right second deciduous molar, acrylic splint or thermoplastic splint was not used. Maxillomandibular fixation using arch bars and wire was also avoided since primary teeth are not stable and can avulse on excessive force.[13] The option of open reduction and internal fixation was discarded due to the presence of permanent tooth buds. Thus conservative management with closed fracture reduction was planned using orthodontic brackets and elastics. Orthodontic brackets were used to engage the elastics from upper arch to lower arch which allowed limited mobility of the jaw and stabilization of the fracture.[14] It was changed daily to maintain adequate traction. Hence there was uneventful healing of the fracture.

Maxillomandibular fixation using brackets and elastics is a novel and non-invasive technique with good prognosis. The advantages of this procedure are: it is cost effective with no special instruments required and no laboratory work. The adverse effects and economical burden of General Anesthesia can be avoided. However, the disadvantages are: difficulty in maintaining oral hygiene, is technique sensitive and weight loss of the patient (due to liquid diet). This procedure is not useful in case of severely displaced fracture. Both parent and patient cooperation and compliance are utmost for the success of treatment. However, literature is scarce[15,16] supporting this treatment plan, hence more prospective studies are required to advocate for and recommend the procedure.

CONCLUSIONS

Closed fracture reduction using orthodontic brackets and elastics is an innovative and conservative chair side procedure. After proper case selection, this technique can be used to effectively and efficiently manage moderately displaced fracture in children.

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Declarations

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