

The Futuristic Era of Paediatric Dentistry: A Review

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ABSTRACT

Over the past few years, paediatric dentistry has made significant advancements. Paediatric dentists may not have as many cutting-edge equipment or therapies as their dental colleagues, but improvements in technology have nonetheless greatly enhanced their practises in recent years. The way dentistry is practised is changing as a result of new technology. New imaging technologies, restorative techniques, the use of the internet and powerful electronic gadgets, and other innovations are examples of developments that have had a significant impact on dentistry. It is a fundamental necessity for all the dentists, to know the advancements in their field in order to incorporate them into their day-to-day practice. So, in the present review, authors discuss various recent advancements in the field of Paediatric Dentistry, that can aid the dentist to deliver better treatment and to obtain the patient's satisfaction. In the last few years paediatric dentistry has come a long way. Despite the fact that, children's dentists may not have as many creative treatment alternatives as their dental colleagues, advancements in recent years have greatly improved their practices. As a result of new technologies, the practice of dentistry is evolving.

Keywords: Computer-controlled local anaesthetic delivery, Dental anxiety, Digital imaging fiber optic transillumination, Nanorobots, Painless dentistry, Quantitative light-induced fluorescence

INTRODUCTION

When it comes to dentistry, there is no one-size-fits-all solution to a problem. As a result, all dentists must be aware of recent breakthroughs in their area in order to incorporate them into their daily practice. Paediatric dentistry has undergone significant changes as a result of advancements in technology, materials, and disease awareness [1]. With the introduction and utilisation of new technologies, the practice of dentistry undergoes a paradigm shift. Advances in dentistry include new imaging technologies, restorative techniques, the internet and sophisticated electronic gadgets, laser dentistry, and new materials [1]. As a result, the current literature's goal is to summarise recent advancements in Paediatric dentistry.

FUTURISTIC ERA OF CARIES DIAGNOSIS

Dental caries is easier to treat, costs less money to treat, and takes less time to restore teeth if it is caught early and diagnosed. The fissures on the occlusal surface of the tooth are frequently the site where dental caries begins. Visual inspection, tactile sense, and radiography are the main tools used in conventional examination for caries detection. While these approaches are effective at finding cavitated lesions, they are frequently insufficient for finding early lesions. New detection techniques have been created to help with better diagnosis as a result of these shortcomings. The following are general requirements for the ideal caries detection method [1]:

- The ideal approach for detecting dental caries should record the entire progression of the disease, from the earliest stage through the cavitation stage.
- It must be precise.
- It must be exact.
- It should be simple to use, beneficial for all tooth surfaces, including cavities next to restorations, and simple to apply.
- It should evaluate the lesion's activity.
- It should be sensitive, enabling the early detection of lesions [1].

In the study by Oh SH et al., evaluated dental caries detection ability between the Qraycam and Qraypen on the same dental caries lesions. In conclusion, the ΔF^{aver} , obtained from the Qraycam Pro[®](QP) devices showed diagnostic value mainly for screening

of demineralised teeth. The loss of fluorescence measured in teeth was found to be significantly linked with the loss of minerals within the lesion, suggesting that it could be utilised to detect and monitor minute changes in demineralisation/remineralisation in early carious lesions without cavities. Dental caries, plaques, and calculi generate red fluorescence, which is derived from porphyrin-induced metabolites produced by oral microorganisms [2].

Digital Fiber Optic Transillumination (DIFOTI) is the first and only dental diagnostic imaging device to be certified for the diagnosis of incipient, frank, and recurrent caries. Transillumination is a technique that uses optic fiber technology to target a tooth with high-intensity white light from a handheld device. Caries-affected tissue absorbs considerably more light than healthy tissue, allowing us to see that the surrounding tissue is whiter and opaquer. Carious lesions diffuse visible light; thus, the lesion seems darker [3]. Schneiderman A et al., discovered that the DIFOTI methodology has higher sensitivity for detecting approximal, occlusal, and smooth surface caries than standard radiography methods [4].

FUTURISTIC ERA OF CARIES PREVENTION-CARIES VACCINE

The generation of particular antibodies from adaptive immunity is another line of defense in the human body that can be used to combat *Streptococcus mutans* invasion. In dental caries, secretory IgA (antibodies found in saliva and produced by the mucosal immune system) plays a major role in immune defense. Antigen-specific IgA-producing B cells migrate to effector organs such as the salivary glands. After mucosal vaccination with *S. mutans* antigens at inductive locations, such as Gut Associated Lymphoid Tissue (GALT) and Nasopharynx Associated Lymphoid Tissue (NALT). Following this, these B-cells differentiate and mature and IgA is secreted in the lamina propria, where it crosses the effector tissue channels into the saliva [5]. Following the subcutaneous administration of AgI/II in Freund's incomplete adjuvant to Rhesus monkeys, Lehner T et al., found a 70% decrease in tooth caries [6]. In 2018, Alam MK et al., reported that the dextranucrase antibodies may be helpful in combating the dental caries as they have inhibitory effect on the cariogenic potential of *S. mutans* [7].

Dextranucrase antibodies have recently been shown to suppress acid formation and lower the hydrophobicity of *S. mutans*, further enhancing their anticariogenic ability according to study by Rather SA et al., [8].

S. mutans colonisation can be efficiently prevented with a vaccination or monoclonal antibody. According to the finding by Chen F and Wang D, more clinical data on caries experience is needed, however before they can be proven useful in the fight against dental caries [5].

FUTURISTIC ERA OF COMPUTER CONTROLLED LOCAL ANAESTHESIA DELIVERY (CCLAD) SYSTEM

In this method the local anaesthesia is delivered at a controlled speed, this helps in depositing small amount of anaesthesia at a slow speed which can reduce pain not only from resistance felt in the tissues, but also from anaesthesia taking effect simultaneously with injection, which in turn allows the anaesthetic to be injected into tissue that has already been anaesthetised. It is important for the operator to look at the design of the system which includes parameters like weight, infection management, speed and mode of drug injection, possibility of aspiration etc before choosing a suitable one. The first Computer Controlled Local Anaesthesia Delivery (CCLAD) system used was the Wand system (introduced in 1997) and some subsequent versions include Wand Plus and Compu Dent. Comfort control syringe (introduced in 2001) is another device that differs from the Wand system in a way that it does not possess a foot control [9].

Visual Analogue Scale (VAS) scores for pain at the end of the periodontal procedure also showed significantly lower pain with CCLAD. This is in agreement with the findings of studies by Asarch T et al., [10], Gibson RS et al., [11], Allen KD et al., [12], Fukayama H et al., [13] and Palm AM et al., [14]. Reduced pain may be attributed to a more accurate technique and greater precision in the delivery of local anaesthesia using CCLAD [15].

Buzzy system: Buzzy is a hand-held gadget that uses a combination of vibration, ice, and distraction tactics to naturally and swiftly reduce severe pain from needle sticks such as IV starts, blood draws, finger pricks, and vaccines [16].

FUTURISTIC ERA OF CARIES MANAGEMENT BY CHEMOMECHANICALLY METHOD OF CARIES REMOVAL

Chemomechanical Caries Removal (CMCR) is a minimally invasive procedure that uses a chemical substance to remove diseased dentine. This dissolution-based technique is used to remove cavities. This procedure removes soft carious structure without drilling by using a chemical agent in conjunction with a non traumatic mechanical force. It was first used in dentistry as an alternative to the use of burs and local anaesthesia, and it is primarily intended to reduce patient discomfort and preserve healthy tooth structure, therefore adhering to the notion of Minimally Invasive Dentistry (MID). Chemomechanical Caries Removal (CMCR) has historically employed a variety of chemicals and procedures, but only a select number have achieved widespread clinical acceptance [17]. The chemomechanical method is an effective alternative for caries removal because it combines [1]:

- I. Atraumatic properties
- II. Bactericide and bacteriostatic action, and
- III. The active ingredient softens the predegraded collagen of the lesion without causing pain or having negative effects on adjacent healthy tissues.

Kotb RM et al., observed conventional removal of carious tissue using diamond and/or stainless steel burs in permanent teeth with dentin caries left a residual smear layer, whereas the use of Papacarie® resulted in more comparative clinical evaluation of chemomechanical

caries removal agent Papacarie® with conventional method among rural population in India [18]. High-speed and low-speed tools used in restorative procedures may not retain healthy tissue. Chemomechanical removal, on the other hand, is a viable alternative to this idea. Papain's significant proteolytic activity, as a result of its impact on denatured collagen molecules, may make it easier to remove diseased dentin with the help of a blunt dentin spoon. The presence of antiprotease alpha-1-antitrypsin in healthy tissues, which prevents the material's proteolytic activity, is another significant benefit of using these chemomechanical agents. As a result, just the tissue containing denatured collagen fibers is eliminated, while the afflicted dentin, which can regenerate, is left intact. This preservation demonstrates the necessity of avoiding lesions in healthy tissue by employing blunt hand devices. The Brix 3000 is a fantastic choice for removing clinical caries. Chemomechanical caries removal has a significant benefit for both children and adults compliance with dental treatment, because when anxiety is heightened by a painful stimulus and the use of anaesthesia, it compromises adult patients' treatment cooperation, potentially jeopardising their quality of life if the procedure is not completed [19].

FUTURISTIC ERA OF DENTAL MATERIALS USED IN PAEDIATRIC DENTISTRY

1. **Silver Diamine Fluoride (SDF):** It is a silver-based fluoride liquid that is used to stop caries from spreading by denaturing and breaking down germs in the diseased area. Because of its capacity to enter dentinal tubules and decrease discomfort in deep lesions when administered in indirect pulp therapy, SDF is utilised as a supplement to restorative care. SDF has the ability to stop incipient lesions if used alone. In young children who are unable to cooperate in a typical dental environment, arresting these lesions offers the potential to eliminate the need for treatment under general anaesthesia or restorative treatments [20,21].

In 2017, a guideline was published by the American Academy of Paediatric Dentistry published for the "use of silver diamine fluoride for dental caries management in children and adolescents, including those with special healthcare needs. [22]. This guideline encouraged the use of this therapy for caries arrest, much as fluoride varnish is used for caries prevention. In November 2016, a breakthrough therapy status was granted to SDF by the United States Food and Drug Administration [23]. Arrest in the carious lesions up to 84% on the application of SDF (38%) was reported by Chu CH et al., [24].

2. **Active bioactive restoratives:** Bioactive materials that perform well in a moist oral environment, neutralise circumstances that cause tooth caries, offer preventative benefits, and maximise remineralisation potential. ACTIVA™ BioACTIVE products that mimic the physical and chemical properties of natural teeth, are the first dental-resins with a shock absorbing rubberised resin component, reactive ionomer glass fillers and bioactive ionic resin matrix. These materials are actively involved in the regulation of the natural chemistry of our teeth and saliva by participating in the cycles of ionic exchange. Thus, they help in the maintenance of oral health and tooth structure. These bioactive compounds are involved in ionic exchange cycles that help to maintain tooth structure and oral health by regulating the natural chemistry of our teeth and saliva [25].
3. **Cention N:** The liquid of Cention N is made up of a combination of four monomers that are often found in resin composites. It does not contain any acidic monomers or water, thus it does not have any adhesive potential from the start (the manufacturer indicates this with an adhesive in non retentive cavities). The liquid also contains photo polymerisation and chemo polymerisation activators, making it a real bulk-fill material theoretically. The composition of this material's powder, notably

the reactive fillers it contains, is its distinguishing attribute. This material is a powder-liquid mixture that needs to be spatulated by hand. Cention N, like gomomers and compomers, releases ions, particularly fluoride, whenever it is introduced in the oral environment, especially in an acidic environment [26].

4. **Surefil one:** Surefil One is principally made up of a high molecular weight polyacrylic acid that has been functionalised with polymerisable groups {called Modified Polyacid System (MOPOS) by the manufacturer}. This polyacrylic acid mimics the Vitrebond copolymer found in Vitremer and Ketac Nano in terms of structure. In addition, monomers with two photopolymerisable ends are present in the liquid and serve as a cross-linker between functionalised polyacrylic acid chains. Finally, the composition contains photopolymerisation and chemo polymerisation agents, as well as a certain amount of water. This material comes in the form of a single-use capsule that must be mechanically vibrated before use and is a true bulk-fill substance in theory. Surefil One has the unique attribute of being recommended by the manufacturer for use in all sorts of restorations [27].

FUTURISTIC ERA OF BEHAVIOUR-SHAPING TECHNIQUE

Dental phobia is a widespread psychological and instinctual response that is amplified in children. The most common cause of uncooperative behaviour in the dental office is anxiety-related behaviour. Strong-willed children, according to study, are those who have a lot of uncooperative behaviour [28]. One of the most serious effects of such strong-willed behaviour is that therapy may be delayed or terminated before it is completed, resulting in a reduction in the quality of care offered. For disruptive behaviours, there are a few behaviour management approaches but for strong-willed kids there are none. The management of strong-willed youngsters takes a lot of time. Furthermore, overprotective and indulgent parental attitudes are on the rise, making unpleasant tactics like Hand-Over-Mouth Exercise (HOME) and physical restraints harder to execute. As a result, pharmaceutical behaviour control techniques have an advantage over traditional methods. An effective approach of coping with strong-willed children is required. Thaumaturgy is a novel strategy for dealing with strong-willed children. Thaumaturgy is a technique that helps the dentist execute necessary treatments by distracting and relaxing the child [29]. "Little Lovely Dentist" is a Google Play Store and App Store application produced by Leaf Cottage Software and Shanghai Edaysoft Co. Ltd., respectively. It can be used to teach youngsters about treatment procedures such preventative cleanings, pit and fissure sealants, restorations and extractions while also emphasising the necessity of maintaining oral hygiene, particularly in the interdental areas by brushing [29].

Allen KD and Stokes TF [30], and Allen KD et al., [31] successfully used escape and reward strategies during restorative treatment on 3-6-year-old children who presented with disruptive behaviour. The use of contingent escape in the dental operator is one management strategy that may be implemented easily with minimal preparation. Escape is one of the most common and potent sources of reinforcement available and is an unavoidable feature of the typical restorative dental visit. In fact, Disruptive conduct is frequently maintained when dental treatment is stopped in response to it, which is a regular practise Allen KD and Stokes TF [30].

FUTURISTIC ERA OF NANOMATERIALS AND NANOROBOTICS IN PAEDIATRIC DENTISTRY

Application of the main principles of nanotechnology in dentistry has led to the development of a new concept "nano dentistry" which may be defined as the improvement and maintenance of oral health through the use of nanomaterials and biotechnology, including tissue engineering and nanorobotics [32].

- (a) **Addition of silver nanoparticles to composite resin:** represents a major advancement in the clinical management of lost enamel surfaces, and the introduction of nanoparticles in fissure sealants, fluorides, and toothpastes can assist in the prevention of dental caries [32].

das Neves PBS et al., evaluated physical properties and antibacterial activity of a light-activated composite modified with silver Nanoparticles (AgNPs) at two different concentrations (0.3% wt and 0.6% wt). It was concluded that the composite modified with 0.3% wt of AgNPs was less conducive to biofilm growth, without compromising the strength in compression and surface roughness when compared to the conventional composite [33].

Morales Quirogas E et al., in 2014 studied the effect of silver nanoparticles addition to pit and fissure sealant. It was found that, there was no significant difference with respect to marginal seal or microleakage in comparison to the conventional sealant when applied to primary teeth [34].

- (b) **Sealants:** Braun A et al., demonstrated that relative to conventional sealant materials, fissure sealants containing nanofillers exerted minimal effect on laser fluorescence values during caries detection. As a result, nanoparticles could be utilised to monitor caries progression beneath sealants and commence therapy as soon as possible. Further research into the characteristics of these materials as well as the long-term viability of various treatment procedures, is required [35].
- (c) **Nano Silver Fluorides (NSF):** NSF are a type of silver fluoride. The creation of new formulations incorporating silver nanoparticles that produce less discoloration since the particles are smaller and do not oxidise. Smaller silver particles provide more surface contact with cariogenic cells. Nano silver fluoride, a novel formulation using silver nanoparticles, chitosan, and fluoride, has antibacterial effects against *Lactobacilli* and *Streptococcus mutans* [32].
- (d) **Toothpastes made of Nanohydroxyapatite:** Nanohydroxyapatite toothpastes deliver hydroxyapatite particles in a nanocrystalline form with a size of 20-50 nm, which is favorable to natural repair. Nanohydroxyapatite toothpastes are highly bioactive and biocompatible with potassium nitrate, which plugs exposed dentinal tubules and forms a protective covering that reduces tooth sensitivity by blocking the transmission of external stimuli [32].
- (e) **Orthodontic therapy:** Nanorobots may directly govern periodontal tissues such as the gingiva, periodontal ligament, alveolar bone, and cementum, allowing for quick and painless vertical repositioning, rotation, and tooth straightening in a matter of hours [36].

FUTURISTIC ERA OF SPACE MAINTAINER (DIGITAINERS)-DIGITAL SPACE MAINTAINERS

According to Baroni C et al., [37] Rajab LD [38] ; Fathian M et al., [39] band and loop space maintainers have high success rates. However, solder failure, disintegration of cement, long construction and caries formation along the margins of the band are some of the associated disadvantages. Considering this, there has been many pilot studies that explains the use of newer adhesive directly bonded splints like glass fibre reinforced composite, as fixed space maintainers Ribbond [40], EverStick is a translucent-coloured, semi-manufactured product made of glass fibers, thermoplastic polymer, and a light curing resin matrix for reinforcing the dental polymer. The use of fiber-reinforced plastics in dentistry is increasing. EverStick is a new alternative to conventional fixed space maintainers and has been evaluated and used in pediatric dentistry, namely for band-and-loop type appliances [41,42]. A biocompatible aesthetic material called Ribbond is created from high-strength polyethylene fibres. This material has a number of benefits, including a quick application process, good strength, and ease of adhesion to dental shapes

[43]. There are numerous choices for designing different types of space maintainers. The term "Digital Space Maintainers" refers to space maintainers who use CAD-CAM or 3D printing technology with contemporary and biocompatible materials [44].

Polyether Ether Ketone (PEEK) Polymer, BruxZir® and Trillio are some of the materials used for fabrication of a digital space maintainer. PEEK polymer has strong mechanical properties, chemical resistance, dimensional and high-temperature stability. It can also be used in patients with metal allergy as they have a natural tooth colored appearance. BruxZir® has three to four times higher fracture toughness than zirconia. It also has minimal thermal expansion, which makes it stable in the varying temperatures in the oral cavity [44].

FUTURISTIC ERA OF PAEDIATRIC CROWNS

Pedo jacket crown: Pedo jacket crown is made up of tooth coloured polyester material and is filled with resin material. It is left on the tooth after polymerisation apart from being removed from celluloid crown form after curing of luting resin cement [45]. As an aesthetic restorative option in paediatric patients, Ghosh A and Zahir S, suggested the use of Pedo jacket crowns cemented using resin cements [46].

New millennium crown: They were introduced in market by the Success Essentials, Space Maintain Laboratory. These crowns are constructed of laboratory-improved composite resin. They resemble the strip crown and pedo jacket crown. The benefit of using a high-speed finishing bur to polish and reshape them [46].

Pedo pearl: It is a novel kind of crown that is now being created and tried out in the real world. It is a metal crown form that resembles an Stainless Steel Crowns (SSC), but the epoxy paint has been totally painted to look like tooth enamel. Because the epoxy coating adheres to aluminium considerably better than stainless steel, these crowns are fashioned of aluminium rather than stainless steel. In the primary dentition, they act as the final permanent crown. Sahana S et al., list several benefits including that they are simple to cut and crimp without chipping [47].

Artglass crowns: An anterior primary tooth restoration called an artglass crown, also referred to as Glastech, is made of artglass, a polymer glass. It is a brand-new multifunctional methacrylate with the capacity to create highly cross-linked, three-dimensional molecular networks. In comparison to strip crowns, they offer superior durability and aesthetics. Thanks to the use of microglass and silica as filler materials. It offers two benefits: the longevity and aesthetics of porcelains, as well as the bondability and feel of composites [46].

Figaro crowns: The list of aesthetic complete coronal crowns that can be used in paediatric patients now includes Figaro crowns. These crowns are made of composite resin that is covered in either fibreglass or quartz filaments or fibres. The resin composite is built of a highly biocompatible medical-grade composite that is also used in pacemakers, ocular, and cochlear implant devices. Compared to stainless steel and zirconia crowns, the strength and biocompatibility of composite materials with some flexibility are significantly closer to tooth structure. The crowns accurately reflect a natural tooth's real anatomy. The Figaro crown embraces the genuine tooth's architecture, creating an aesthetically pleasing result with more natural-looking teeth than zirconia and SSC, which are limited in their ability to match the tooth's shape and more closely resemble hills and valleys [46].

CONCLUSION(S)

The impending developments in paediatric dentistry practice necessitate a thorough examination of the full spectrum of the speciality, from undergraduate and postgraduate education to clinical Pedodontics practice. To assess effectiveness and long-term

consequences, new technology and sound science should always go hand in hand. Paediatric and Preventative Dentistry is a vast topic that has yet to be fully investigated.

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