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Classic to Classy-Refinement in Pediatric Endodontics –A Review

Dr. HeenaKagdi, studying 3rd Year Post Graduate student in Department of Pedodontics and Preventive Dentistry, Bharti Vidyapeeth Dental College and Hospital,Pune-411046

Dr. Shweta Chaudhary, MDS, Associate professor, Department of Pedodontics and Preventive Dentistry, Bharti Vidyapeeth Dental College and Hospital,Pune-411046

Corresponding Author: Dr. Heena Kagdi, Studying 3rd Year Post Graduate student in Department of Pedodontics and Preventive Dentistry, Bharti Vidyapeeth Dental College and Hospital,Pune-411046, India.

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Abstract

Despite the extensive progress that has been achieved in prevention of dental caries worldwide, and the variety of treatment modalities to treat inflamed and/or infected pulp, a remarkable number of complications of untreated or poorly treated primary teeth and/or young immature permanent teeth are still encountered. This demands exact diagnosis, thorough knowledge of pulpal conditions and therapies, and also the value of the individual tooth for the occlusal development. Hence, pediatric endodontics has its own characteristics and includes the pulpal treatment of primary and young immature permanent teeth. Pulpectomy of primary molar teeth is considered as a reasonable treatment approach to ensure either normal shedding or a long-term survival in instances of retention. Despite being a more conservative treatment option than extraction, efficient pulpectomy of bizarre and tortuous root canals encased in roots programmed for physiologic resorption that show close proximity to developing permanent tooth buds presents a critical endodontic challenge. Various factors such as instrumentation technique, obturating materials, irrigants, root canal morphology, root resorption, and follow-up period also plays an important role in deciding whether the endodontic treatment is successful or not. Recently various newer technologies like nickel–titanium (Ni–Ti) rotary files systems, use of the endodontic microscope and various newer irrigation systems and newer obturating materials have been developed for use in pediatric endodontics. As pediatric dentists are gaining more interest in the newer modalities, and for better understanding and evidences favouring it, this article reviews the use of nickel–titanium rotary files & newer irrigating systems vs conventional root canal preparation systems along with various newer obturating materials used in primary teeth.

Keywords: pediatric endodontics, primary teeth, pulpectomy

Introduction

Despite the advances made in protection from tooth decay, the widespread natural dentition protection awareness, and the increasing number of patients seeking help from pedodontic clinics, the early loss of the deciduous teeth is still a common problem[1]. Early loss of deciduous teeth may cause the mesialization of permanent teeth, arc length loss, and ultimately malocclusions.

Furthermore, keeping the deciduous teeth in the mouth by treatment is very important to ensure aesthetic and chewing functions, preventing the ectopic or early eruption of the bottom permanent teeth, preventing the abnormal tongue habits created by positioning the tongue in the toothless cavity and thus negatively affecting speech[2,3]. Maintaining the integrity of the dental arch in the primary and mixed dentition is essential for establishing occlusion and function in the permanent dentition. The primary reasons for premature loss of teeth in children are either dental caries or dental trauma[4]. Proximity of decay or trauma to pulp tissue may lead to pulpitis or even pulp necrosis. Whenever feasible, dental treatment should attempt to maintain pulp vitality, particularly in immature permanent teeth. Pulp vitality leads to development of a favorable crown-root ratio, apical closure and formation of secondary radicular dentin. However, when irreversible pulpitis or pulp necrosis occur, nonvital pulp therapy procedures are required to alleviate patient symptoms and maintain a functional tooth in the dental arch. The exploration to find new material and techniques to increase success in deciduous teeth endodontic treatments is going on. This compilation aims to review the new material and techniques that have become recently prominent in the deciduous teeth root canal treatment.

Root Canal Treatment for Deciduous Teeth

Root canal treatment is indicated in the deciduous teeth with chronic inflammation or necrosis, and this treatment aims to purify the root canals from infection, and to keep the teeth in the mouth until the age they normally fall off. For this purpose, in the canal treatment process, the new advances are benefited from for deciduous teeth just like the permanent teeth.[5,6]

a) Root Canal Assessment

Digital imaging technique is used in the measurements of canal height and canal preparation. The basic advantages of the digital imaging techniques over conventional radiographies are their higher speed of imaging, image-saving abilities and enabling changes on the images[7]. The studies comparing digital and conventional radiographies regarding the canal measurement of the deciduous teeth found that, apart from the a forementioned advantages of digital imaging techniques, their image quality yielded similar results to conventional radiographies, and there was no statistically significant difference between the two systems [8,9].

The use of apex finders, especially when the radiographical imaging of the root apexes are blocked by anatomical structures, is very helpful. Besides, contrary to radiographic methods, not applying radiation to the patient, and eliminating the need for time to process the film are other important advantages[10]. Various studies on deciduous teeth indicate that, using apex locator have been successful in the deciduous teeth that show different degrees of root resorption[11-14]. Kim et al[15] In their study compared the measurements taken with Root ZX with those supported by radiographies, found that merging the two methods increases the success rate. The 84% success rate with the measurements made by using Root ZX alone was raised to 96% by adding the use of radiographies.

Instrumentation

Rotary instrumentation is an evolution in the field of endodontics. Due to their low flexibility, the stainless steel instruments routinely used in root canal treatment may cause undesirable canal shapes especially in the curvy canals, and may cause perforations[16]. In order to overcome this problem, the Ni-Ti high flexibility canal instruments have been developed. The results of majority of studies revealed the NiTi rotary instrumentation to be superior over the manual instrumentation in terms of time of

instrumentation and efficiency to clean the root canal system of primary teeth.

Nickel-titanium alloy was developed in 1960s and first NiTi rotary file appeared in the market around 1993, used in permanent teeth. Barr et al. (2000)[19] was the first to use nickel titanium rotary files for instrumentation of root canals in primary teeth. He was of the opinion that the root canal preparation in primary teeth was cost-effective and rapid, resulting in consistently uniform and predictable obturation. Despite its advantages the use of rotary instruments in primary teeth is not much popular.

The most important advantages offered by the Ni-Ti rotary instrument systems are increasing the cutting effectiveness of the files, facilitating the shaping of the curvy canals, shortening the work time, and thus simplifying the canal preparation procedure[16- 19].

For the molar deciduous teeth, in the studies comparing the rotary tool system and K type file, the canal shaping performed by rotary tool system was completed faster than the K type, furthermore, it was demonstrated that the rotary tool system enables smoother canal surface and more conical shape, and facilitated the flow of the filling material within the canal[20,21]. Katge et al.[22] In their study regarding canal cleansing effectiveness, concluded that the rotary tool systems are superior to the preparations performed via K type hand file; while Nazari Moghaddam et al.[23] could not find any significant difference between the two. Various Niti Rotary file systems are stated below with the evidences supporting its use.

Ni–Ti PROFILE

Shashikiran et al. compared the Ni–Ti rotary PROFILE and K files hand instrumentation on root canal preparation of primary and permanent molars for their efficacy in preparation time, instrumentation failure, and shaping the canals. They concluded that PROFLE 0.04 taper 29 series prepared canal rapidly than conventional K files (Shashikiran, 2006).

The K3 Endo Ni–Ti rotary file system

It was introduced in 2002. These files are designed with a wide radial land, which is meant to make the instrument more resistant to torsional and rotary stresses. It also features “radial land relief”, which aids in protecting the file from “over engagement”, in the canal; thus, less instrument separation or distortion should occur. According to Ankrum et al., this file features a variable core diameter designed to increase flexibility, and it has a safe-ended tip to decrease the incidence of ledging, perforation, and zipping (Ankrum et al., 2004). Numerous studies have shown that Ni–Ti rotary instruments can effectively produce a well-tapered root canal form that is sufficient for obturation, with minimal risk of transporting the original canal (Bertrand et al., 2001; Hulsmann et al., 2001; Thompson and Dummer, 1998).

Guelzow et al. compared various parameters of root canal preparation using a manual technique and six different rotary Ni–Ti instruments. They concluded that all Ni–Ti systems maintained the canal curvature and were more rapid than a standardized manual technique.

ProTaper

This instruments created more regular canal diameters (Guelzow et al., 2005). According to Barr et al., maintaining the original path of the root canal is essential to ensure the integrity of the germ of the permanent successor (Barr et al., 1999, 2000) Elmsallati et al. showed that K3 Rotary System® produces minimum wear of root canal walls, which is an interesting aspect in the endodontic preparation of primary teeth (Elmsallati et al., 2006).

Francinne et al. evaluated apical displacement and time needed for instrumentation of root canals of primary molars by the K3 rotary system and manual K files and

found a significantly shorter clinical time for the rotary system.

Mtwo endodontic instruments

A new generation of Ni–Ti rotary files appeared with the **Mtwo endodontic instruments**. The specific design and flexibility of Mtwo instrument maintain the original root canal curvature and these instruments are effective and safe, so cleaning can be completed in less time in permanent teeth (Foschi et al., 2004; Kuzekanani et al., 2009; Malagino et al., 2012; Schafer et al., 2006a,b; Thompson and Dummer, 1997).

Azar et al. compared the cleaning efficacy of manual K files and two rotary systems-Mtwo and ProTaper for root canal preparation in primary molars and concluded that all the three systems showed equally acceptable cleaning ability in primary molar root canals. They modified the sequence of the three ProTaper instruments slightly to prepare the canals. Root canals were cleaned in a crown down method with three instruments in the sequence from S1 in the coronal third of the root canal, S2 in the middle third, and F1 till the working length (Azar et al., 2012). Pinheiro et al. used a hybrid technique for instrumentation of canals in primary molars with the ProTaper system and K-files (DentsplyMaillefer).

Flex-Master files

Another new generation files are, have round passive tips, a modified cross section, convex triangular shape with sharp cutting edges, and no radial lands. They resemble K-file configuration enhancing dentine cutting effectiveness in permanent teeth (Hidsmann et al., 2003; Hubscher et al., 2003; Weiger et al., 2003; Zarrabi et al., 2006). Makarem et al. conducted a randomized controlled clinical trial in the pulpectomy of primary second molar teeth. They achieved superior radiographic findings and less chair time with Flex-Master system (Makarem et al., 2014). Bahrololoomi et al. also suggested the application of the Flex-Master system for preparation of primary root canals during pulpectomy (Bahrololoomi et al., 2007).

Hero 642 system

Hero 642 and its new variant Hero Shaper in which helix angle increases from tip to shank have improved efficiency, flexibility, and strength in root canal treatments of permanent teeth (Veltri et al., 2005). Kummer et al., prepared root canals with the Hero 642 system and a reducing 50:1 handpiece. Preparation was performed with 21 mm nickel titanium instruments with 2% and 4% tapers using the crown down technique. The protocol established for instrumentation comprised a kit with 3 instruments: (1) Hero 642 taper 0.04, size 30, 2 mm short of the working length; (2) Hero 642 taper 0.02, size 35, up to the working length; (3) Hero 642 taper 0.02, size 40, up to the working length. Each Hero instrument was introduced into the canal with a gentle push and pull motion (Kummer et al., 2008). In another study Musale et al. evaluated the efficacy of rotary PROFILE®, ProTaper, Hero Shaper, and K file in shaping ability, cleaning efficacy, preparation time and instrument distortion in primary molars and concluded that rotary files prepared more conical canals in primary teeth than manual instruments. Reduced preparation time was also noticed (Musale and Mujawar, 2014).

According to musale et al application of protocols for permanent teeth to primary teeth may lead to lateral perforation on the inner root surface, especially in curved molar roots. The abrupt cervical constriction, with a shelf of dentin overlying the canal orifice results in an acutely curved root canal orifice in primary molars which should be removed to improve the straight line access and reduce the risk of instrument separation (Musale, 2013). Yang et al. also reported less canal transportation and better centering ability using the Hero Shaper (Yang et al., 1996).

Pro Taper Next

It has recently been introduced which consists of five files (X1–X5). It is made up of the M-wire Ni–Ti technology that is formed by characteristic thermo mechanical processing. The instrument is flexible and there is increased resistance to cyclic fatigue. Hence, there are less chances of instrument separation (Dhingra et al., 2014; Rahman et al., 2014).

Wave-One and Reciproc brands

They adopted the single file system and advocated the reciprocation concept. These files are made of a special Ni–Ti alloy called M-wire that is created by an innovative thermal treatment process. This procedure has been developed using superelastic Ni–Ti wire blanks that contain substantial stable martensite for clinical use. The benefits of M-wire are increased flexibility of the instruments and resistance to cyclic fatigue (Young–Jun Lim et al., 2013; Plotino et al., 2012). According to Webber, while current teaching advocates the use of multiple Ni–Ti files of different diameters and tapers to gradually enlarge the root canal, only one Wave One single shaping file is required to prepare the canal to an adequate size and taper, even in narrow and curved canals (Webber, 2011).

Katge et al. concluded for their study on primary molar pulpectomy that the reciprocating system (Wave One) and the rotary system (Pro Taper) showed better cleaning efficiency when compared to manual instrumentation especially in the coronal and middle one third of root canals (Katge et al., 2014).

Recent advancement includes the use of exclusive **pediatric rotary file - Kedo-S** (Reeganz Dental Care Pvt. Ltd., India) with modified length, taper, and tip size for performing pulpectomy in primary teeth more conveniently and efficiently. This system consists of three sets of files - D1, E1, and U1. The former is for the canal preparation of the primary molars, while the latter was indicated exclusively to prepare the primary maxillary anterior.[Jeevanandan et.al in 2017][54]

Govindaraju et al. conducted a study comparing Protaper, Mtwo, and Hand files for canal instrumentation and reported that the canal instrumentation time was statistically reduced with the use of rotary files. No significant differences were noted in the quality of obturation among the three groups.[17] Furthermore, in another study comparing Protaper, K3 rotary files, and Hand files, it was demonstrated that there was a decrease in the instrumentation time with Protaper files followed by K3 rotary files. There was no statistically significant difference in the quality of obturation between rotary and hand instrumentation.[55]

Ramazani et al in 2016 stated that cleanliness, at coronal third showed Reciproc was better than K-file ,but not more effective than Mtwo. Furthermore, Mtwo leaved the canal cleaner than K-file. In the middle third, only Reciproc exhibited better cleaning efficacy than K-file. In the apical third, no difference was detected between the groups. Regarding shaping ability, no differences were found between Reciproc and Mtwo. Meanwhile, both displayed better shaping efficacy than K-file. Between each two groups, there were differences in preparation time with Reciproc being the fastest. No file failure occurred.[71]

b) Canal Irrigation Agents

Because of its positive qualities like being non-toxic to periapical tissues, and its safe use with children, but considering its negative characteristics such as not having an antibacterial effect and not removing the smear layer, sterile saline solution is used in combination with other irrigation solutions [24,25.]

Sodium hypochlorite

It is an agent often preferred for its qualities such as solving the vital and nonvital tissues well, being a wide-spectrum antibacterial agent, its easy diffuse on the walls of the dent due to low surface tension, and being easily and cheaply obtainable. Sodium hypochlorite concentration and toxicity increase in direct ratio [26]. In their study where they studied the effect of using 1% sodium hypochlorite (NaOCl) and various percentages of (4%, 6% and 8%) citric acid use on the removal of smear layer in molar deciduous teeth, Götze Gda et al.[27] suggested the use of 1% NaOCl and 6% citric acid as a chemical substance for irrigation for deciduous teeth. In the studies where the effectiveness of sodium hypochlorite on Enterococcus faecalis in deciduous tooth canals was analyzed, successful results were obtained[26,28.] Additionally, in the studies on deciduous teeth, it was found to remove the smear layer [29]. The toxic effects of the sodium hypochlorite overflowing from the apex on the periapical tissues root resorption and canal height measurement in deciduous teeth are recommended to be carefully performed. [30,31]

Chlorhexidine gluconate

It is an agent with broad antimicrobial spectrum and tissue solvent quality. It was shown to be effective on E. faecalis in the deciduous teeth [26]. In their study, Onçağ et al. [32] showed that 2% chlorhexidine gluconate has more antibacterial effect and less toxic effect than 5, 25% sodium hypochlorite. Ethylene diamine tetraacetic acid (EDTA), a chelation agent, causes demineralization and increases the permeability of dentine. With its combined use with sodium hypochlorite, it is highly effective on removal of the smear layer [33]. Sodium hypochlorite, chlorhexidine, gluconate, citric acid and EDTA, which are all among irrigation solutions used in deciduous teeth, were compared with respect to cytotoxicity, and chlorhexidine gluconate was reported to have a lower level of toxic effect than others [34].

Mixture of tetracycline, acid and detergent (MTAD)

It is a canal irrigation solution including tetracycline and acid. It has an antibacterial effect on E. feacalis and bacteria isolated from deciduous teeth [35,36]. In addition, it is also reported to lead to successful results in removing the smear layer in deciduous teeth [24]. Apart from the traditional irrigation agents, use of ozonized water, a method applied in deciduous teeth was found to be effective on E. faecalis [26]. Propolis, another antibacterial product, had antibacterial effect on bacteria isolated from the deciduous tooth canals [37]. Kapdan et al. [28] reported that the irrigation method with laser had antibacterial effect on deciduous tooth canals.

Intracanal antibiotics as a substitute for achieving disinfection

The sole purpose behind intracanal antibiotic medicament is to eliminate microbes. If this motive is achieved by some other means then antibiotics can be avoided. The EndoVac apical negative-pressure system of irrigation can answer. EndoVac delivers irrigating agents safely to the full extent of the root-canal terminus, thereby removing of organic tissue and microbial contaminants effectively. Also, it is the only method capable of cleaning the isthmus area.Thus, creating optimum conditions for regenerative endodontic procedures without the use of antibiotics.[56]

Herbal Irrigants Triphala and Green tea polyphenols (GTP)

Triphala is one of the well known Indian Ayurvedic herbal formulation consisting of dried and powdered fruits of three medicinal plants namely Terminalia Bellerica, Terminalia Chebula and Emblica Officinalis.[57] Triphala achieved 100% killing of E faecalis at 6 min. This may be attributed to its formulation, which contains three different medicinal plants in equal proportions; in such

formulations, different compounds may help enhance the potency of the active compounds, producing an additive or synergistic effect.[57] Triphala contains fruits that are rich in citric acid, which may aid in removal of the smear layer. The polyphenols found in Green tea are more commonly known as flavanols or catechins. Green tea polyphenols have significant antioxidant, anticariogenic, an anti-inflammatory, thermogenic, probiotic and antimicrobial properties in numerous human, animal and in vitro studies.[58] It can be used as an effective antiplaque angent because of its antioxidant properties and it can effectively inhibit the biofilm formation.[59] An in vitro study conducted to evaluate the antimicrobial efficacy of Triphala, GTPs, MTAD, and 5% Sodium Hypochlorite against E faecalis biofilm formed on tooth substrate showed maximum antibacterial activity with NaOCl and statistically significant antibacterial activity with Triphala, GTPs and MTAD.[57]

Morinda Citrifolia (NONI)

Morinda Citrifolia commercially known as Noni, is indigenous to tropical countries and is considered as and is indigenous to tropical countries and is considered as an important folk medicine. Its juice has a broad range of therapeutic effects including antibacterial, anti-inflammatory, antiviral, antitumor, antihelmenthic, analgesic, hypotensive, anti-inflammatory and immune enhancing effects. An invitro study compared the effectiveness of MCJ with NaOCl and CHX to remove the smear layer from the root canal walls of instrumented teeth. It was concluded that the efficacy of Morinda Citrifolia was similar to NaOCl in conjunction with EDTA as an intracanal irrigant. The antimicrobial activity of 2% CHX gel propolis, Morinda Citrifolia juice and Ca(OH)2 has been compared on E.faecalis infected root canal dentin at two different depths and three intervals. It was concluded that Propolis and Morinda Citrifolia were effective against E. faecalis in dentin on extracted teeth.[60]Morinda Citrifolia appears to be the first juice to be identified as a possible alternative to the use of NaOCl as an intracanal irrigant.

German chamomile and tea tree oil

The German chamomile (Marticaria recutitia L.) has been used for centuries as a medicinal plant mostly for its antiinflammatory, analgesic, anti-microbial, antispasmic and sedative properties. German chamomile, in particular, is the most commonly used variety. Tea tree oil (Melaleuca alternifolia) as it is more commonly known, is a native Australian plant with many properties such as being an antiseptic, an antifungal agent and a mild solvent. Tea tree oil's major active component is terpinen-4-ol(typically 30- 40%). This compound is responsible for its antibacterial and antifungal properties.[61] In order to avoid the undesirable effects of NaOCl, an SEM study was conducted using two medicinal plants i.e german chamomile extract and tea tree oil which might disinfect the root canal system with less toxicity when used as irrigants. It was concluded that the efficacy of chamomile to remove smear layer was superior to NaOCl alone but less than NaOCl combined with EDTA.[62]

Materials Used in Deciduous Tooth Canal Treatments

Calcium Hydroxide

Because pastes containing calcium hydroxide have a high level of biocompatibility and alkaline pH and because they can be absorbed out the root canal system, they are frequently favored as root canal sealing materials. In addition, it has several advantages like being easily prepared and applied, having no irritant effects on periapical tissues and having no toxic effect on permanent dental germ [38]. Also, it is reported to have antibacterial effect on bacteria isolated from the deciduous tooth canals [39]. Although calcium hydroxide is used successfully in deciduous tooth canal treatment, the biggest disadvantage

of the material is that it cannot be resorbed from the canal before the deciduous tooth physical resorption process [39, 40].

Zinc-Oxide Eugenol

Besides the anti-inflammatory and antibacterial features of eugenol, it is also reported to have cytotoxic effect [41]. Some researchers stated that eugenol might cause foreign tissue reaction and osteonecrosis if eugenol is transmitted to periapical tissues. Another disadvantage of zinc-oxide eugenol paste is that it results in problems with the coming permanent tooth and causes wastes in the tissues following the deciduous tooth since it is not resorbed in accordance with the root resorption [41,42].

Iodoform

Besides its antiseptic features, when used for canal filling in deciduous teeth, it is resorbed in accordance with the root, and it does not cause any harmful effect on the permanent tooth germ. It can easily be applied to root canals and side canals. In addition, it is also reported that the excessive iodoform path replaces the normal tissue rapidly and that it does not cause any foreign object reaction. The material is sometimes resorbed more rapidly than the root and makes the canals empty [41].

Calcium Hydroxide-Iodoform Pastes

The purpose of adding iodoform into calcium hydroxide is to combine the known positive features of both pastes and to increase the antibacterial effectiveness of calcium hydroxide. The calcium hydroxide-iodoform paste has several advantages such as being easy to apply, having no toxic effect on the permanent teeth, being able to resorb with roots and being a radio opaque material [42]. The parts of the material exceeding the canal to the periapical tissues are rapidly resorbed and does not form a hard body. In this way, it minimizes the probability of the canal filling path to change the direction of the permanent tooth. In addition, two basic materials forming the paste (calcium hydroxide and iodoform) are responsible for the high-level antibacterial features of the material [38]. In their study, Estrela et al. [43], for investigating the effect of iodoform on the antibacterial effectiveness of calcium hydroxide, used the agar diffusion method and found that iodoform did not have any effect on the antibacterial effectiveness of calcium hydroxide. Harini Priya et al. [44] compared the antibacterial effectiveness of four canal filling pastes (KH, ZOE, Vitapex and Metapex) on the bacteria they obtained via the devital deciduous teeth. The results revealed that facultative/aerob from all the devital deciduous teeth and anaerob microorganisms from 80% of them were isolated. In addition, in one of the samples, Candida albicans was found. The researchers reported that ZOE had the highest level of antibacterial effectiveness on the microorganisms in question and that the calcium-iodoform paste ranked the second in terms of antibacterial effectiveness. In clinical and histopathological studies, it was found that canal fillings with calcium hydroxideiodoform paste in deciduous teeth led to successful results and that in these cases, bone regeneration was observed [38,45]. It was also reported that wall adaptation and impermeability were good. The mixture of calcium hydroxide-iodoform is thought to be an ideal pulpal filling material for deciduous teeth [38, 46]. In addition, some researchers stated that the paste is resorbed early in the canal, which does not have negative influence on the success of the treatment, though [45, 46]. Nakornchai et al. [45], in their 12-month study, reported clinical success rates of %96 for calcium hydroxide-iodoform paste and %56 for radiographic. Howley et al. [47] found in their study on deciduous incisor teeth that calcium hydroxide-iodoform paste had a success rate of 100% clinically and 73% radiographically. In another study conducted in a period of 18 months by Subramaniam and Gilhotra [48], who compared calcium hydroxide-iodoform paste, zincoxide

eugenol and calcium hydroxide-iodoform-zinc oxide eugenol, it was found that calcium hydroxideiodoform paste demonstrated a success rate of 100%, while calcium hydroxide-iodoform-zinc oxide eugenol paste and zinc oxide eugenol had a success rate of 93.3%. Gupta and Das [49], in their study in which they followed the canal treatments using zinc oxide eugenol and calcium hydroxide-iodoform paste on necrotic deciduous teeth for six months, found that calcium hydroxide-iodoform paste had a success rate of 90.48% and that zinc oxide eugenol had a success rate of 85.71%.

Calcium Hydroxide-Iodoform-Zinc Oxide Eugenol Paste

The compound of zinc oxide eugenol, calcium hydroxide and iodoform removing the disadvantages of these materials was produced to benefit from its advantages. Calcium hydroxide-iodoform-zinc oxide eugenol paste is not resorbed as long as it is found in the canal [50]. Due to its hydrophilic feature, it is appropriate to use in wet canal surfaces. It has an antibacterial effect and allows disinfection in accessory canals and dentin tubules which cannot be mechanically cleaned [51]. In their retrospective study investigating the longterm effects of canal treatment in deciduous teeth, Moskovitz et al. [52] evaluated the success of the root canal treatment applied using the calcium hydroxideiodoform-zinc oxide eugenol paste on 242 deciduous molar teeth at the end of 33.5 months The researchers reported 90% success for teeth receiving radiolucent in the root environment and provided no information about the place or width of the radiolucent area for these teeth. Rewal et al.[53] compared calcium hydroxideiodoform-zinc oxide eugenol paste and zinc oxide eugenol paste and found that calcium hydroxideiodoform-zinc oxide eugenol paste was a good choice for deciduous teeth canal treatments with a rate of 100%.

Lesion sterilization and tissue repair (LSTR)

In recent years, Cariology Research Unit of Niigata University School of Dentistry has developed the concept of LSTR. The theory behind LSTR is that the repair of damaged tissue might occur if lesions are disinfected. This has also been referred to noninstrumental endodontic treatment (NIET). The mix is also called as triple Antibiotic paste, Antibiotic mixture. It uses a mixture of 3 Antibiotics 1. Metronidazole 2. Ciprofloxacin 3. minocycline. The walls of access cavity were chemically cleaned with EDTA, a chelating agent, which is used to improve the chemo mechanical debridement because of its ability to remove smear layer and allowing Antibiotic to penetrate into the dentinlal tubules. Pulpal floor is covered with 3 mix-MP. The procedure which is termed as “medication cavity”.

Pulpotec

Pulpotec has antiseptic, antibacterial and anti-inflammatory properties [63] The main component of this product is iodoform, and due to its antiseptic properties, it acts like an antibiotic paste at the entry of the empty root canal. Pulpotec can be used in the teeth showing bone lesion and help in reduction of clinical signs of infection. The clinical and radiological results show that, this procedure could be considered as an alternative to the conventional endodontic treatment for necrotic primary teeth in paediatric dentistry [64]

Aloe vera

Aloevera is an herbal and naturally found material and its properties made possible its wide usage in dentistry for various therapeutic properties. It enhances various phases of wound healing process, such as macrophage recruitment, collagen synthesis and wound contraction [65] Khairwa et al [66]evaluated clinical and radiographic success of zinc oxide combined with aloe vera and showed good

success rate. They reported that this material can be used as an alternative for zinc oxide eugenol.

Zinc oxide eugenol and aloe vera

Khairwa et al. evaluated clinically and radiographically a mixture of zinc oxide eugenol and aloe vera as an obturating material for Pulpectomy in a total of 15 primary molars for a period of 9 months.The incidence of pain present preoperatively reduced to 86.67% postoperatively. Tenderness to percussion was noted in all the patients preoperatively. At 9 months, the reduction of tenderness to percussion in 93.34% of cases and was highly significant. Mobility and sinus formation was not observed in any of the patients at any time interval. Periapical radiolucency was present in all the 15 cases before the start of the study. Radiographic examination was carried out at seven days, one month, 3 months, 6 months and 9 months interval and it was observed that 11 cases (73.34%) demonstrated arrest or decrease of radiolucency. This was highly significant [68]

Ozone

Ozone is gaseous, energized form of oxygen, it is unstable and dissociates readily back into oxygen, thus liberating so called singlet oxygen, which is a strong oxidizing agent. They are responsible for remarkable bactericidal and fungicidal effects. In the study conducted by Chandra et al. [67] there was good clinical success rate at 12 months follow up, which was attributed to the antibacterial and excellent healing properties of ozone peroxides. There is also progressive bone regeneration observed at the follow ups. ZOE had radiographic success rate less than that of ozonated oil-ZOE. Accordingly,they[67] have concluded that, it can be considered as a good alternative for ZOE.

Zinc oxide eugenol, calcium hydroxide, and sodium fluoride

A mixture of Calcium hydroxide, Zinc oxide powder, and Sodium fluoride (10%) was used as an obturating material, combining the advantages of both Calcium hydroxide and zinc oxide. Calcium fluoride as a reaction product added radiopacity to the root canal filling material. Addition of fluoride had given the material a resorption rate similar to the resorption rate of the roots of the primary pulpectomized teeth. In cases of overfilled canals, the material was not seen to resorb even after two years of follow-up completely; hence care should be taken not to over push the material beyond the apex. Different concentrations of sodium fluoride as liquid was added to the mixture of zinc oxide and calcium hydroxide and was evaluated for the resorption of the root canal filling material intraarticularly, interradicularly and periapically. The mixture made by using 8% sodium fluoride showed good result.[69]

Chitra HAP-Fil

Jeeva and Retnakumari et al. observed the Current trend in dentistry towards the use of biomaterials such as hydroxy apatite. In an attempt to find an appropriate root canal obturating material, they designed a new product named “Chitra HAP-Fil”. It is a hydroxyapatite nanoparticle gel based root filler material, which exactly corresponds to the mineral content of bone and dentine, deemed to be highly biocompatible. “Chitra HAP-Fil” apparently satisfies all requirements of an ideal pulpectomy material. This study was carried out to investigate the cellular and microbial response of Chitra HAP-Fil in comparison with Zinc oxide eugenol and Metapex by invitro methods.In Hydroxy apatite - Iodoform paste (Chitra HAP-Fil), The prime ingredient is hydroxyapatite nanoparticle gel (65%) which is the basic mineral content of human bone and pure Iodoform (32%) which imparts antibacterial property to the paste. The gelling agent (alginate) – 3% (including 0.2% surfactant) binds with the calcium ions in the hydroxyapatite. The study evaluated the cytotoxicity and antimicrobial activity

of three pulpectomy materials, namely Zinc oxide eugenol, Chitra HAP-Fil and Metapex. The cellular response of three materials were evaluated and results showed that Metapex is significantly least cytotoxic than Chitra HAP Fil which is less cytotoxic than Zinc oxide eugenol [70]

Conclusion

Unless protective treatments become common in deciduous teeth, endodontic treatments will go on playing a big role in the treatment of tooth decays. This situation brings about search for new materials and techniques. The treatment modalities and medicaments that have been discussed, highlighting the most substantiated and qualifying those are revolutionary in pediatric dentistry. And more research and further innovation will help enhancing the quality of pediatric dental practice.

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