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Review

Root Canal Filling Materials in Primary Teeth – Review

Maria Shindova

Department of Paediatric Dentistry, Faculty of Dental Medicine, Medical University of Plovdiv, Plovdiv, Bulgaria

Corresponding author: Maria Shindova, Department of Paediatric Dentistry, Faculty of Dental Medicine, Medical University of Plovdiv, 3 Hristo Botev Blvd., 4000 Plovdiv, Bulgaria; E-mail: mariya.shindova@gmail.com; Tel.: + 359 898 390 935

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Abstract

Inadequate treatment of endodontic infections in primary teeth results in a loss of a deciduous tooth or abnormality in the development of hard dental tissues of the permanent successor. The main goal is to maintain the integrity and health of the primary tooth until their physiological exfoliation. The success of the endodontic treatment depends on the antimicrobial activity of the root canal filling material that contributes to the elimination or reduction of the microbial infection of the root canal system. The aim of this article is to systematically review the contemporary scientific literature concerning the root canal filling materials used in primary teeth. A critical evaluation of the antimicrobial activity, as well as the advantages and disadvantages of the investigated materials, has been made. Knowledge of the composition and characteristics of the available obturating materials is a useful advantage to dentists to address the functional problems associated with endodontic infections in very young patients. Future studies should also seek and compare the long-term effects of the use of traditional and alternative intracanal materials.

Keywords

paediatric dentistry, primary dentition, root filling materials

INTRODUCTION

Endodontic infection of the primary teeth is an infection of the root canal system and as such it can involve the pulp and the periapical tissues surrounding the apex of the tooth root. The best treatment option in such cases is pulpectomy. This treatment modality consists in complete removal of the necrotic and irreversibly infected pulp tissue of the pulp chamber and root canals of a tooth affected by extensive caries lesions, traumatic injuries or other causes.[1,2] The main goal is to maintain the integrity and health of the primary tooth until their physiological exfoliation.[3] As the tooth remains asymptomatic, in anatomical and functional condition, it performs an extremely important role in the masticatory process and has phonetic, aesthetic, and morphological functions.[1,3] The inadequate or inappropriate treatment or lack of treatment at all of the endodontic infection results in a loss of the deciduous tooth or abnormality in the development of hard dental tissues of the permanent successor known as Turner's hypoplasia. The loss of teeth leads to many problems such as loss of the arch length, inadequate space for permanent teeth, ectopic eruption, disturbance in the eruption sequence, development of the tongue thrusting habit, embarrassment, speech disorders, and eating and masticatory disorders.[4,5] The success of the endodontic treatment depends on the elimination or reduction of the microbial infection of the root canal systems.[6] Rocha et al. found that microorganisms with a predominance of anaerobic bacteria were disseminated within the whole root canal system (dentinal tubules, accessory canals, secondary canals, apical foramen, apical root cementum surface, etc.) as well as on the physiological resorptive areas on the external apical tooth surface.[7] Thus,

three important and essential elements in pulp therapy are required – adequate root canal debridement, antimicrobial irrigants, and antibacterial filling materials.[8] The complex anatomy of the root canal system (sharp curvatures and lateral canals) and the physiological resorption (no apical limit, occurs irregularly, not seen radiographically oftentimes) make the access and the instrumentation hard.[3,9,10] In addition, Faria et al. found that several resistant microorganisms could persist after biomechanical preparation and use of intracanal irrigants.[11] Observing the importance of this aspect of the endodontic infections in primary dentition, a significant number of researchers emphasized the antimicrobial activity of the root canal filling material. The major goal of the filling materials is to eliminate the microorganisms from the root canal system thus neutralizing their toxic products, preventing reinfections, and supporting the healing process.[12-14]

AIM

The aim of this article is to systematically review the contemporary scientific literature concerning the root canal filling materials used in deciduous dentition. A critical evaluation of the antimicrobial activity and the advantages and disadvantages of the investigated materials has been made. The expository analysis provides insight into and summarizes the succession in the right therapeutic approach.

The ideal characteristics of a root canal filling material in primary teeth include biocompatibility, broad antimicrobial activity, to be a bactericidal material or not to encourage microbial growth, degradation similar to the physiological tooth root resorption, easy filling and removal of the material from the root canal system, resorbable in cases of periapical extrusion, no aggression to the periapical tissues and tooth germ of the permanent tooth, radiopacity, and no discoloration of the tooth.[9,15,16] Considering the limitations of the root canal instrumentation and the obstacles to the intracanal irrigants, the use of root canal filling material with antimicrobial activity is of great importance for the success of the endodontic treatment in primary dentition.[10,13] Numerous researchers investigated the antimicrobial spectrum of action of the materials used and the results obtained demonstrated significant divergence.[17-20] The agar diffusion test has been widely used for this purpose.[3,6,15,16,21,22] As an in vitro method, it requires the investigated material to diffuse into the agar, and the inhibitory effects are a combination of diffusion potential and antimicrobial activity.[23]

The root canal filling materials used in deciduous dentition are divided into several groups according to their active ingredients **(Table 1)**. They could be used alone or in combinations with other active substances (formocresol, chlorhexidine, tetracycline, chloramphenicol, zinc acetate, metronidazole, etc.), be available in ready-to-use paste form or for ex tempore preparation.

Zinc oxide eugenol

Zinc oxide eugenol (ZOE) is a mixture of zinc oxide (powder) and eugenol (liquid). It is the first recommended obturating material for primary teeth and is still the most commonly and traditionally used material in the USA for treatment of endoinfections in deciduous teeth and the second choice in Brazilia.[10,21] The disadvantages of this material include a slower rate of resorption than the physiological one of the root of the primary teeth, absence of biocompatibility, transitory to severe irritation of the periapical tissues, necrosis of the alveolar bone and cementum, but it does not show cytotoxicity.[10,23,24] Antoniazzi et al. showed a risk of causing a deviation of eruption trajectory of the permanent successor tooth if the paste was forced through the radicular apex.[3] The same authors also found more rapid absorption of ZOE when mixed with blood, fluids, and debris. Quieroz et al. and Kriplani et al. found a strong antimicrobial activity against *E. faecalis*, *E. coli*, *S. aureus*, *Str. mutans*, and *Kocuria rhizophila*, with the largest zones of bacterial growth of inhibition formed around *E. coli*.[6,13] The results of most studies investigating its antibacterial efficiency demonstrated that ZOE inhibited more effectively gram-negative than gram-positive bacteria.[13,25] Several authors attributed the antimicrobial effects of ZOE to eugenol.[13,14,16] Navit et al. observed that eugenol-based root canal filling materials showed the highest antimicrobial activity against *E. faecalis* at 24 hours time intervals.[21]

In contrast, in an in-vitro evaluation of antimicrobial efficiency, ZOE demonstrated no inhibition of microbial growth against the most prevalent organisms in infected canals of primary teeth.[10] Concerns about the surroundings of ZOE led to a search of alternative root canal filling materials for deciduous teeth and it has been combined with various materials such as cresol and formocresol which increase its success rate but do not make it more resorbable than ZOE alone.[4]

Iodoform-based pastes (IBP)

Iodoform is a bactericidal, non-irritant radiopaque material and with high rates of clinical success in pulpotomies and pulpectomies.[3,16] Iodoform pastes have better resorbability, biocompatibility, and disinfectant properties than ZOE.[4,20] Gomes et al. considered that due to the incorporation of iodoform as a bactericidal agent, the iodoform-based pastes showed better antimicrobial activity.[16] Its antiseptic action is due to the slow release of iodine as an oxidizing agent, causing irreversible oxidization and inactivation of essential metabolic compounds such as proteins, nucleotides, and fatty acids.[16] In 2006, a study demonstrated total microbial growth inhibition of Guedes-Pinto paste, while a year later, Piva et al. reported the opposite effect of the same material.[10,18] Endoflas is a mixture, containing powder of iodoform (40.6%), zinc oxide (56.5%), calcium hydroxide (1.07%), barium sulfate (1.63%), and liquid consisting of

Table 1. Root canal filling materials used in primary teeth

Root canal filling material	Composition – active ingredients	Commercial products	Mixing ratio
Zinc oxide eugenol (ZOE)	Powder: Zinc oxide Liquid: Eugenol	-	*Ex tempore* 0.2 g/1 scoop: 7 drops/0.07 cc
Calcium hydroxide-based pastes	Powder: Calcium hydroxide Liquid: Sterile water	Hydrocal Calcium hydroxide (Dental powder)	*Ex tempore* 0.17 g/1 scoop: 10 drops/0.1 cc
	Calcium hydroxide, water, glycerine, polyethylene glycol	Apexical *Calcipast* *Calxyd*	Available in paste form
Calcium hydroxide+iodorm-based pastes	Calcium hydroxide, iodoform, silicone oil	Metapex Vitapex *Calcipast*+I	Available in paste form
Iodorm-based pastes	Powder: Iodorm, calcium hydroxide, zinc oxide, barium sulfate Liquid: Eugenol	Endoflas	*Ex tempore* Mix the components to a homogeneous thin paste consistency
	Iodoform	KRI paste Guenes-Pinto paste Maisto paste	Available in paste form
Calcium hydroxide+chlorhexidine-based pastes	Powder: Calcium hydroxide Liquid 2% Chlorhexidine	Cavipac + Dentochlor	*Ex tempore* 2 g powder per 1 ml of liquid
ZOE+chlorhexidine-based pastes	Powder: Zinc oxide powder + Chlorhexidine dihydrochloride Liquid: Eugenol	-	*Ex tempore* 0.2 g: 0.002 g: 0.07 cc
Mineral trioxide aggregate (MTA)	Powder: SiO_2, K_2O, Al_2O_3, Na_2O, Fe_2O_3, SO_2, CaO, Bi_2O_3, MgO, and several mineral oxides Liquid: Distilled water	ProRoot MTA MTA Angelus	*Ex tempore* 0.0013 g: 0.05 mL

eugenol and paramonochlorphenol. The results of a recent study demonstrated that Endoflas showed the maximum mean zone of inhibition against *E. faecalis*.[21] The antimicrobial activity of eugenol-based root canal filling materials such as Endoflas and ZOE is due to the action of eugenol, causing protein denaturation rendering the microorganisms non-functional.[21] In addition, the authors found that ZOE and materials containing zinc oxide were more effective against microorganisms compared to materials without zinc oxide.[15] IBPs cause yellow-brownish discoloration of the tooth crown. Nowadays, this type of pastes is no longer available for use in Europe and alternative components are researched.

Calcium hydroxide-based pastes ($Ca(OH)_2$)-based pastes)

Calcium hydroxide has a moderate to weak antimicrobial action as a result of its ionic dissociation into Ca^{2+} and OH^- ions.[15] This process depends on the vehicle used in the formulation of the root canal filling material – aqueous, oily and viscous.[20] Ozalp et al. reported a high degree of solubility when an aqueous vehicle is used that resulted in complete absorption of the paste from the root canal before the end of the physiological resorption, requiring new endodontic obturation.[26] The authors also found that the solubility of the pastes with a viscous vehicle was low, while those with oily vehicles had the lowest one. When used alone, calcium hydroxide does not inhibit *E. faecalis* and *E. coli*, which could be explained by their tolerance of high pH values, varying from 9 to 11.[20,22] The neutralization of the high pH by blood or buffers in culture media is a possible reason. Rezende et al. emphasized the precipitation of the medicament on the agar in in-vitro experiments, preventing its diffusion.[20,27] Basir et al. and Asgary et al. reported that $Ca(OH)_2$-based pastes had the highest antimicrobial activity after 24, 48, and 72 hours compared to MTA, Portland cement, Dycal and Sealapex against *S. aureus*, *E. faecalis*, and *B. subtitlis*.[4,12,28] However, some studies demonstrated contradictory results and reported weak inhibition of *E. faecalis* by $Ca(OH)_2$.[20,29] Navit et al. used $Ca(OH)_2$ in combination with chlorhexidine and reported the best results against *E. faecalis* in comparison with Metapex.[21]

The possible reason could be the antibacterial and antifungal efficiency of the used broad-spectrum antiseptic.[21]

Calcium hydroxide + iodoform-based pastes

The combination of calcium hydroxide pastes with an oily vehicle and iodoform as an antibacterial substance showed good results in the endodontic treatment in primary teeth.[15,30] When combining pure iodoform-based pastes with calcium hydroxide-based pastes, excellent results were also obtained based on clinical, radiographic and histological evaluation.[3] One study found that Vitapex was more effective than ZOE and no extruded material was observed in the periapical tissues, while particles of ZOE of extruded material had not changed in size at the end of the experiment.[20] However, Ozalp et al. emphasize that the complete resorption of the root canal filling is a disadvantage, requiring retreatment of the tooth until the physiological change of the tooth occurs.[26] Mortazavi et al. considered it a good alternative to ZOE due to the more convenient application of the paste as well as resorption similar to the rate of the physiological resorption of deciduous teeth.[30] Concerning the antimicrobial activity of Vitapex, the authors found also that it was statistically significantly better than the root canal filling material containing $Ca(OH)_2$ alone.[20,26] In several studies, the combined use of $Ca(OH)_2$ + iodoform exhibited no antimicrobial action against pure cultures of microorganisms in the diffusion agar test, probably due to the reaction between the calcium hydroxide and the diacid combinations of endodontic substances.[4,6,15,18]

Other root canal filling materials

In India, the use of antibacterial mixture including ciprofloxacin, metronidazole, and minocycline demonstrated considerable clinical and radiographic success.[5]

In 2020, Brazilian researchers investigated an experimental phytotherapeutic paste containing terpineol and cinnamaldehyde for endodontic treatment of primary teeth and reported antimicrobial activity against *E. faecalis* similar to the ZOE paste.[9]

Kirplani et al. found a superior antimicrobial efficiency of Aloe vera and sterile water as an obturating material in primary teeth compared to ZOE, Metapex, and calcium hydroxide.[6]

In 2008, Fabiane et al. determined that MTA had high levels of antimicrobial activity in comparison with ZOE and a combination of calcium hydroxide and iodoform. In contrast, ten years later, MTA showed no antibacterial activity in an in vitro study in Iran.[10]

CONCLUSIONS

Numerous root canal filling materials for deciduous teeth are described in dental literature.[20,26,31] However, there is little agreement between paediatric dental practitioners for the best available treatment option.[20,32] Future studies should also seek the long-term effects of the treatment. The antimicrobial activity is the first step in the investigation of the filling materials. The next step includes tests associated with genotoxicity, cytotoxicity, carcinogenicity.[3] A balance needs to be achieved. Knowledge of the indications for the use, composition, and characteristics of the available root filling materials carries a huge advantage for the dentists when they have to address the functional problems associated with an endodontic infection in very young patients.

REFERENCES

1. American Academy of Pediatric Dentistry. Guideline on pulp therapy for primary and young permanent teeth. Pediatr Dent 2009; 31(6):179–86.
2. Bodrumlu E, Semiz M. Antibacterial activity of a new endodontic sealer against Entercoccus faecalis. J Can Dent Assoc 2006; 72:637.
3. Antoniazzi BF, Pires CW, Bresolin CR, et al. Antimicrobial activity of different filling pastes for deciduous tooth treatment. Braz Oral Res 2015; 29:1–6.
4. Basir L, Khanehmasjedi M, Khosravi A, et al. Investigating the antimicrobial activity of different root canal filling pastes in deciduous teeth. Clin Cosmet Investig Dent 2019; 11:321.
5. Prabhakar AR, Sridevi E, Raju OS, et al. Endodontic treatment of primary teeth using combination of antibacterial drugs: an in vivo study. J Indian Soc Pedod Prev Dent 2008; 26 Suppl 1:S5–10.
6. Kriplani R, Thosar N, Baliga MS, et al. Comparative evaluation of antimicrobial efficacy of various root canal filling materials along with aloevera used in primary teeth: a microbiological study. J Clin Pediatr Dent 2013; 37(3):257–62.
7. Rocha CT, Rossi MA, Leonardo MR, et al. Biofilm on the apical region of roots in primary teeth with vital and necrotic pulps with or without radiographically evident apical pathosis. Int Endod J 2008; 41(8):664–9.
8. Tronstad L. Recent development in endodontic research. Scand J Dent Res 1992; 100(1):52–9.
9. Freire AR, Freire DE, Sousa SA, et al. Antibacterial and solubility analysis of experimental phytotherapeutic paste for endodontic treatment of primary teeth. Pesqui Bras Odontopediatria Clín Integr 2020; 21.
10. Fabiane P, Faraco Junior IM, Estrela C. Antimicrobial activity of different root canal filling pastes used in deciduous teeth. Materials Research 2008; 11(2):171–3.
11. Faria G, Nelson-Filho P, Freitas AC, et al. Antibacterial effect of root canal preparation and calcium hydroxide paste (Calen) intracanal dressing in primary teeth with apical periodontitis. J Appl Oral Sci 2005; 13(4):351–5.
12. Estrela C, Bammann LL, Pimenta FC, et al. Control of microor-

ganisms in vitro by calcium hydroxide pastes. Int Endod J 2001; 34(5):341–5.
13. Queiroz AM, Nelson-Filho P, Silva LA, et al. Antibacterial activity of root canal filling materials for primary teeth: zinc oxide and eugenol cement, Calen paste thickened with zinc oxide, Sealapex and EndoREZ. Braz Dent J 2009; 20(4):290–6.
14. Leonardo MR, Da Silva LA, Tanomaru Filho M, et al. In vitro evaluation of antimicrobial activity of sealers and pastes used in endodontics. J Endod 2000; 26(7):391–4.
15. Hegde S, Lala PK, Dinesh RB, et al. An in vitro evaluation of antimicrobial efficacy of primary root canal filling materials. J Clin Pediatr Dent 2012; 37(1):59–64.
16. Reddy S, Ramakrishna Y. Evaluation of antimicrobial efficacy of various root canal filling materials used in primary teeth: a microbiological study. J Clin Pediatr Dent 2007; 31(3):193–8.
17. Silva LA, Nelson-Filho P, Faria G, et al. Bacterial profile in primary teeth with necrotic pulp and periapical lesion. Braz Dent J 2006; 17(2):144–8.
18. Amorim LD, Toledo OA, Estrela CR, et al. Antimicrobial analysis of different root canal filling pastes used in pediatric dentistry by two experimental methods. Braz Dent J 2006; 17(4):317–22.
19. Silva CM, Candelária LFA, Bombana AC. Estudo comparativo da ação antimicrobiana entre cinco pastas de obturação de canais radiculares de dentes decíduos. [Comparative study of the antimicrobial effect of five root canal filling materials for deciduous teeth.] J Bras Odontopediatr Odontol Bebê 2002; 5(28):502–10.
20. Barja-Fidalgo F, Moutinho-Ribeiro M, Oliveira MA, et al. A systematic review of root canal filling materials for deciduous teeth: is there an alternative for zinc oxide-eugenol? ISRN Dent 2011; 2011:367318.
21. Navit S, Jaiswal N, Khan SA, et al. Antimicrobial efficacy of contemporary obturating materials used in primary teeth – an in-vitro study. J Clin Diagn Res 2016; 10(9):ZC09–ZC12.
22. Monajemzadeh A, Asoor SA, Aslani S, et al. In vitro antimicrobial effect of different root canal sealers against oral pathogens. Curr Med Mycol 2017; 3(2):7–12.
23. Tchaou W-S, Turng B-F, Minah GF, et al. In vitro inhibition of bacteria from root canals of primary teeth by various dental materials. Pediatr Dent 1995; 17(5):351–5.
24. Grossman LI. Microbiology. Chapter 2. In: Chandra BS, Krishna VG, editors. Grossman's Endodontics Practice. 12th ed. Lippincott William & Wilkins; 2010:43–52.
25. Tchaou WS, Turng BF, Minah GE, et al. Inhibition of pure cultures of oral bacteria by root canal filling materials. Pediatric Dentistry 1996; 18:444–9.
26. Ozalp N, Saroğlu I, Sönmez H. Evaluation of various root canal filling materials in primary molar pulpectomies: an in vivo study. Am J Dent 2005; 18(6):347–50.
27. Rezende GP, Costa LR, Pimenta FC, et al. In vitro antimicrobial activity of endodontic pastes with propolis extracts and calcium hydroxide: a preliminary study. Braz Dent J 2008; 19(4):301–5.
28. Asgary S, Kamrani FA. Antibacterial effects of five different root canal sealing materials. J Oral Sci 2008; 50(4):469–74.
29. Chawla HS, Setia S, Gupta N, et al. Evaluation of a mixture of zinc oxide, calcium hydroxide, and sodium fluoride as a new root canal filling material for primary teeth. J Indian Soc Pedod Prev Dent 2008; 26(2):53–8.
30. Mortazavi M, Mesbahi M. Comparison of zinc oxide and eugenol, and Vitapex for root canal treatment of necrotic primary teeth. Int J Paediatr Dent 2004; 14(6):417–24.
31. Takushige T, Cruz EV, Asgor Moral A, et al. Endodontic treatment of primary teeth using a combination of antibacterial drugs. Int Endod J 2004; 37(2):132–8.
32. Dunston B, Coll JA. A survey of primary tooth pulp therapy as taught in US dental schools and practiced by diplomats of the American Board of Pediatric Dentistry. Pediatr Dent 2008; 30(1):42–8.

Материалы для пломбирования корневых каналов молочных зубов – обзор

Мария Шиндова

Кафедра детской дентальной медицины, Факультет дентальной медицины, Медицинский университет – Пловдив, Пловдив, Болгария

Адрес для корреспонденции: Мария Шиндова, Кафедра детской дентальной медицины, Факультет дентальной медицины, Медицинский университет – Пловдив, бул. „Христо Ботев“ № 3, 4000 Пловдив, Болгария; E-mail: mariya.shindova@gmail.com; Tel.: + 359 898 390 935

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Резюме

Неправильное лечение эндодонтических инфекций временных зубов приводит к потере молочного зуба или аномалии в развитии твёрдых зубных тканей постоянных зубных элементов.

Основная цель – сохранить целостность и здоровье молочного зуба до его физиологического разрушения. Успех эндодонтического лечения зависит от антимикробной активности пломбировочного материала канала, который способствует устранению или уменьшению микробной инфекции системы корневых каналов. Целью данной статьи является систематический обзор современной литературы, посвящённой пломбировочным материалам для временных зубов. Дана критическая оценка антимикробной активности, а также преимуществ и недостатков исследуемых материалов. Знание состава и характеристик имеющихся пломбировочных материалов является полезным преимуществом для стоматологов при решении функциональных проблем, связанных с эндодонтическими инфекциями у многих молодых пациентов. В будущих исследованиях также следует искать и сравнивать долгосрочные эффекты использования традиционных и альтернативных внутриканальных материалов.

Ключевые слова

детская стоматология, первичный прикус, материалы для пломбирования корней