

Clinical and Radiographical Evaluation of Single- versus Multiple-Visit Pulpectomy Treatment in Primary Teeth with Apical Periodontitis

Bhargavi S. Patel, Shantanu R. Choudhari, Swati Goyal, Chetana B. Patel, Sweta A. Waghela

Department of Pediatric and Preventive Dentistry, Government Dental College and Hospital, Ahmedabad, Gujarat, India

Abstract

Context: This study highlights success rate as well as advantages and disadvantages of single- versus multiple-visit pulpectomy in children. **Aims:** This study was aimed to compare the success rate of single- and multiple-visit pulpectomy in primary teeth with apical periodontitis. **Settings and Design:** It was a randomized, double-blind study. The study was conducted in children with one or more restorable sixty primary molars with deep carious lesions and requiring pulpectomy in the age group of 4–8 years. **Subjects and Methods:** Selected teeth were divided into two groups of thirty each and treated either in single visit or multiple visits. Follow-up was done at the period of 1 month, 3 months, and 6 months and evaluated using Gutmann criteria. **Statistical Analysis Used:** The normality of data was checked by Shapiro–Wilk test. Intragroup comparison was made by using Friedman test and *post hoc*-Wilcoxon test. Mann–Whitney U-test was used for inter group comparison. **Results:** Clinical and radiographical success for both group showed statistically significant ($P < 0.001$) improvement when the baseline score (preoperative) was compared with other time intervals. No statistically significant difference ($P > 0.05$) was obtained when clinical outcome was compared between two groups. Although radiographical success for multiple-visit group is slightly more than the single-visit group at all time intervals, statistically it was not significant ($P > 0.05$). **Conclusions:** Single-visit can be considered a viable alternative to multiple-visit pulpectomy considering its various advantages, especially in children.

Keywords: Apical periodontitis, intracanal medicament, Metapex, multiple-visit pulpectomy, primary teeth, pulpectomy, single-visit pulpectomy

Submitted: 05-Mar-2020; **Revised:** 30-Jul-2020; **Accepted:** 25-Aug-2020; **Published:** 15-Oct-2020

INTRODUCTION

Dental caries is one of the most common bacterial diseases affecting humans. Pulpectomy is performed in teeth having irreversibly inflamed and necrotic pulp and helps to retain teeth in arch till their natural exfoliation time. Premature exfoliation of teeth can lead to malocclusion, esthetic, phonetic, or functional problems.^[1] The goal of pulpectomy is to reduce the bacterial count and promote healing of periradicular tissue.^[2] Apical periodontitis is inflammation and destruction of periradicular tissues caused by agents of endodontic origin. Conventionally, endodontic treatment is completed in multiple visits for such teeth, but in current times, single visit gaining popularity due to various advantages. Both modalities are practiced clinically still rationale for the same remains debatable. This study was done to evaluate the possible

advantages and disadvantages of single- and multiple-visit pulpectomy and its clinical application.

SUBJECTS AND METHODS

The present study was conducted in children with one or more restorable sixty primary molars with deep carious lesions and requiring pulpectomy having 4–8 years age. The study design was approved by the institutional ethical committee.

Address for correspondence: Dr. Bhargavi S. Patel,

5th Floor, Department of Pediatric and Preventive Dentistry, Government Dental College and Hospital, Civil Hospital Campus, Asarwa, Ahmedabad - 380 016, Gujarat, India.
E-mail: bhrgvi1994@gmail.com

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Patel BS, Choudhari SR, Goyal S, Patel CB, Waghela SA. Clinical and radiographical evaluation of single- versus multiple-visit pulpectomy treatment in primary teeth with apical periodontitis. *Indian J Dent Sci* 2020;12:225-31.

Access this article online

Quick Response Code:



Website:
www.ijds.in

DOI:
10.4103/IJDS.IJDS_34_20

Table 1: Gutmann Criteria for clinical and radiographic examination

Failure (0)	Questionable (1)	Success (2)
Clinical		
Persistent subjective symptoms	Sporadic vague symptomology often not reproducible	No tenderness to percussion or palpation
Recurrent sinus tract or swelling	Pressure sensation or feeling of fullness	Normal mobility
Predictable discomfort to percussion or palpation	Low grade discomfort following percussion, palpation or chewing	No sinus tract formation
Evidence of irreparable tooth fracture	Discomfort when pressure is applied by the tongue	Tooth function
Excessive mobility or progressive periodontal breakdown	Superimposed sinusitis with a focus on the treated tooth	No sign of infection or swelling
Inability to function on the tooth	Occasional need for analgesics to relieve minimal discomfort	No evidence of subjective discomfort
Radio-graphical		
Increased periodontal ligament space (> 2 mm)	Increased periodontal ligament space(> 1 mm and <2 mm)	Normal to slightly thickened periodontal ligament space
Lack of osseous repair within rarefaction or increased rarefaction	Stationary rarefaction or slight repair evident	Elimination of previous rarefaction
Lack of new lamina dura	Increased lamina dura in relation to adjacent teeth	Normal lamina dura in relation to adjacent teeth
Presence of osseous rarefactions in periradicular areas where previously none existed	Evidence of resorption	No evidence of resorption
Visible patent canal space - unfilled or significant voids in obturation	Voids in obturation density	Dense, three dimensional obturation of canal space extending to cementum dentin junction (1 mm from apex)
Excessive overextension with voids in apical third active resorption coupled with other radiographic signs of failure.	Extension of filling material beyond anatomic apex	

Inclusion criteria for the study were (1) Children aged 4–8 years, (2) teeth with apical periodontitis after clinical and radiographical confirmation, (3) healthy patients, (4) presence of 2/3rd of root, and (5) restorable teeth. Exclusion criteria were (1) patients with systemic disease and special health-care needs, (2) insufficient tooth structure, (3) exfoliating tooth, and (4) evidence of internal or external resorption.

A detailed history and full-mouth examination was carried out. Standardized periapical radiographs were taken, and baseline score was noted. Randomization, enrollment, and assignment of participants to interventions were done by co-investigators.

Study design

It was a randomized and double-blind study. Selected teeth were randomly divided into two groups of thirty each as follows:

- Group 1: The single-visit group (study group)
- Group 2: The multiple-visit group (control group).

Randomization was carried out using envelope draw method. The parents were explained in detail about the study and allowed to participate in the study only after signed consent forms and also given choice to withdraw from the study at any point.

Clinical procedure

All treatment sessions were carried out by a single operator to eliminate inter-operator bias. Anesthesia was achieved by administering 2% lidocaine with 1:100,000 epinephrine (Nandini Medical Laboratories Pvt. Ltd, Indore, MP). Isolation was obtained using a rubber dam (GDC dental dam kit peedo) [Figure 1].

After removal of caries, access cavities were made and pulp extirpation was done. The working length was established with radiographic method (E speed film). Canals were debrided thoroughly with precurved k files (Mani, 21 mm) starting from 15 size file and then sequentially increasing up to size of 35. Canals were carefully irrigated with 2.5% sodium hypochlorite (Vishal dentocare Limited, Ahmedabad, India), 17% ethylenediaminetetraacetic acid (EDTA) and normal saline alternatively in between and root canal preparation was completed.

For the single-visit group, the canals were dried with paper points and obturated at the same appointment with metapex using disposable tips provided by manufacturer. Access cavities were then restored with restorative GIC (Gc Gold Label 2, Gc Corporation, Tokyo, Japan) and stainless steel crowns were placed in the same visit.

For the multiple-visit group, cotton pellet dampened with formocresol (Pharmadent Remedies Pvt. Ltd., Vadodara, India) was placed in chamber for 24 h and sealed with Cavitemp (Ammdent Cavitemp Temporary Filling). After 24 h, the cotton pellet was removed and irrigation with saline was done. Then, obturation was done with Metapex and stainless steel crowns were placed in the same visit.

A determination of treatment outcome as successful, questionable, and failure was made clinically and radiographically using criteria proposed by Gutman^[3,4] [Table 1] after 1-month, 3-month, and 6-month period by co-investigators. Each checkup involved a clinical and

Table 2: Comparison of clinical outcomes for single-visit group according to time intervals

Time intervals	Minimum	Mean±SD	Median	Maximum	P ^a
Baseline (n=30)	0	0.73±0.45	1.00	1	<0.001**
After 1 month (n=30)	1	1.73±0.45	2.00	2	
After 3 months (n=30)	1	1.87±0.35	2.00	2	
After 6 months (n=28)	0	1.89±0.42	2.00	2	

^aFriedman test, **P<0.001 highly significant. SD: Standard deviation

Table 3: Comparison of radiographical outcome for single-visit group according to time intervals

Time intervals	Minimum	Mean±SD	Median	Maximum	P ^a
Baseline (n=30)	0	0.70±0.47	1.00	1	<0.001**
After 1 month (n=30)	1	1.77±0.43	2.00	2	
After 3 months (n=30)	1	1.83±0.38	2.00	2	
After 6 months (n=28)	0	1.89±0.42	2.00	2	

^aFriedman test, **P<0.001 highly significant. SD: Standard deviation

radiographic examination of the pulpectomized teeth and their periradicular area.

RESULTS

Statistical analysis

After collection of data, the data were coded and entered in Microsoft Excel 2019. The normalcy of data was checked by Shapiro–Wilk test. Intragroup comparison was made by using Friedman test and *post hoc*-Wilcoxon test. Mann–Whitney U-test was used for intergroup comparison. The level of significance was kept at 5%.

Clinical and radiographical outcome for single-visit group

The result shows statistically significant ($P < 0.001$) improvement in the clinical score when the baseline score was compared with other time intervals. However, no significant difference ($P > 0.05$) was found for 1 month versus 6 months and 3 months versus 6 months [Table 2].

The mean radiographical score for single visit at baseline was 0.70 ± 0.47 , which increased statistically ($P < 0.001$) as the time period increases – at 6 months the mean score was found to be 1.89 ± 0.42 . Statistically highly significant difference ($P < 0.001$) was observed when the baseline score was compared with other time period [Table 3].

Clinical and radiographical outcomes for multiple-visit group

The clinical outcomes for multiple-visit group according to the time interval are shown in Table 4. Significant difference was observed when the mean score of baseline was compared with rest of the time intervals ($P < 0.001$).

The radiographical mean score for multiple visit group significantly ($P < 0.001$) increases as the time interval increases, having the maximum mean score of 1.93 ± 0.27 after 6 months. Statistically highly significant ($P < 0.001$) result was obtained when the mean score of baseline compared with rest of the time intervals [Table 5].

Intergroup comparison of clinical and radiographical outcomes

The intergroup comparison of mean score was made by applying Mann–Whitney U-test. Comparison of clinical outcome at different time intervals between groups is shown in Graph 1. The mean score of clinical outcome is more for multiple-visit group at 1 month and 3 months and at 6 months, the mean score of clinical outcome was same for both the groups. No statistically significant difference ($P > 0.05$) was obtained when the mean score of clinical outcomes was compared between two groups. Graph 2 shows comparison of radiographical outcome at different time intervals in between two groups. Although the radiographical outcome for multiple-visit group is slightly more than the single-visit group at all time intervals, statistically it was not significant ($P > 0.05$).

DISCUSSION

Primary teeth play very important role in the development of occlusion. Pulpectomy includes removal of irreversibly inflamed or necrotic pulp tissue by cleaning the root canal system, followed by filling of the root canal with a material that resorbs at the same rate or faster than the primary root and can be eliminated rapidly if accidentally extruded through the apex.^[5]

This prospective study was conducted on teeth with similar pathology (apical periodontitis). Multiple-visit pulpectomy was taken as control group as conventionally treatment for apical periodontitis was completed in multiple visits with the use of different intracanal medicaments. Considering many advantages of single-visit pulpectomy, single visit was taken as experimental group to assess its outcome clinically and radiographically.^[6-12]

Children with age of 4–8 years with one or more primary molar having apical periodontitis were selected for the study irrespective of their sex, race, ethnicity, or social background. This age group was selected considering incomplete root

Table 4: Comparison of clinical outcomes for multiple-visit group according to time intervals

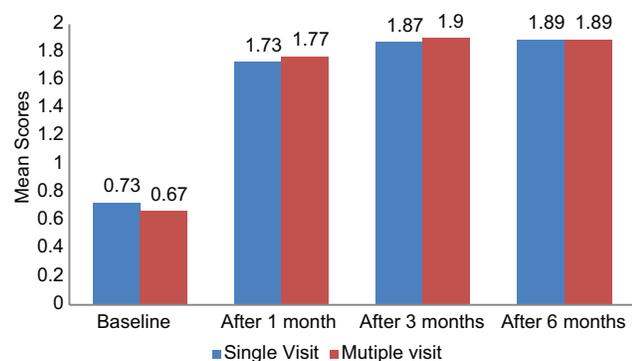
Time intervals	Minimum	Mean±SD	Median	Maximum	P ^a
Baseline (n=30)	0	0.67±0.48	1.00	1	<0.001**
After 1 month (n=30)	1	1.77±0.43	2.00	2	
After 3 months (n=30)	1	1.90±0.31	2.00	2	
After 6 months (n=27)	0	1.89±0.42	2.00	2	

^aFriedman test, **P<0.001 highly significant. SD: Standard deviation

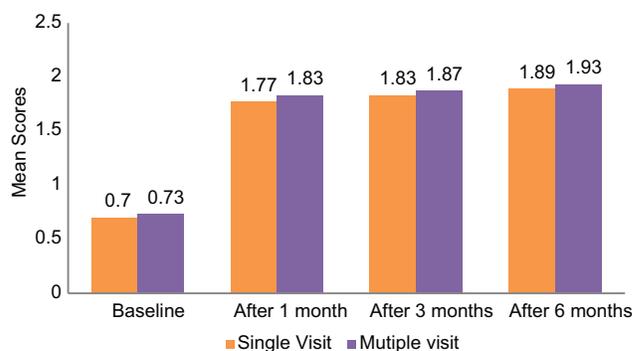
Table 5: Comparison of radiographical outcome for multiple-visit group according to time intervals

Time intervals	Minimum	Mean±SD	Median	Maximum	P ^a
Baseline (n=30)	0	0.73±0.45	1.00	1	<0.001**
After 1 month (n=30)	1	1.83±0.38	2.00	2	
After 3 months (n=30)	1	1.87±0.35	2.00	2	
After 6 months (n=27)	1	1.93±0.27	2.00	2	

^aFriedman test, **P<0.001 highly significant. SD: Standard deviation



Graph 1: Comparison of clinical outcome at different time intervals between groups



Graph 2: Comparison of radiographical outcomes at different time intervals between groups

formation and lack of co-operation in younger ones and physiological root resorption in elder ones.

Selection of patients and treatment done were in accordance with AAPD guidelines on pulp therapy for primary and immature permanent teeth.^[2] Clinical outcome studies require a long follow-up time to monitor, demand substantial economic resources, and pose the risk of losing patients at follow-ups. Total five teeth (8%) were lost at the end of 6-month follow-up period. However, the loss did not alter the situation to an extent that would render statistical comparisons and conclusions invalid.

For successful endodontic treatment, effective isolation is mandatory. Isolation during operative procedure was obtained using rubber dam as per recommendation given by the American Academy of Pediatric Dentistry and the UK National Clinical Guidelines for pulp treatment in the primary dentition, which suggest that the application of the rubber dam^[5,6] or equally effective isolation technique^[5] is mandatory to minimize bacterial contamination of the treatment site.

Another problem affecting success is microleakage. The SSC is extremely durable, relatively inexpensive, subject to minimal technique sensitivity during placement, and offers the

advantage of full coronal coverage.^[12] For standardization, all teeth received stainless steel crown luted with glass ionomer cement to minimize microleakage and have better results. The objective of pulpectomy as per AAPD guidelines is that radiographical infectious process should resolve in 6-month period and bone deposition should follow, and pretreatment clinical sign and symptoms should resolve in few weeks.^[13,14] Based on this, follow-up was done till 6-month period to see outcome.

Periradicular periodontitis is an inflammatory disease process consisting of host responses to infection of the root canal system of the affected tooth. It is very well known that apical periodontitis is caused by bacteria within root canals^[15] The treatment of apical periodontitis should be directed towards removal of the cause, i.e., bacterial eradication.^[16,17] Therefore, endodontic treatment is aimed to eliminate as many of these bacteria as possible. The number of visits required to treat periapical periodontitis is one of the debatable issues in endodontics. The accepted procedure is complete debridement and irrigation of the root canal during the first appointment, followed by the application of intracanal medicament. Obturation is then completed at the second or a later appointment.

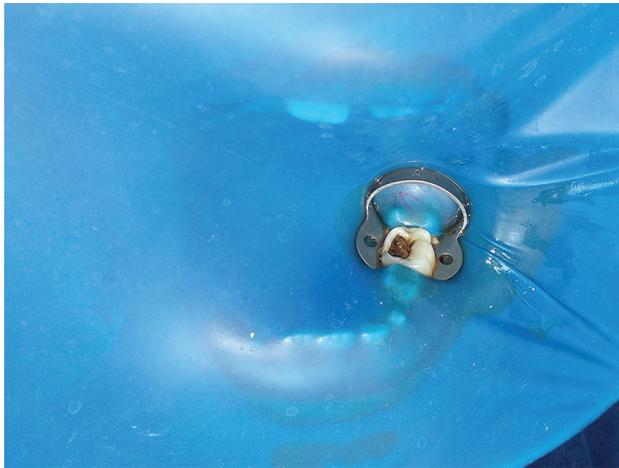


Figure 1: Clinical procedure under rubber dam

Mechanical instrumentation alone causes a 100–1000-fold decline in the number of bacteria, but complete eradication can be seen in only 20%–43% of the cases. Chemical disinfection is necessary to remove microorganisms, their by-products, pulp tissue remnant, and other debris from the root canal because it is difficult to eliminate all microorganism from an infected root canal system by mechanical instrumentation alone.^[2] Added antibacterial irrigation with NaOCl alternating with saline results in disinfection in some 40%–60% of the teeth thus treated.^[16,17] EDTA is normally used in a concentration of 17% and can remove the smear layers when in direct contact with the root canal wall for <1 min.^[18] The efficacy of EDTA in removing the smear layer was revealed by Mancini *et al.*^[19] as well as da Silva *et al.*^[20]

For optimal success, it is necessary to place intracanal medicaments within the pulp chamber or canals, which exert their antimicrobial effect by direct contact with the organisms or by way of vapor action that reaches all the irregularities within the canals to eliminate the endodontic infection and the microbial proliferation in the root canal system and neutralize the bacterial endotoxin in teeth with pulp necrosis.^[21] Formocresol is widely used in dentistry because of its antibacterial properties in root canal disinfection; it contains formaldehyde, an effective alkylating agent, and cresol, a protein-coagulating phenolic compound. Formocresol has antibacterial action due to the release of formaldehyde vapors which act as a germicidal agent.^[22]

Although widely accepted and used, the intracanal medicament in a treatment strategy has disadvantages like: (1) it does not necessarily kill all the remaining intracanal flora^[6-11] and (2) needs at least two visits to be optimally potent and (3) a temporal seal needs to be placed between appointments, thereby exposing root canals to risk of coronal leakage, which might lead to failure.^[23] The rationale behind immediate root filling is to prevent bacterial growth, as employed in single-visit endodontic treatment, which works in most infected cases.^[24] Also, single-visit treatments avoid the risk of coronal leakage if adhesive materials are used.

The outcomes of endodontic treatment might be influenced by several factors such as clinical approaches, skill and experience of operators and evaluators and follow-up periods. The overall high success rates of both groups obtained in this study could be attributed to proper isolation, high aseptic standards, correct protocols, and use of bactericidal iodoform paste as obturating material.

In this study, the clinical outcome of single-visit group was comparable to multiple-visit group during all the follow-up visits. For single- as well as multiple-visit groups, a significant change in radiographic scores occurred with time, i.e., there is increase in success, which is in accordance with clinical outcome. Multiple-visit group has slightly more radiographic success rate than single-visit group at all time intervals but statistically not significant. There could be several possible reasons for comparable success of both groups: Use of same method for isolation, i.e., rubber dam, single operator providing uniform standard treatment, proper instrumentation technique, selection of appropriate irrigant, and careful handling of the irrigating solution and measures that minimized microleakage and reinfection.

In recent time, one issue debated is whether meticulous cleaning by instrumentation and irrigation may reduce the need for intracanal medicament and provide effective satisfactory disinfection of the canal system or not. In a systematic review by Lin *et al.*,^[25] mechanical instrumentation with repeated irrigation with copious amounts of an antimicrobial agent was found to be the most efficient way to lessen the intracanal bacterial level.

Iodoform is a potent bactericidal, nonirritant, radiopaque agent and well suited for a nonshrinking and nonsoluble paste.^[26] Reyes and Reina^[27] and Kubota *et al.*^[28] suggested combining calcium hydroxide with iodoform gives excellent clinical, radiographical, and histological results. Easy resorption from the periapical areas, no foreign-body reaction, and potent germicidal properties are the requirements fulfilled by calcium-iodoform pastes that can successfully be used as root canal filling material. Machida Y^[29] found calcium hydroxide iodoform paste to resorb a little faster than the rate of root resorption. He considers calcium hydroxide iodoform mixture to be a nearly ideal pulpal filling material for primary teeth.

One case in group 1 (single visit) showed questionable parameter (0) as it required analgesics occasionally till the end of 6 month. Radiographically slight repair was evident. Another one in same group had reading of failure (0) in that predictable discomfort on pressure was present clinically and radiographically increased width of PDL (>2 mm) was seen.

In multiple-visit group, two teeth were recorded in questionable category (0). On clinical examination, one of them has low-grade discomfort on biting, often not reproducible and another has discomfort present only when pressure applied by tongue. Radiographically they had increased width of PDL (>1 mm and <2 mm) and increased lamina dura in relation

to adjacent teeth respectively. Teeth with questionable reading were kept on further follow up and they might require longer follow-up to conclude.

Bharuka and Mandroli^[4] conducted study in primary teeth with apical periodontitis and reported similar success rate for both single- and two-visit groups. Result of this study is in accordance with their study. Similar results were obtained by Molander *et al.*,^[7] Penesis *et al.*^[8] and Weiger *et al.*^[30]

Multiple-visit endodontic treatment has disadvantages such as interappointment contamination and flare ups caused by leakage or loss of temporary seal, prolonged time taken leading to patient fatigue, operator fatigue, and discontinued treatment, leading to failures. Nevertheless, some professionals prefer the multiple-visit approach to ensure no pain or postoperative complications before obturation of the root canal system as well as for greater likelihood of achieving microbiological reduction levels compatible with tissue repair through the use of intracanal medication, chemical and mechanical preparation, and additional therapies.

Single-visit pulpectomy is attractive as it involves less number of visits, less time, and thus is less expensive and very well accepted by patients. Also, reduced need of local anesthesia, less number of time rubber dam application and trauma due to clamp are additional advantages when children are considered. Many practitioners experience high success rates with this technique based on patient acceptance, lack of significant flare-ups, and practice management considerations. Such single-visit treatment would, if successful, be time-saving, and reduce the risk of inter-appointment infection.

CONCLUSIONS

Although the choice of treatment modality depends on operator, within limitation of the study, this present study gave evidence that, given a meticulously cleaned root canal, Single-visit pulpectomy treatment is as effective as multiple-visit pulpectomy. Single-visit can be considered a viable alternative to multiple-visit pulpectomy considering its various advantages, especially in children.

Limitations of the study

In the present study, the sample size was small and follow-up was done for the period of 6 months. Such small sample size and short observation periods may not reflect the long-term outcome. More studies using longer observation periods and larger samples are required to establish evidence-based decision regarding single-visit pulpectomy for primary teeth with apical periodontitis.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

- Fuks AB, Kupietzky A, Guelmann M. Pulp Therapy for the Primary Dentition. Editor(s): Nowak AJ, Christensen JR, Mabry TR, Townsend JA, Wells MH, Pediatric Denti-stry (Sixth Edition), Content Repository Only!. 2019;329-351.e1.
- American Academy of Pediatric Dentistry: Reference Manual. Guidelines for pulp therapy for primary and young permanent teeth. *Pediatr Dent* 2008-2009;30:170-4.
- Gutmann JL. Clinical, radiographic, and histologic perspectives on success and failure in endodontics. *Dent Clin North Am* 1992;36:379-92.
- Bharuka SB, Mandroli PS. Single-versus two-visit pulpectomy treatment in primary teeth with apical periodontitis: A double-blind, parallel group, randomized controlled trial. *J Indian Soc Pedod Prev Dent* 2016;34:383-90.
- Rodd HD, Waterhouse PJ, Fuks AB, Fayle SA, Moffat MA, British Society of Paediatric Dentistry. Pulp therapy for primary molars. *Int J Paediatr Dent* 2006;16 Suppl 1:15-23.
- Peters LB, van Winkelhoff AJ, Buijs JF, Wesselink PR. Effects of instrumentation, irrigation and dressing with calcium hydroxide on infection in pulpless teeth with periapical bone lesions. *Int Endod J* 2002;35:13-21.
- Molander A, Warfvinge J, Reit C, Kvist T. Clinical and radiographic evaluation of one-and two-visit endodontic treatment of asymptomatic necrotic teeth with apical periodontitis: A randomized clinical trial. *J Endod* 2007;33:1145-8.
- Penesis VA, Fitzgerald PI, Fayad MI, Wenckus CS, BeGole EA, Johnson BR. Outcome of one-visit and two-visit endodontic treatment of necrotic teeth with apical periodontitis: A randomized controlled trial with one-year evaluation. *J Endod* 2008;34:251-7.
- Paredes-Vieyra J, Enriquez FJ. Success rate of single-versus two-visit root canal treatment of teeth with apical periodontitis: A randomized controlled trial. *J Endod* 2012;38:1164-9.
- Dorasani G, Madhusudhana K, Chinni SK. Clinical and radiographic evaluation of single-visit and multi-visit endodontic treatment of teeth with periapical pathology: An *in vivo* study. *J Conserv Dent* 2013;16:484-8.
- Trope M, Delano EO, Orstavik D. Endodontic treatment of teeth with apical periodontitis: Single vs. multivisit treatment. *J Endod* 1999;25:345-50.
- Seale NS. The use of stainless steel crowns. *Pediatr Dent* 2002;24:501-5.
- Casas MJ, Kenny DJ, Johnston DH, Judd PL. Long-term outcomes of primary molar ferric sulfate pulpotomy and root canal therapy. *Pediatr Dent* 2004;26:44-8.
- 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;18:347-50.
- Kakehashi S, Stanley HR, Fitzgerald RJ. The effects of surgical exposures of dental pulps in germfree and conventional laboratory rats. *J South Calif Dent Assoc* 1966;34:449-51.
- Nair PN. Pathogenesis of apical periodontitis and the causes of endodontic failures. *Crit Rev Oral Biol Med* 2004;15:348-81.
- Trope M, Bergenholtz G. Microbiological basis for endodontic treatment: Can a maximal outcome be achieved in one visit. *Endod Topics* 2002;1:40-53.
- Calt S, Serper A. Time-dependent effects of EDTA on dentin structures. *J Endod* 2002;28:17-9.
- Mancini M, Armellini E, Casaglia A, Cerroni L, Cianconi L. A comparative study of smear layer removal and erosion in apical intraradicular dentine with three irrigating solutions: A scanning electron microscopy evaluation. *J Endod* 2009;35:900-3.
- da Silva LA, Sanguino AC, Rocha CT, Leonardo MR, Silva RA. Scanning electron microscopic preliminary study of the efficacy of SmearClear and EDTA for smear layer removal after root canal instrumentation in permanent teeth. *J Endod* 2008;34:1541-4.
- Buckley J. The chemistry of pulp decomposition, with a rational treatment for this condition and its sequelae. *Am Dent J* 1904;3:746-71.
- Schilder H. Intracanal medication. In: Ingle JJ: *Endodontics*. Philadelphia: Lea & Febiger; 1965. p. 488.
- Ray HA, Trope M. Periapical status of endodontically treated teeth in relation to the technical quality of the root filling and the coronal restoration. *Int Endod J* 1995;28:12-8.

24. Chng H. Root canal therapy-single-visit or multiple-visit approach? Singapore Dent J 2003;25:31-3.
25. Lin LM, Lin J, Rosenberg PA. One-appointment endodontic therapy: Biological considerations. J Am Dent Assoc 2007;138:1456-62.
26. Castagnola L, Orlay HG. Treatment of gangrene of the pulp by the walkoff method. Br Dent J 1952;93:93-102.
27. Reyes AD, Reina ES. Root canal treatment in necrotic primary molars. J Pedod 1989;14:36-9.
28. Kubota K, Golden BE, Penugonda B. Root canal filling materials for primary teeth: A review of the literature. ASDC J Dent Child 1992;59:225-7.
29. Machida Y. A clinico-radiographical study of root canal filling in the deciduous teeth with Vitapex. Japanese J Pedod 1978;16:360-5.
30. Weiger R, Rosendahl R, Löst C. Influence of calcium hydroxide intracanal dressings on the prognosis of teeth with endodontically induced periapical lesions. Int Endod J 2000;33:219-26.