ORIGINAL ARTICLE

Comparative evaluation of turmeric extract versus formocresol as pulpotomy agents in primary teeth

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ABSTRACT

Background and Objective: Formocresol is a commonly used pulpotomy agent for primary teeth but concerns about its safety and efficacy have prompted the exploration of alternative treatments. This study aimed to compare the efficacy of turmeric extract and formocresol as pulpotomy agents in primary molars, with the goal of identifying a potentially more effective and safer herbal alternative.

Methods: This experimental study comprised 54 asymptomatic carious primary molar teeth, divided into three groups according to the time of extraction of teeth: 1 week, 2 weeks and 6 months. Each time-point group contained 18 teeth, which were further subdivided into two subgroups of nine teeth each, based on the pulpotomy agent used: Formocresol or turmeric extract. Teeth were evaluated histologically post-extraction to assess the level of inflammation and dentine bridge formation. Statistical analysis was performed using Fisher's exact test in statistical software.

Results: Teeth treated with formocresol showed a higher degree of inflammation compared to turmeric extract over time (p-value = 0.005). In addition, dentine formation was observed in 25%-50% of teeth treated with turmeric extract after 6 months as compared to no bridge formation in teeth treated with formocresol.

Conclusion: Turmeric extract has potent anti-inflammatory and regenerative effects on the dentine in primary molars compared to formocresol. Being a biocompatible agent, it may be used as an alternative for pulpotomy in primary teeth.

Keywords: Formocresol, turmeric extract, pulpotomy, primary molars.

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Introduction

The pulpotomy procedure involves the removal of the coronal part of the dental pulp that has undergone inflammation or degenerative changes, while preserving the vitality of radicular pulp tissue. This radicular pulp is then covered with a suitable dressing or medicament to promote healing of the amputation site.[1]

The dental pulp is unique among human tissues in that it is applied with multiple types of therapeutic agents for healing purposes. Pulp tissue has undifferentiated cells of mesenchyme that can be differentiated into any other types of cells including odontoblasts and fibroblasts, for the repair and protection of the damaged hard tissue of tooth and for the soft tissue of pulp. The ability of stem cells to differentiate and stimulate the formation of cells like odontoblasts more than fibroblasts is a very important step in dentin repair.[2] Maintaining pulp vitality after any therapeutic procedure is of utmost importance, as this tissue has unique characteristics that are pivotal for the preservation of a tooth.[3]

Formocresol has been the most widely used pulpotomy agent in primary teeth and considered as 'Gold Standard' because of its ease of use and good clinical results.[4,5] Formocresol binds with the protein molecule and prevents tissue autolysis. After formocresol dressing, the radicular pulp undergoes three distinct phases: the coronal third experiences fixation, the middle third of pulp tissue shows the loss of integrity and the apical portion exhibits growth of granulation tissue.[6] Despite good clinical results, formocresol is known to be mutagenic and carcinogenic and can cause hyperplasia of the permanent tooth.[7]

Herbal extracts have been used for several thousand years in the field of traditional medicine and are increasingly

being explored in dentistry for their anti-inflammatory and antimicrobial properties.[8] Turmeric, known for its anti-inflammatory, anti-carcinogenic and wound-healing properties, has shown promising results as a dental therapeutic agent. It has been used experimentally in endodontics as an intra-canal medicament and antiseptic irrigant.[9]

Recent research indicates a shift from traditional chemically synthesised pulpotomy medicaments toward natural products.[10] Natural product use is increasing owing to their fewer side effects, ease of availability and financial considerations in developing countries.[11] For the people of the sub-continent, turmeric is a local product that is easily available, cost effective and has marvelous healing properties. This study aimed to compare the efficacy of turmeric extract and formocresol as pulpotomy agents in primary molars, with the goal of identifying a potentially more effective and safer herbal alternative. The results of this study will help in finding locally available, cost effective, less harmful and natural pulpotomy agent for the preservation of primary teeth.

Methods

This experimental study was carried out at the Pediatric Dentistry Department, de'Montmorency College of Dentistry, Lahore, Pakistan, and Histopathological Laboratory of Postgraduate Medical Institute (PGMI), Lahore, Pakistan, over a period of 12 months (Jan 2019-Jan 2020). The study was approved by the Institutional Review Board of PGMI, Lahore.

A random sampling method was employed to select a sample of 54 patients as the participants of this study. The subject selection included healthy children of 5-9 years old of either gender with prior consent from parents. The inclusion criteria were symptomless carious primary molar teeth having normal physiological mobility and with 2/3rd of the intact root.

While teeth having tenderness upon percussion, or depicting signs of internal/external resorption of root or any malformed teeth with hypoplasia, were excluded.

After selection, clinical evaluations, vitality tests and diagnostic periapical radiographs were performed. Each selected tooth was given local anesthesia and isolated using a rubber dam. Then, cleaning was performed by using 0.2% chlorhexidine solution. For the preparation of occlusal cavities, sterile round diamond bur No.330 was used at high speed, under air water spray coolant. The roof of the coronal pulp chamber was removed by high-speed bur and a spoon excavator was used for cutting off coronal pulp tissue. A moist cotton pellet was placed to control pulpal hemorrhage.

For carrying out pulpotomy procedures, patients were placed into three groups based on the time of tooth extraction. Each group was further sub-divided into two subgroups according to the types of materials used for pulpotomy that is, formocresol (FC group, control group) and turmeric extract (TE group).

FC group

A sterile cotton pellet lightly moistened with formocresol (1/5 conc.) then blotted, was placed against pulpal stumps for 5 minutes.

TE group

Amputated pulpal stumps were covered with aqueous turmeric extract (TE). 200 g ground turmeric powder was dried in an oven at 40°C for 24 hours. After which it was boiled in 500 ml of distilled water and spray dried to make a paste.[12]

All the extracts were prepared by experienced staff at Pakistan Council of Scientific and Industrial Research Laboratories Lahore, with the permission of the authorities as collaborators.

Finally, all treated teeth were restored with light cure glass-ionomer cement. The restored teeth were extracted after 1 week, 2 weeks and 6 months to compare and assess the histological response of the pulp to formocresol and aqueous turmeric extract.

After extraction, teeth were fixed in 4% neutral buffered formalin and apical foramina were occluded with wax. Demineralisation was performed in 5% trichloro-acetic acid. Longitudinal serial sections (5 µm) were prepared, processed and stained with haematoxylin and eosin and trichrome stain.[13] Specimens were examined under a light microscope for pulp inflammation and dentin bridge formation by an experienced histopathologist. The assessment was based on:

- **Inflammatory Cell Count**[14]
  (neutrophils, lymphocytes and macrophages)
  Grade 1: Absent or zero inflammatory cells.
  Grade 2: Mild including <30 inflammatory cells.
  Grade 3: Moderate including ≥30 inflammatory cells <60 inflammatory cells.
  Grade 4: Severe including ≥60 inflammatory cells.
- **Dentine Bridge Formation**[15]
  Grade 0: No presence of dentin bridge formation.
  Grade 1: Bridge formation <25%.
  Grade 2: Bridge formation >25% but <50%.
  Grade 3: Bridge formation >50% but <75%.
  Grade 4: Bridge formation 100%.

Statistical analysis

The data were analysed using Statistical Package for the Social Sciences version 26.0. Fisher's exact test was used for the comparison of inflammatory cell responses (quantitative analysis) and dentin bridge formation among

groups (qualitative analysis). A *p*-value ≤ 0.05 was taken as significant.

Results

Inflammatory cell response

The inflammatory cell response in formocresol and turmeric groups showed a significant difference ($p = 0.005$) (Table 1).

At 2 weeks, formocresol and turmeric-treated teeth showed inflammatory cell response scores of grade 3 in 77.8% of teeth and grade 4 was observed in 22.2% of teeth. In the turmeric group, grade 3 was observed in 22.2% teeth and grade 2 was observed in 77.8% teeth (Table 2).

At 6 months, Table 3 shows inflammatory cell response in formocresol and turmeric-treated groups ($p = 0.001$).

Dentin bridge formation after 6 months

In formocresol and turmeric-treated groups, the dentin bridge formation of grade 0 was observed in 88.9% and 33.3% of teeth while grade 1 was observed only in 11.1% of teeth in each group, respectively (Table 4).

Discussion

Maintaining the vitality of the dental pulp is crucial for the long-term viability of teeth, as it enables the pulp to perform essential functions, including dentin bridge formation. The ultimate goal of vital pulp therapy is to regenerate the dentin-pulp complex, ensuring both structural and functional restoration. While histological examination can definitively verify pulp vitality, its practical application in clinical settings is limited. Clinicians often rely on clinical and radiographic evaluations, which may not fully capture the true vitality of the pulp. A tooth is considered clinically successful if it remains symptom-free, responds appropriately to sensitivity tests and exhibits normal radiographic findings.[16]

This study aimed to assess the effectiveness of turmeric extract in pulpotomy therapy, comparing it with traditional formocresol. The focus was on evaluating anti-inflammatory,

Table 1. *Comparison of inflammatory cell response in both groups after 1 week.*

Groups	Inflammatory cell response				
	Grade 1 (%)	Grade 2 (%)	Grade 3 (%)	Grade 4 (%)	*p*-value[a]
Formocresol group	0 (0%)	0 (0%)	8 (88.9%)	1 (11.1%)	0.005
Turmeric group	0 (0%)	5 (55.6%)	4 (44.4%)	0 (0%)	

[a]Fisher's exact test.

Table 2. *Comparison of inflammatory cell response in both groups after 2 weeks.*

Groups	Inflammatory cell response				
	Grade 1 (%)	Grade 2 (%)	Grade 3 (%)	Grade 4 (%)	*p*-value[a]
Formocresol group	0 (0%)	0 (0%)	7 (77.8%)	2 (22.2%)	0.004
Turmeric group	0 (0%)	7 (77.8%)	2 (22.2%)	0 (0%)	

[a]Fisher's exact test.

Table 3. *Comparison of inflammatory cell response after six months in both groups.*

Groups	Inflammatory cell response				
	Grade 1 (%)	Grade 2 (%)	Grade 3 (%)	Grade 4 (%)	*p*-value[a]
Formocresol group	0 (0%)	0 (0%)	6 (66.7%)	3 (33.3%)	0.001
Turmeric group	0 (0%)	8 (88.9%)	1 (11.1%)	0 (0%)	

[a]Fisher's xact test.

Table 4. *Comparison of dentin bridge formation after six months in both groups.*

Groups	Dentin bridge formation					
	Grade 0 (%)	Grade 1 (%)	Grade 2 (%)	Grade 3 (%)	Grade 4 (%)	*p*[a]
Formocresol group	8 (88.9%)	1 (11.1%)	0 (0%)	0 (0%)	0 (0%)	0.005
Turmeric group	3 (33.3%)	6 (66.7%)	0 (0%)	0 (0%)	0 (0%)	

[a]Fisher's exact test.

antibacterial and wound-healing effects, positioning turmeric as a natural alternative to a synthetic material.[17]

Formocresol

Formocresol has been a standard pulpotomy agent for over six decades due to its clinical success, despite ongoing concerns about its toxicity and mutagenic potential.[18] In this study, formocresol treatment led to a range of clinical outcomes. Initially, 88.9% of teeth showed a clinical success rate, though this declined over time. By 6 months, there was a significant frequency of pain, fistulas and abscesses, with a clinical success rate ranging from 66.7% to 88.9%. These findings align with previous studies that reported varying success rates for formocresol, with some studies highlighting its limitations due to its potential for inducing severe pulp inflammation and necrosis.[18–20]

Histological examination revealed moderate to severe inflammation and minimal reparative dentin formation. The results corroborate earlier studies that criticised formocresol for its potential to cause chronic inflammation and limited dentin bridging.[13]

Turmeric extract

Turmeric extract, known for its anti-inflammatory and healing properties, demonstrated promising results. Clinically, it achieved a 100% success rate by 6 months, with only one instance of pain on percussion noted initially. This performance was superior to formocresol over time. The results are consistent with recent studies that showed turmeric's efficacy in pulpotomy, supporting its potential as a viable alternative to traditional materials.[21–23]

Histologically, turmeric-treated teeth exhibited mild to moderate inflammation initially, with significant healing evident by 6 months. Notably, extensive reparative dentin formation was observed, supporting turmeric's role in promoting pulp regeneration. These findings are consistent with animal studies demonstrating turmeric's effectiveness in reducing inflammation and facilitating dentin repair.[24,25]

Limitations of the study

This study's limitations include a small sample size and a relatively short follow-up period. These factors may impact the generalisability of the findings and the long-term assessment of clinical outcomes. Future research should address these limitations by incorporating larger sample sizes and extended follow-up periods to provide a more comprehensive evaluation of turmeric's effectiveness and potential long-term benefits.

In light of the findings of the study following recommendations are made.

- Research on natural products as pulpotomy agents should be encouraged, by considering the safety and bio-compatibility of these.
- Sub-continent has a high production of turmeric, so it can give cheap and locally available alternatives to synthetic pulpotomy agents. It will reduce the financial health burden on developing countries like Pakistan.

Conclusion

Turmeric extract has shown promising results as an alternative to formocresol in pulpotomy therapy for primary teeth. Its use aligns with the growing interest in natural and biocompatible materials for dental treatments. Further studies are needed to validate these findings and explore turmeric's potential in broader clinical applications.

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List of Abbreviations

FC	Formocresol
PGMI	Postgraduate Medical Institute
TE	Turmeric extract

Conflict of interest

None to declare.

Grant support and financial disclosure

None to disclose.

Ethics approval

The study is approved by the Institutional Ethical Committee of Postgraduate Medical Institute Lahore, Pakistan, vide Letter No: PGMI/21-16.

Authors' contributions

NB: Conception, designing the study content, data collection, investigations and writing.
SN: Supervision, data analysis, critical review and intellectual input.
MAH: Drafting the manuscript, critical intellectual review and acquisition of data.
RD: Writing and drafting the manuscript, acquisition of data, critical intellectual input.
ALL AUTHORS: Approval and responsibility for the final version of the manuscript to be published.

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References

1. Lai G, Sheng K, Zhao J, Ding N, Zhao S, Wang J. A retrospective study on the outcome of pulpotomy with iRoot BP plus in primary molars and its relationship with hemostasis time. BMC Oral Health. 2024;24(1):1134. https://doi.org/10.1186/s12903-024-04816-3
2. Philip N, Suneja B. Minimally invasive endodontics: a new era for pulpotomy in mature permanent teeth. Br Dent J. 2022;233(12):1035–41. https://doi.org/10.1038/s41415-022-5316-1
3. Boyer KR, Nguyen JT. An update on vital pulp therapy. J Calif Dent Assoc. 2023;51(1):2244707. https://doi.org/10.1080/19424396.2023.2244707
4. Ahuja S, Surabhi K, Gandhi K, Kapoor R, Malhotra R, Kumar D. Comparative evaluation of success of biodentine and mineral trioxide aggregate with formocresol as pulpotomy medicaments in primary molars: an *in vivo* study. Int J Clin Pediatr Dent. 2020;13(2):167–73. https://doi.org/10.5005/jp-journals-10005-1740
5. Goinka C, Galla PK, Madhavi K, Malempet A, Suryadevara S, Reddy KS. A histopathological comparison of Formocresol, propolis, and growth factor as pulpotomy medicaments in primary teeth: an *in vivo* study. Dent Res J (Isfahan). 2023;20:15. https://doi.org/10.4103/1735-3327.367914
6. Bagchi P, Kashyap N, Biswas S. Pulpotomy: modern concepts and materials. Int J Oral Health Dent. 2021;7:245–52. https://doi.org/10.18231/j.ijohd.2021.049
7. Mustafa S, Ezz Eldin Taha S, Eldin Mostafa Elbehairy S, Youssef Abd Al R, Youssef Abd Al Gawad R, Noshy Kirollos F. Clinical and radiographic evaluation of aloe vera gel versus formocresol pulpotomy of vital primary molars: a randomized clinical trial. Int J Dent Oral Sci. 2021;8(9):4267–74. https://doi.org/10.19070/2377-8075-21000869
8. Sharaf RM, Kabil NS, Youssef FS, Awad BG. Clinical and radiographic evaluation of *Nigella sativa* and *Aloe vera* as pulpotomy medicaments in primary teeth: a randomized controlled trial. Int J Clin Pediatr Dent. 2023;16(Suppl 2):195–201. https://doi.org/10.5005/jp-journals-10005-2657
9. Sahiti PS, Kamatham R. Comparative evaluation of a modified endodontic approach using *Curcuma longa* L. and conventional pulpectomy in primary molars: a randomized clinical trial. Ayu. 2021;42(3):130–7. https://doi.org/10.4103/ayu.ayu_12_20
10. Sherif DA, El-Marhomy AZ. Clinical outcome of herbal versus bio-inductive pulp capping material in vital pulp therapy. Egypt Dent J. 2024;70(4):3927–37. https://doi.org/10.21608/edj.2024.304325.3116
11. Mazhar M, Naz S, Zahra A, Bashir N, Dastgeer R. Turmeric gel as an alternative non-vital pulpotomy medicament in primary teeth-a randomized controlled trial. Biomedica. 2024;41(1):18–25. https://doi.org/10.24911/BioMedica/5-1135
12. Prabhakar A, Taur S, Hadakar S, Sugandhan S. Comparison of antibacterial efficacy of calcium hydroxide paste, 2% chlorhexidine gel and turmeric extract as an intracanal medicament and their effect on microhardness of root dentin: an *in vitro* study. Int J Clin Pediatr Dent. 2013;6(3):171–7. https://doi.org/10.5005/jp-journals-10005-1213
13. Mohamed AA, Mounir MM, Wahba NA, El-Meligy OA, Sabbarini JM. Comparison of pulpal response following pulpotomy procedure using enamel matrix derivative versus Formocresol in primary dentition. Calcif Tissue Int. 2004;75:243–52.
14. Aeinehchi M, Eslami B, Ghanbariha M, Saffar AS. Mineral trioxide aggregate (MTA) and calcium hydroxide as pulp-capping agents in human teeth: a preliminary report. Int Endod J. 2003;36(3):225–31. https://doi.org/10.1046/j.1365-2591.2003.00652.x
15. Ratnakumari N, Thomas B. A Histopathological comparison of pulpal response to chitra-CPC and formocresol used as pulpotomy agents in primary teeth: a clinical trial. Int J Clin Pediatr Dent. 2012;5(1):6–13. https://doi.org/10.5005/jp-journals-10005-1126
16. Abd-Allah NF, Farid MH, El Malt MA. Evaluation of the effect of turmeric gel and turmeric powder as pulpotomy medicaments in primary teeth. Al-Azhar J Dent. 2021;8(4):695–701. https://doi.org/10.21608/adjg.2021.23022.1223
17. Guang J, Li J, Hao L. Clinical observation and histopathological evaluation of pulp after pulpotomy of primary teeth with Formocresol and biodentine. Cell Mol Biol (Noisy-le-grand). 2022;68(5):83–8. https://doi.org/10.14715/cmb/2022.68.5.11
18. Ghoname N, Yagi A, Gonna S, Kabbash A, Deraz EM. Acemannan and Formocresol pulpotomies in primary teeth: a comparative histopathological study. J Gastroenterol Hepatol Res. 2017;6:2386–91. https://doi.org/10.17554/j.issn.2224-3992.2017.06.711
19. Suprakasam S, Kakkachi Parambil RS, Hari K, Viswanathan P, Abraham I, Mathai ET. Comparative long-term outcomes of formocresol, mineral trioxide aggregate, and laser pulpotomy techniques in primary teeth. J Pharm Bioallied Sci. 2024;16(Suppl 4):S3233–5. https://doi.org/10.4103/jpbs.jpbs_711_24
20. Haghgoo R, Abbasi F. A histopathological comparison of pulpotomy with sodium hypochlorite and Formocresol. Iran Endod J. 2012;7(2):60–2.
21. Yagi A, Gonna S, Kabbash A, Ghoname N. Efficacy of *Aloe vera* as a pulpotomy agent in children primary teeth: clinical and radiographic studies. J Gastroenterol Hepatol Res. 2019;8:2946–51. https://doi.org/10.17554/j.issn.2224-3992.2019.08.842
22. Purohit RN, Bhatt M, Purohit K, Acharya J, Kumar R, Garg R. Clinical and radiological evaluation of turmeric powder as a pulpotomy medicament in primary teeth: an *in vivo* study. Int J Clin Pediatr Dent. 2017;10(1):37–40. https://doi.org/10.5005/jp-journals-10005-1404
23. Hugar SM, Kukreja P, Hugar SS, Gokhale N, Assudani H. Comparative evaluation of clinical and radiographic success of formocresol, propolis, turmeric gel, and calcium hydroxide on pulpotomized primary molars: a preliminary study. Int J Clin Pediatr Dent. 2017;10(1):18–23. https://doi.org/10.5005/jp-journals-10005-1400
24. Prabhakar AR, Mandroli PS, Bhat K. Pulpotomy with curcumin: histological comparison with mineral trioxide aggregate in rats. Indian J Dent Res. 2019;30(1):31–6. https://doi.org/10.4103/ijdr.ijdr_278_17
25. Mandrol PS, Bhat K, Prabhakar AR. An *in vitro* evaluation of cytotoxicity of curcumin against human dental pulp fibroblasts. J Indian Soc Pedod Prev Dent. 2016;34(3):269–72. https://doi.org/10.4103/0970-4388.186757