 DOI: 10.21608/adjalexu.2024.261358.1463

Clinical and Radiographic Success Rate of TheraCal PT versus MTA in Pulpotomy of Primary molars: A Randomised Clinical Pilot Study.

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ABSTRACT

INTRODUCTION: Caries commonly affect primary teeth in school/preschool children and can cause early tooth loss. It is vital to preserve primary teeth to prevent space loss until permanent successor erupts. Primary teeth with deep caries and vital pulp with reversible pulpits are indicated for pulpotomy. It involves eradicating caries, removing the inflammatory area, and placing the necessary medications. There is no evidence of which pulpotomy medication is the most effective.

OBJECTIVE: To evaluate clinical and radiographic success rate (survival rate) following TheraCal PT (TPT) pulpotomy compared to Mineral-Trioxide-Aggregate (MTA) pulpotomy in primary molars indicated for vital pulpotomy.

METHODS AND MATERIALS: This was a Randomised Clinical Trial (RCT) following CONSORT Statement 2010. Twenty participants were recruited as a pilot study and divided equally into the TPT group (Intervention) and MTA+ group (control). All included molars were assessed after 6 months for clinical success regarding the absence of spontaneous pain and swelling. Also, radiographic success was assessed regarding widening in periodontal membrane space, periapical radiolucency, furcation involvement, and external/internal root restoration. The time elapsed from the beginning of hemostasis until the final restoration placement was also recorded.

RESULTS: Clinically, both materials exhibited 100% survival rate after six months. However, radiographic assessments have shown 90% and 40% success rates for the MTA and TPT groups, respectively.

CONCLUSION: within the limitation of the current trial, MTA and TPT medications had excellent clinical success rate of 100% in the short term; however, MTA revealed a higher radiographic success rate than TPT (90% and 40%, respectively).

KEYWORDs: TheraCal PT, MTA, pulpotomy, primary molar, Vital pulp treatment

RUNNING TITLE: TheraCal-PT versus MTA in pulpotomy of primary molars

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INTRODUCTION

Scientific background and explanation of the rationale

The most prevalent chronic childhood illness is dental caries, and if left untreated, it can advance to the dental pulp and lead to the total loss of the primary tooth. It is vital to preserve primary teeth to prevent space loss until the permanent tooth erupts. Depending on the severity of the caries condition, the treatment of primary molars includes pulp capping, partial and total pulpotomy, and pulpectomy for inflamed pulp [1]. The fundamental goal of pulpotomy in primary dentition is to preserve the integrity and health of the oral tissues in which the inflammatory coronal pulp is removed and the radicular pulp is protected using an appropriate medicament and a proper coronal seal [2].

Research into pulpotomy of primary teeth has escalated in recent years because of breakthroughs in our understanding of pulp biology, regeneration of the pulp-dentin complex, and the varied interactions between conventional and novel biomaterials [3, 4]. Formocresol, ferric sulfate, sodium hypochlorite, calcium hydroxide, and calcium-silicate-based biomaterials like Mineral Trioxide Aggregate (MTA), Biodentine, and bioceramic paste/putty are some of the most commonly used materials with acceptable results. Due to their biocompatibility, bioactivity, and exceptional sealing ability, tricalcium silicates (TCSs) such as MTA and Biodentine are the most prominent materials used in permanent and primary teeth [5].

Compared to alternative materials used in primary tooth pulpotomy, MTA demonstrates superior performance and excellent success rates through its bio-inductive, regenerative capabilities, excellent biocompatibility, promotes tissue regeneration, and provides good marginal integrity with no microleakage, assuring its safety and efficacy [6]. MTA is the gold standard as a pulp dressing material [1]. On the other hand, MTA has several downsides, including discolouring teeth, taking more than two hours to reach the final setting, being difficult to handle, and being expensive.

One of the recently introduced TCSs dressing materials, which was improved to overcome MTA drawbacks, was TheraCal LC

(TLC) (BISCO Inc., Schaumburg, IL, USA). TLC was presented in 2011 as "a novel light-curable MTA-like material" with controlled setting time (light cured) and not reported to cause discolouration [7]. However, TheraCal LC has controversial biological properties, which hinder its recommendation as a pulp capping materials [8-10]. Also, TLC showed unfavorable outcomes when used in pulpotomy procedures for primary and permanent teeth [10, 11].

To overcome TLC problems, Bisco has recently launched a new dual-cured resin-modified calcium silicate-based cement, TheraCal PT (TPT), in May 2019 [12]. Its primary indication is pulpotomy since it can be used in adequate thickness. TPT has enhanced setting time, simple syringe application, moisture tolerance, and pulpal floor adaptation with minimal manipulation and is commercialised by BISCO as a biocompatible material with improved chemical properties, which counteract the potentially harmful effects of residual unpolymerised monomers [13].

TPT is Comparable to MTA in terms of its cytocompatibility; both were significantly more biocompatible than TLC due to increased cell viability, migration rates, cell adhesion, and decreased risks of cell necrosis, all crucial factors influencing pulpal injury healing[14]. Direct comparisons between TPT biological properties and MTA were not made clinically when we registered the current trial. However, during the following years, a published non-randomised clinical trial assessed TPT's clinical and radiographic success rates in 4 vital pulp therapy techniques, including pulpotomy in primary molars, over 12 months [15]. We couldn't find any randomised clinical trials (RCTs) comparing both materials.

Null hypothesis:

TPT pulpotomy had a similar success rate as MTA pulpotomy in primary molars after 6 months, both clinically and radiographically, with a shorter chair side time of application.

Objectives:

A pilot study to compare the survival rate (including clinical and radiographic success rates) after 6 months of TPT versus MTA in pulpotomy of vital primary molars with deep caries.

MATERIALS AND METHODS

Following the CONSORT statement 2010 for reporting RCTs [16].

Trial design

The current trial was designed to be a preliminary (pilot) study. It was an RCT with a parallel design and a 1:1 allocation ratio between the MTA and TPT arms.

Changes to methods after trial commencement: N/A

Clinical trial registration:

The Research Ethics Committee, Faculty of Dentistry, Cairo University approved the current study on 23-2-2021, Ref. no. 15-2-21. The trial registration on www.clinicaltrials.gov ID was NCT04617600 in 5/11/2020.

Participants

Eligibility criteria

The participating children were healthy and cooperative aged 4-7 years, with carious vital primary lower molars indicated for pulpotomy with reversible pulpitis, restorable teeth, and normal radiographic findings. Molars were selected according to AAPD guidelines (2021) [2]. Only lower molars were selected because of ease of visualization and direct access to the root canals [17]. Also, superimpositions are less in the mandibular arch so that root status could be evaluated accurately.

Exclusion criteria included children who could not attend the follow-up visits, had previously accessed teeth, or had uncontrolled bleeding after pulpotomy. Also, children with parents who refused to participate in the trial had a history of spontaneous or prolonged pain, swelling, tenderness to percussion or palpation, or pathological mobility were excluded.

Settings and locations where the data were collected

The current investigation was conducted in the Pediatric Dentistry and Dental Public Health department- Faculty of Dentistry, Cairo University, Egypt. The operator was a post-graduate student (RG) without assistance (the trial's principal investigator and the dental unit was Knight Dental unit (Midmark Corporation, Patterson Blvd., Ohio, USA).

Interventions:

After determining the child's eligibility for the research, the principal investigator (RG) informed the parent or legal guardian about the trial procedures, prospective benefits, and expected dangers. The trial discussion explanation was simplified and clear of uncomfortable words for the children. The eligible children verbally agreed, and the guardian completed an Arabic-language consent form for clinical treatments.

Personal, medical, and dental histories were obtained from all children. Digital preoperative periapical radiographs were taken for all molars to exclude any apical pathosis indicating non-vitality of the teeth. Under local anaesthesia and rubber dam isolation, caries was removed, and access cavity was done using a water-cooled (#330) high-speed carbide bur. Each tooth was anesthetized using the inferior alveolar nerve block technique by applying topical anesthetic gel (I-gel, Dent dental supply, USA) (20% benzocaine) at the site of needle insertion for 2-3 minutes, followed by injection of local anesthesia by the use of 4% articaine (Articaine (D.C.I) 40.00mg hydrochloride, Epinephrine (D.C.I) (tartrate) 0.01mg) (Inibsa Dental S.L.U, Spain) using a long disposable needle

(C-k dental ind.co., ltd, Korea) and metallic dental aspirating syringe (Bibodent, Egypt) [18].

The coronal pulp tissue was amputated using a sharp spoon excavator. The pulp chamber was irrigated with physiologic saline. Pulp hemostasis was achieved using a sterile wet cotton pellet for two to three minutes. If hemostasis was not achieved after that, the tooth was excluded from the study, and a pulpectomy was done. Previous procedures were carried out for both groups.

Pulpotomy dressing materials were applied then to the pulp chamber. TPT was applied to the intervention group according to the manufacturer's instructions to a thickness of 2 mm, followed by light curing. In comparison, MTA+ (UI, Kwiatkowskiego 1, 37-450 Stalowa Wola, Polska) was manipulated in the ratio of 3:1 (powder: liquid) to obtain a putty mix according to manufacturer instructions. This mix was placed over the radicular pulp of the control group with the help of a suitable sterile amalgam carrier. Gentle condensation of the mix was done in the pulp chamber with a moistened cotton pellet.

In both groups, the rest of the pulp chamber was filled with glass ionomer restoration, and all molars were finally restored with a stainless-steel crown (Kids Crown, Shinghung, Seoul, Korea) Cemented with glass-ionomer cement. Postoperative radiographs were then taken using a size 1 digital radiographic sensor (KaVo, Tuusula, Finland) using a phosphor storage plate (PSP) imaging plate, dental X-ray unit Sordex X-ray machine (Acteon Group, X-mind DC, Rome, Italy) with the following exposure parameters 70 kVp, 7 mA and 0.05 second exposure time. Radiographs were captured using the standardised paralleling technique by the (XCP) (Super Bite, Hawe Neos DentalSA, Switzerland) alignment system and the film holder of the XCP was reduced in length and width by a straight handpiece to accommodate the shallow floor of the mouth in children. Digital intraoral imaging scanner (KaVo Scan eXam One, PaloDEx Group Oy, Tuusula, Finland) scanned the imaging plate automatically, with optimised images displayed in seconds. Postoperative occlusal photographs were taken, too (Fig. 1).

Outcomes:

All predetermined outcomes at the clinical trial registration were measured to avoid reporting bias. The primary outcome was "survival rate" [19] in terms of clinical success and was assessed at 3 and 6 months by 2 blinded assessors (SA and PN). Clinical success means the absence of spontaneous pain (binary outcome assessed by direct questioning to the patient and parent) and absence of swelling (binary outcome assessed visually and recorded by the intra-oral photographs).

Secondary outcome measures included radiographic assessment [20] at baseline and 6 months with blinded assessors (SA and PN). In case both assessors differed in a score, they discussed till reaching a consensus. The overall inter-observer agreement for clinical and radiographic assessments has shown near-perfect agreement between observers ($\kappa = 0.97$). The radiographic success was indicated by the absence of periapical radiolucency, external/internal root resorption, widening in periodontal membrane space, and furcation involvement. Time elapsed till the final restoration was performed in minutes using a stopwatch by the principal investigator (RG) [20, 21].

Sample size

Twenty patients of the outpatients attending the Pediatric Dentistry and Dental Public Health department clinic, Faculty of Dentistry, Cairo University, were recruited since it was a pilot study. This sample was divided into two groups, 10 per group, to calculate the success rate of TPT in pulpotomy of primary teeth since there were no previous clinical trials about its effectiveness when this trial was registered. The participants were randomly allocated to one of the tested groups, TPT or MTA groups.

Randomisation

Allocation concealment

The allocation sequence was concealed from each subject, who was instructed to choose an envelope after obtaining hemostasis.

- Sequence generation Simple randomisation was done using opaque sealed envelopes containing 4-time folded paper with the intervention written in. Sequence generation was done simply by shuffling the envelopes.
- Allocation concealment mechanism by sequentially numbered opaque sealed envelopes using 4 times folded paper, including the pulp dressing material. Each participant was instructed to choose an envelope after finishing pulpotomy and obtaining hemostasis of pulp tissues.
- Implementation of the principal investigator (RG) and, with the help of (PN and SA) generated the allocation sequence, enrolled participants, and assigned participants to interventions groups. PN and SA carried out the outcome assessment.

Blinding:

Only assessors (PN and SA) and statisticians were blinded to the trial materials used in every patient. In contrast, the operator (RG) and patients were not blinded due to the difference in the materials' shape and application protocol. However, performance and detection biases were minimised by allocation concealment and detecting all the predetermined outcomes at the follow-up visits, and the assessors were pre-calibrated.

Statistical analysis:

Data were analysed using Medcalc 19 for Windows (MedCalc Software Ltd, Ostend, Belgium). Category data were frequency and percentage, intergroup comparisons were made using the Chi-Squared test, and intragroup comparisons were

made within each intervention using Cochran's Q-test and multiple comparisons. Kolmogorov-Smirnov and Shapiro-Wilk were used for continuous data to test for normality. An independent t-test was utilised with a significance threshold of ($P < 0.05$) to compare continuous data across groups. The mean difference was used to evaluate effect size. The Cohen's kappa coefficient measured inter-observer agreement. All tests were two-tailed, with a confidence limit of 95% and 80% power and statistical significance threshold set at ($P < 0.05$).

Ethical considerations:

The protocol and the specific informed consent forms (local Arabic language and English versions) were reviewed, approved and agreed upon by the Research Ethics Committee of the Faculty of Dentistry, Cairo University and approval number (15221).

The patient's complete, detailed personal data was written on a separate sheet with the patient's serial number for further contact with the patient. Those sheets can be only seen by the operators and were stored with the corresponding author to assure the confidentiality of the participants and data protection. Consent was taken from the legal guardians of the participants to use their data in the current study, and data will be maintained and secured for 10 years after the trial for further follow-up. Full mouth treatment was offered to all participating children in addition to postoperative care and preventive measures through regular follow-up visits after the end of the trial. Molars with adverse radiographic signs were considered a failure. Still, they were not managed by pulpectomy or extraction unless accompanied by clinical signs of failure, e.g., pain, increased mobility, swelling, and sinus or fistula formation. Once those teeth show clinical symptoms of failure, they were planned for pulpectomy or extraction.

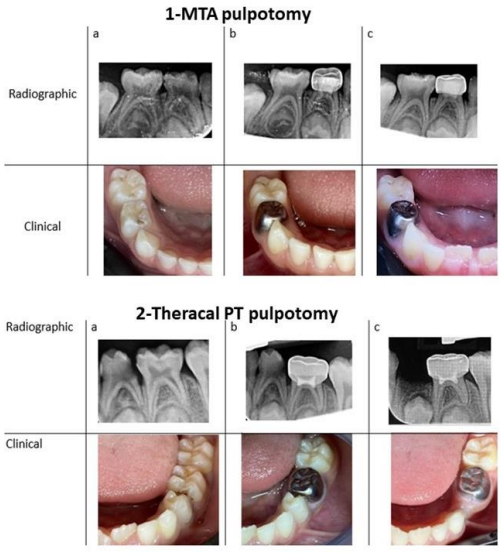

Fig. 1: Case no. 1: A 5-year-old boy having deep caries at the lower right first primary molar, pulpotomy was done using TPT.
Case no. 2: A 6-year-old boy had a deep carious lesion at the lower left second primary molar; Pulpotomy was done using MTA.
(a) Perioperative radiograph (b) Baseline (c) 6-months

RESULTS:

Participant flow and Recruitment

At 3 and 6 months follow-up, twenty participants (10 per each group) completed the follow-up with a retention rate of 100%, as shown in the Participant flow diagram (Fig. 2), according to the CONSORT statement 2010 [16].

Baseline data

The mean age of participants in the current study was 5.67±0.92 years, and male to female ratio was 9:11. There was no statistical significance difference between both groups, as shown in Table 1.

Numbers analysed

After 6 months, all participants were analysed, with no dropouts in both groups.

Outcomes and estimation

Primary outcome

After 3 and 6 months, both materials demonstrated a 100% survival rate for the tested clinical parameters with no significant difference between TPT and MTA groups (P= 1.00) (Table 2, Fig. 3).

Secondary outcomes:

Concerning the radiographic parameters, MTA has shown a 90% success rate, while TPT has a 40% success rate after 6 months (Table 2, Fig. 3).

Radiographic parameters assessed after 6 months included widening of the periodontal membrane space (no statistically significant difference between TPT and MTA groups (P=0.1331)), and it was evident at 40% and 10% of the participants treated with TPT and MTA, respectively. Another parameter was periapical radiolucency, which was evident in 20% of the TPT group, while in the MTA group, it was not evident. However, there was no statistically significant difference between both groups (P= 0.1462). Furcation involvement was the third radiographic parameter, and there was no statistically significant difference between TPT and MTA groups after 6 months (P=0.1462). However, 20 % of the participants treated with TPT showed furcation involvement. The last radiographic parameter was internal/external root resorption. Treatment with TPT and MTA+ did not cause internal root resorption. However, TPT caused external root resorption in 50% of participants. No internal/external root resorption was observed in the MTA group. There was a statistically significant difference between TPT and MTA concerning external root resorption (P= 0.0118).

The overall clinical and radiographic measurements for TPT and MTA groups at the end of the clinical trial showed 100% success for TPT and MTA regarding the clinical assessment. On the contrary, concerning the radiographic assessment, there was a 60% failure in the TPT group, while the MTA group showed only 10% failure (Table 2, Fig. 3). Of the failed cases, one lower first primary molar was in the MTA group, and four lower primary molar was in the TPT group (two first primary molars and two second primary molars).

Considering the time elapsed until the final restoration, results showed a statistically significant difference between TPT and MTA+ (P=0.0108). The mean difference between (TPT) and (MTA) was 0.97±0.76 minutes (without calculating the15 min waiting for the initial setting of the MTA after moistened cotton application onto MTA at the pulp chamber, with TPT showing less time elapsed until the final restoration (Table 3).

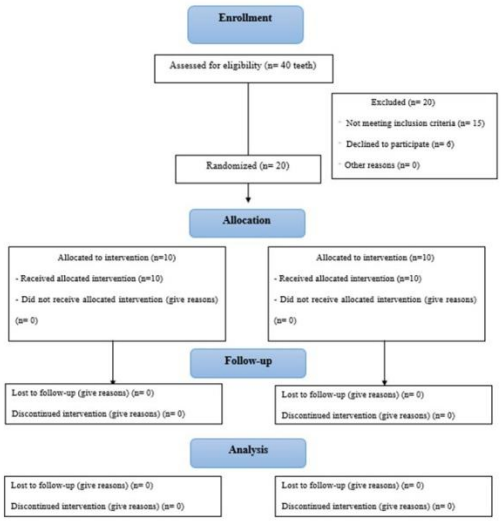

Fig. 2: CONSORT flow chart of the participants

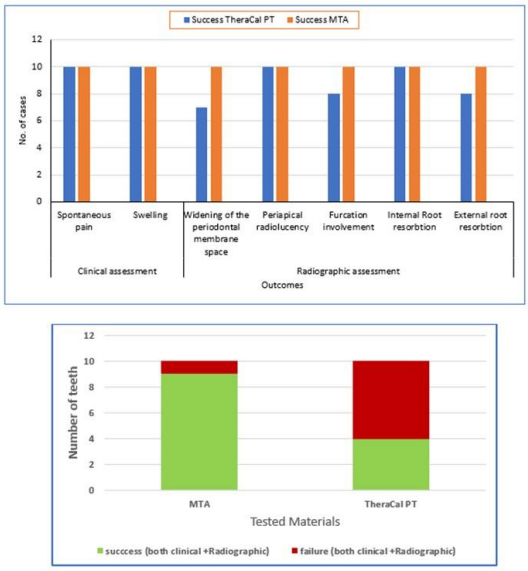

Fig 3. Graph showing outcomes measured for both groups and Overall success and failure after the end of the trial (After 6 months).

Table 1: Baseline data for TPT and MTA groups with no dropouts at 6 months

Baseline data		Theracal PT (n=10)	MTA (n=10)	Total (n=20)	P value*
Age		5.65±1.05 years	5.70±0.82 years	5.67±0.92	P=0.907
Gender	Boys	4(40%)	5(50%)	9(45%)	P=0.6613
	Girls	6(60%)	5(50%)	11(55%)	
Partiipating tooth	LRD	3(30%)	2(20%)	5(25%)	P=0.3916
	LRE	3(30%)	1(10%)	4(20%)	
	LLD	3(30%)	3(30%)	6(30%)	
	LLE	1(10%)	4(40%)	5(25%)	

LRD= Lower right first primary molar**; LRE** = Lower right second primary molar**; LLD** = Lower left first primary molar**; LLE** = Lower left second primary molar; * Statistical significance level was set at ($P \leq 0.05$), and thus, there was no statistically significant difference between the two groups.

Table 2: The overall clinical and radiographic measurements for both groups regarding the success and failure rates after 6-month follow-ups

Outcomes		TPT		MTA		
		Success n (%)	Failure n (%)	Success n (%)	Failure n (%)	P-value
Clinical assessment	Spontaneous pain	10 (100%)	0 (0%)	10 (100%)	0 (0%)	
	Swelling	10 (100%)	0 (0%)	10 (100%)	0 (0%)	
Overall clinical failure		**10 (100%)**	**0 (0%)**	**10 (100%)**	**0 (0%)**	P > 0.05 *
Radiograph assessment	Periapical radiolucency	8 (80%)	2 (20%)	10 (100%)	0 (0%)	
	Presence of internal root resorption	10 (100%)	0 (0%)	10 (100%)	0 (0%)	
	Presence of external root resorption	5 (50%)	5 (50%)	10 (100%)	0 (0%)	
	Widening of the periodontal membrane space	6 (60%)	4 (40%)	9 (90%)	1 (10%)	
	Furcation involvement	8 (80%)	2 (20%)	10 (100%)	0 (0%)	
Overall radiographic failure		**4 (40%)**	**6 (60%)**	**9 (90%)**	**1 (10%)**	P < 0.05 **

*Non statistically significant
**Statistically significant

Table 3: Mean and standard deviation of time elapsed till final restoration performed of both materials.

Follow-up	TPT		MTA		Mean difference		P-value
	Mean	SD	Mean	SD	Mean	SD	
Baseline	4.91	0.80	5.89 *	0.73	0.97	0.76	P = 0.0108 **

*+ 15 min waiting for initial setting of the MTA after moistened cotton application onto MTA at the pulp chamber
** significant at P < 0.05

DISCUSSION

The current study was a pilot study since there were no previous clinical trials about the effectiveness of TPT compared to other materials in pulpotomy of primary teeth, and only one online case report was reported [22] during the registration of this trial. However, a non-randomised clinical trial was recently done [15] using TPT in vital pulp therapy.
A recent split-mouth clinical trial reported that overall success rates were 99.3% and 98.1% in the MTA and TLC groups after the 12-month follow-up [23]. However, similar to the TPT group results, a radiographic failure in the TLC group was reported. High sealing ability, biocompatibility leading to hard tissue bridge construction, and robust barrier building against future microbial infiltration into the canals are likely the reasons for MTA's superiority. On the other hand, the bacteriostatic qualities of the cement, which may be due to its high alkalinity, may explain the clinical success rates of TPT in our investigation.

The clinical evaluation revealed no significant difference between the MTA and TPT groups. In contrast, MTA has a success rate of 90% for the radiographic parameters evaluated, as it appears to meet the requirement for pulp capping materials. MTA stimulates the formation of dentin bridges and prevents microleakage. Moreover, the material sets slowly, which is not a disadvantage; the slower setting prevents shrinkage [24].

In contrast, TPT showed a 40% success rate for the tested radiographic parameters, although in-vitro studies showed promising results regarding TPT [12]. These results agreed with previous studies, as the employed materials did not impact the pulpotomy effectiveness [1, 25-28]

In the context of radiographic assessment within the TPT group, the failure of the radiograph can be ascribed to unnoticed inflammation in the remaining pulp during the treatment, which might have resulted in diagnostic inaccuracies. Alternatively, it may be caused by anachoresis, which refers to the transportation of foreign bodies through the blood or lymph nodes and their subsequent accumulation at the site of inflammation [29].

Root resorption occurs when the pulp becomes inflamed by an infection [30]. However, owing to its surface biocompatibility, which may allow bone and cementum to adhere to it, MTA has been used as a restorative material [31, 32]. A possible explanation for the high failure rates shown with the TPT by a considerable amount of external root resorption may be attributed to unknown irritation from the resin component (even though it's a dual-cured pulpotomy treatment, uncured resin monomers still may be found) or any component within the material that causes pulpal inflammation and necrosis with root and bone resorption [11, 33, 34].

The teeth exhibiting one of the radiographic pathological conditions were not instantly treated and were monitored for subsequent evaluation, as they remained asymptomatic and had no indications of clinical failures[24]. Hence, as Smith et al. asserted, a more relevant strategy for establishing criteria to evaluate the radiographic success of pulpotomy research might involve distinguishing between osseous alterations and dental changes [35]

One case recorded a failure in the MTA group; this failure was a widening of the periodontal ligament space. The widening can occur when microorganisms originating from the gingival sulcus infiltrate the pulp chamber via the periodontal membrane, utilising either a lateral channel or the apical foramen as a conduit. The pathway for bacteria to access the oral cavity is facilitated by dental prophylaxis, dental luxation, and the migration of epithelial insertion, leading to the formation of periodontal pockets [36, 37].
A high incidence of auxiliary canals on the pulp chamber floor also makes furcation radiolucency a typical finding in primary teeth with infected and inflammatory pulp [38-41].

Furthermore, TPT showed less time elapsed till the final restoration than MTA, and this may be attributed to the mixing step in which the ready-to-use mixed syringe delivers easily and directly dispensed material into the pulp cavity, unlike MTA manual mixing, which requires special tools for delivering the material to the cavity.

Notably, the failure of pulp treatment may be attributed to several variables, including the capping material used, inconsistencies in method, inadequate coronal seal, or inappropriate case selection. The primary determinant for determining whether the pulp is inflamed is the point at which hemostasis is achieved. Typically, un-inflamed pulp requires a maximum of five minutes to attain hemostasis. Therefore, it may be argued that the lack of success seen in pulp treatments can be mainly attributed to the misinterpretation of the pulp's inflammatory condition rather than the materials used for capping, as long as a proper seal is established and a uniform procedure is used [42].

Limitations:
The follow-up period was 6 months, ensuring patient commitment to follow-up periods may be considered short by some clinicians to judge a treatment modality, so adequate and long-term follow-up is preferable to evaluate long-term outcomes. Also, we plan to carry out follow-ups for longer periods if feasible.
Generalisability:
Since it's a pilot study, generalisation was not feasible. It should be performed cautiously through a limited number of populations first to evaluate the treatment and review the outcomes. Further studies with larger sample sizes might be needed for more conclusive results; however, TPT pulpotomy results were not promising.

CONCLUSION

Based on this study's results and within the limitations of the trial, pulpotomy is the treatment of choice for deciduous teeth exhibiting reversible pulpitis. MTA has been a successful treatment modality in primary molars pulpotomy with proven success over the years, showing excellent clinical success and revealing more than twice the radiographic success rate than TPT (90% and 40%, respectively, after 6 months). Short-term results of TPT pulpotomy were not promising and questionable concerning its use in pulpotomy.

FUNDING
This research received no external funding.

CONFLICTS OF INTEREST
The authors declare no conflict of interest.

REFERENCES:

1. Stringhini Junior, E., et al., *MTA and biodentine for primary teeth pulpotomy: a systematic review and meta-analysis of clinical trials.* Clin Oral Investig, 2019. 23(4): p. 1967-1976.
2. American Academy of Pediatric Dentistry, *Pulp therapy for primary and immature permanent teeth. The Reference Manual of Pediatric Dentistry. Chicago, Ill.: American Academy of Pediatric Dentistry.* 2023:457-65.
3. Schmalz, G., M. Widbiller, and K.M. Galler, *Erratum to Clinical Perspectives of Pulp Regeneration [J Endodon 46 (2020) S161-S174].* J Endod, 2021. 47(2): p. 335.
4. Schmalz, G., M. Widbiller, and K.M. Galler, *Clinical Perspectives of Pulp Regeneration.* J Endod, 2020. 46(9S): p. S161-S174.
5. Hanna, S.N., R. Perez Alfayate, and J. Prichard, *Vital Pulp Therapy an Insight Over the Available Literature and Future Expectations.* Eur Endod J, 2020. 5(1): p. 46-53.
6. Tewari, N., et al., *Success of medicaments and techniques for pulpotomy of primary teeth: An overview of systematic reviews.* Int J Paediatr Dent, 2022. 32(6): p. 828-842.
7. Gandolfi, M.G., F. Siboni, and C. Prati, *Chemical-physical properties of TheraCal, a novel light-curable MTA-like material for pulp capping.* International Endodontic Journal, 2012. 45(6): p. 571-9.
8. Jeanneau, C., et al., *Light-cured Tricalcium Silicate Toxicity to the Dental Pulp.* J Endod, 2017. 43(12): p. 2074-2080.
9. Kunert, M. and M. Lukomska-Szymanska, *Bio-Inductive Materials in Direct and Indirect Pulp Capping-A Review Article.* Materials (Basel), 2020. 13(5).
10. Nagi, P.W., N. El-Bardissy, A. Khalifa, M. , *The Effect of Pulpotomy Using Resin-Modified Calcium Silicate versus MTA on Survival Rate of Cariously-Exposed Vital Young Permanent Molars: A Randomized Clinical Trial [Internet] [Ph. D.]. Faculty of oral and dental medicine, Cairo University, [Cairo].* . 2017.
11. Wassel, M.O., Amin, D.H. and Badran, AS *(2017) Clinical, radiographic, and histological evaluation of theracal pulpotomy in human primary teeth. Egyptian Dental Journal, The Egyptian Dental Association (EDA). 63, 2175–85. https://doi.org/10.21608/EDJ.2017.75661.*
12. Elbanna, A., D. Atta, and D.I. Sherief, *In vitro bioactivity of newly introduced dual-cured resin-modified calcium silicate cement.* Dent Res J (Isfahan), 2022. 19: p. 1.
13. Sanz, J.L., et al., *Comparative Biological Properties and Mineralization Potential of 3 Endodontic Materials for Vital Pulp Therapy: Theracal PT, Theracal LC, and Biodentine on Human Dental Pulp Stem Cells.* J Endod, 2021. 47(12): p. 1896-1906.
14. Rodriguez-Lozano, F.J., et al., *Biomineralization potential and biological properties of a new tantalum oxide (Ta(2)O(5))-containing calcium silicate cement.* Clin Oral Investig, 2022. 26(2): p. 1427-1441.
15. Wassel, M., D. Hamdy, and R. Elghazawy, *Evaluation of four vital pulp therapies for primary molars using a dual-cured tricalcium silicate (TheraCal PT): one-year results of a non-randomized clinical trial.* J Clin Pediatr Dent, 2023. 47(2): p. 10-22.
16. Schulz, K.F., D.G. Altman, and D. Moher, *CONSORT 2010 statement: Updated guidelines for reporting parallel group randomised trials.* J Pharmacol Pharmacother, 2010. 1(2): p. 100-7.
17. Mahmoud, S.A., A. Ezzat, and N. Waly, *Evaluation of three root canal filling materials for endodontic retretment of primary molars* PhD thesis of pedodontic Departement, Cairo University., 2011.
18. Stafuzza, T.C., et al., *A randomized clinical trial of cavity liners after selective caries removal: one-year follow-up.* J Appl Oral Sci, 2019. 27: p. e20180700.

19. Gruythuysen, R.J., A.J. van Strijp, and M.K. Wu, *Long-term survival of indirect pulp treatment performed in primary and permanent teeth with clinically diagnosed deep carious lesions.* J Endod, 2010. 36(9): p. 1490-3.
20. Holan, G., A.B. Fuks, and N. Ketlz, *Success rate of formocresol pulpotomy in primary molars restored with stainless steel crown vs amalga.* Pediatr Dent, 2002. 24(3): p. 212-6.
21. Igna, A., *Vital Pulp Therapy in Primary Dentition: Pulpotomy-A 100-Year Challenge.* Children (Basel), 2021. 8(10).
22. Hernandez Cabanillas, J., *Pulpotomy in a Primary Molar Using a Calcium Silicate Material (TPT): A Case report.* . 2020.
23. Hassanpour, S., et al., *Comparison between the Radiographic and Clinical Rates of Success for TheraCal and MTA in Primary Tooth Pulpotomy within a 12-Month Follow-Up: A Split-Mouth Clinical Trial.* Biomed Res Int, 2023. 2023: p. 8735145.
24. Durmus, B. and I. Tanboga, *In vivo evaluation of the treatment outcome of pulpotomy in primary molars using diode laser, formocresol, and ferric sulphate.* Photomed Laser Surg, 2014. 32(5): p. 289-95.
25. Kuo, H.Y., et al., *Clinical outcomes for primary molars treated by different types of pulpotomy: A retrospective cohort study.* J Formos Med Assoc, 2018. 117(1): p. 24-33.
26. Silva, L., et al., *Comparison between calcium hydroxide mixtures and mineral trioxide aggregate in primary teeth pulpotomy: a randomized controlled trial.* J Appl Oral Sci, 2019. 27: p. e20180030.
27. Ansari, G., S.P. Morovati, and S. Asgary, *Evaluation of Four Pulpotomy Techniques in Primary Molars: A Randomized Controlled Trial.* Iran Endod J, 2018. 13(1): p. 7-12.
28. Nagi, P.E., S. El-Bardissy, A. , *A Comparative Clinical Study of MTA Vs Portland cement as Capping Materials in Pulpotomy of Primary Molars [M. Ds]. Faculty of Oral and Dental Medicine, Cairo University, [Cairo].* . 2012.
29. Dezan, E., Holland, R., Consolaro, A., Isaak, F., Ciesielski, N., Gaetti, E. et al., *Experimentally Induced Anachoresis in the Periapical Region After Root Canal Filling* 2012.
30. Vieira-Andrade, R.G., et al., *Inflammatory root resorption in primary molars: prevalence and associated factors.* Braz Oral Res, 2012. 26(4): p. 335-40.
31. White, C., Jr. and N. Bryant, *Combined therapy of mineral trioxide aggregate and guided tissue regeneration in the treatment of external root resorption and an associated osseous defect.* J Periodontol, 2002. 73(12): p. 1517-21.
32. Olivieri, J.G., et al., *Treatment of a perforating inflammatory external root resorption with mineral trioxide aggregate and histologic examination after extraction.* J Endod, 2012. 38(7): p. 1007-11.
33. Parvin, M.K., et al., *Evaluation of Radiological Outcomes of Theracal Light Cured (TLC) And Calcium Hydroxide As Indirect Pulp Capping Agents In The Treatment Of Deep Carious Lesion Of Permanent Molar Teeth.* Mymensingh Med J, 2018. 27(4): p. 859-865.
34. Moselhy, Y.H., Elghazawy, R.K. and Wassel, M.O., *Clinical and Radiographic evaluation of Indirect and Direct Pulp Capping in Primary Molars using TheraCal (LC): A Randomised Clinical Trial.* . 2022.
35. Smith, N.L., Seale, N.S. and Nunn, M.E., *Ferric sulfate pulpotomy in primary molars: A retrospective study.* American Academy of Pediatric Dentistry Pediatric Dentistry, 2000(22): p. 192–9.
36. Narayanan, L.L. and C. Vaishnavi, *Endodontic microbiology.* J Conserv Dent, 2010. 13(4): p. 233-9.
37. Brook, I., *Microbiology and management of endodontic infections in children.* J Clin Pediatr Dent, 2003. 28(1): p. 13-7.
38. Nematollahi, H., et al., *Clinical and radiographic outcomes of laser pulpotomy in vital primary teeth: a systematic review and meta-analysis.* Eur Arch Paediatr Dent, 2018. 19(4): p. 205-220.
39. El Meligy, O., et al., *Biodentine(TM) versus formocresol pulpotomy technique in primary molars: a 12-month randomized controlled clinical trial.* BMC Oral Health, 2019. 19(1): p. 3.
40. Ahuja, S., et al., *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): p. 167-173.
41. Boddeda, K., Rani, C., V Vanga, N. and Chandrabhatla, S. , *Comparative evaluation of biodentine, 2% chlorhexidine with RMGIC and calcium hydroxide as indirect pulp capping materials in primary molars: An in vivo study.* . Journal of the Indian Society of Pedodontics and Preventive Dentistry, J Indian Soc Pedod Prev Dent., 2019(37): p. 60-6.
42. 4Goyal, P., Pandit, I.K., Gugnani, N., Gupta, M., Goel, R. and Gambhir, R.S., *Clinical and radiographic comparison of various medicaments used for pulpotomy in primary molars: A randomised clinical trial.* . European Journal of Dentistry, Eur J Dent., 2016(10): p. 315-20.