Original Research Article

TO EVALUATE THE SUCCESS RATE OF PULPOTOMY IN PRIMARY MOLARS USING FERRIC SULPHATE (FS) AND MINERAL TRIOXIDE AGGREGATE (MTA): A CLINICAL AND RADIOGRAPHIC STUDY

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Abstract

Purpose: The aim of this present study was to observe clinical, radiographic response of pulp to Ferric Sulphate and Mineral Trioxide Aggregate when used as pulpotomy agent in primary molars.

Materials and Methods: Sixty restorable primary molars were selected for the study. The children were chosen who require minimum two pulpotomies in either arch preferably each on the opposite side (i.e. right and left). Primary molars on the right side of the patient were assigned to Ferric Sulphate (FS) (Group A) and left side was assigned for the Mineral Trioxide Aggregate (MTA) (Group B). Statistical analysis was done using the chi-square test.

Results: outcome of the present study was observed for 3 and 6 months. The clinical success rate for MTA and ferric sulphate during 3 and 6 month follow up was 100%. The radiographic follow up of MTA was 100% during 3 and 6 month, whereas it was 96.6% for 3 and 6 month follow up with respect to ferric sulphate. There were no significant differences in the clinical (p>0.1) and radiographic (p> 0.98) success rates among both the groups.

Conclusion: No significant difference was seen between ferric sulphate (Group A) and MTA (Group B) as medicaments for use following pulpotomy. Radiographic success rate was lower for Ferric sulphate (Group A) than that of MTA (Group B) with occurrence of one internal

Comment [TS1]:
1.The title should not start with word (to).
2.The title should include abbreviation.
3.Supposed title is "The success rate of pulpotomy in primary molars using Ferric sulphate and mineral trioxide aggregate: A clinical and radiographic study.

Comment [TS2]:
1.Mention clinical and radiographic assessment parameters.
2.Fix (P value)

Comment [TS3]: It is better to written (follow up after 6 months)

Comment [TS4]: Please fix the brand and type of MTA with mention name of comapny

Comment [TS5]:
1.This more likely to be result and not conclusion.
2.The conclusion should be revised.

resorption seen with first primary molar.

Key words

MTA, ferric sulphate, pulpotomy, stainless steel crown

Comment [TS6]: 1.Avoid abbreviation in keywords.
2.The keywords should findbased on Mesh.

Introduction

There have been many advances in the prevention of dental caries thereby understanding the importance of preserving natural teeth has increased (Caicedo et al., 2006). It has been suggested that the main concept of modern paediatric endodontics should be to keep the pulp of primary teeth vital until their normal physiological resorption rather than just maintaining the teeth (Ibricevic and Al-Jame, 2003). There are many choices for conservative pulp therapies like direct pulp capping, indirect pulp capping, pulpotomy, pulpectomy procedures (Fuks, 2002)

Pulpotomy in primary dentition is the most common endodontic treatment for inflammation of coronal pulp caused by caries or trauma. The rationale for pulpotomy of primary teeth is based on the assumption that inflammation is limited to coronal portion of dental pulp and that the radicular pulp has the potential to heal (Malekafzali et al., 2011). It is difficult to determine the histopathological status of the pulp clinically. Histologically, most primary molars with proximal caries have inflammation in pulp horns, even in small lesion extending less than half intercuspal distance, and manifesting well before clinical exposure (Duggal et al., 2002). The operator relies on subjective criteria to determine whether the remaining pulp is affected or not such as bleeding time of the radicular pulp stump after amputation, color of hemorrhage and consistency of the tissue (Malekafzali et al., 2011)

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Pulpotomy procedure involves removing coronal pulp tissue that has undergone inflammation or degenerative changes and leaving vital tissue in root canals. Medicaments used for primary tooth pulpotomy are classified by action on pulp as, devitalisation (mummification, cauterization), preservation (minimal devitalisation, non-inductive) or regeneration (inductive, reparative) (Ranly, 1994)

Ferric sulphate has gained some popularity because it is claimed to have low toxicity and no systemic side effects. Ferric sulphate is a material which has shown potential for preservation. Ferric sulphate agglutinates blood proteins and controls hemorrhage in the process without clot formation. The agglutination of blood proteins results from reaction of blood with ferric and sulphate ions. This ferric ion- protein complex mechanically seals the cut vessels thus producing haemostasis (Odabas et al., 2012).

Currently interest in more biocompatible material with regeneration potential has promoted Mineral Trioxide Aggregate (MTA) as an alternative pulpotomy medicament. This is non–resorbable, nontoxic, non-carcinogenic material.

Improved and more conservative pulp management has the potential to reduce the need for more invasive endodontic treatment. However, if this is to be achieved in primary teeth, there is a need for better materials for endodontic procedures, especially pulpotomy.

This study was undertaken to compare reaction of ferric sulphate (FS) and mineral trioxide aggregate (MTA) to pulp though their physiochemical reaction to the pulp are different and to look forward for the best possible results to guide our research and development.

The objective of this standardized clinical study is to evaluate effect on clinical and

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radiographic signs in deciduous molars.

Comment [TS7]: This paragraph should be revised to include research question and state the null hypothesis of the study.

MATERIALS AND METHODS:

It was a split mouth study with follow up period of 6 month. Total 60 primary molars in 30 children were selected for the study. 60 teeth were equally distributed between group A (30 teeth) and Group B (30 teeth). Primary molars on the right side of the patient were assigned to Ferric Sulphate (FS) (Group A) and on the left side for the Mineral Trioxide Aggregate (MTA) (Group B). The study was carried out in the department of pedodontics and preventive dentistry, SDKS dental college and hospital, Nagpur, Maharashtra. The study was started on January 2021 and completed on September 2021. Ethical clearance was obtained from institutional review board (IEC/Rep/STRP/03101).

Comment [TS8]: In abstract mention (3-6 months please fix it.

Comment [TS9]: The author not mention whether it is upper or lower primary molars.

Children fulfilling following criteria's were included in study

1. without any systemic disease
2. Primary molars with carious lesions close to the Pulp and no signs of irreversible pulpitis,
3. No radiographic signs of pathological root resorption, furcation radiolucency.

Comment [TS10]: More detail inclusion criteria require:
1.Age
2.Upper or lower.
3.Type of caries lesion based on GV black

PROCEDURE:

Tell show do technique was used before starting the procedure. Topical anesthetic gel was applied before local anesthesia administration. After successful administration of local anesthesia rubber dam was placed with carious tooth (figure 1).

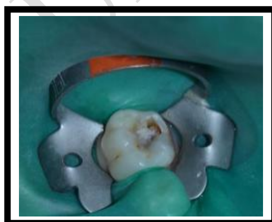
Figure 1

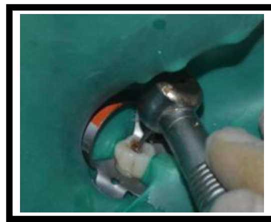
Figure 2

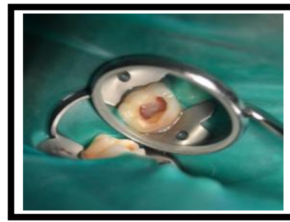
Figure 3

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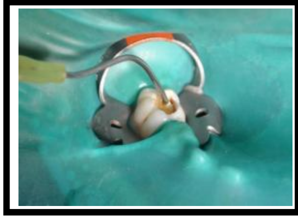

FIGURE 4

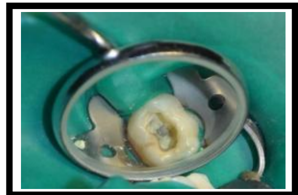

FIGURE 5

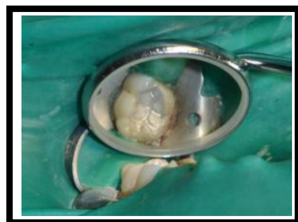

FIGURE 6

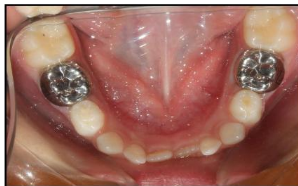

FIGURE 7

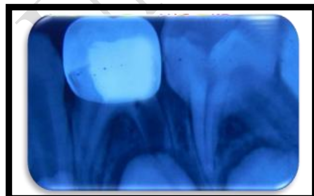

FIGURE 8

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Fig. 1-8. Procedure for local anesthesia rubber dam with carious tooth

Carious excavation was done using slow speed round bur form the axial wall (figure 2). After caries excavation excess cavity was prepared and complete de-roofing was done. Pulp amputation was done using sterile large spoon excavator (figure 3). Complete removal of coronal pulp was inspected visually. Pulp chamber was irrigated with normal saline. After irrigation one or more moistened cotton pellets were applied over the pulp stumps and pressure was applied for few minutes. When cotton pellets were removed hemostasis was apparent. Following hemostasis, ferric sulphate (group A) (figure 4), MTA (group B) (figure 5) was placed over the pulp stumps. In group A, ferric sulphate (Ultradent, Germany) was placed in contact with radicular pulp for fifteen seconds with applicator (Dento-infuser) supplied by manufacturer. After irrigation with normal saline and observation of hemostasis, zinc oxide eugenol was placed in the coronal pulp chamber and cavity was filled with amalgam (figure 6). After eight days, teeth were restored with preformed stainless steel crowns (figure 7).

Comment [TS11]: 1.The procedure not mentions the brand and company of MTA.
2.The procedure not includes how MTA prepared and inserted. It needs revision.

Follow-ups

All the procedure was performed by single operator. Clinical and radiographic follow-up was done after 3 and 6 months. Clinical success was established after negative reporting of spontaneous pain, mobility, swelling and sinus. Absence of external and internal root resorption and bone loss destruction provides the radiographic success.

Comment [TS12]: The limitation of this study is reliability
May agree that clinical procedure performed with single operator but it is important for radiogra[hic assessment to observe with two examiners.

Comment [TS13]: If author said that follow up done after three and six months; then should have two tables for each assessment one after three months and second after six months

Statistical analysis

Statistical analysis was done using SPSS version 21. Chi- square test was used to compare the different clinical and radiographic findings.

Comment [TS14]: Fix P value.

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RESULTS

60 (38 first molar and 22 second molars) primary molars in 30 children were analyzed (Table 1).

Comment [TS15]: Need revision (the paragraph not started with number.

Table 1:- The distribution of primary molars in the two groups

	First Primary Molar		Second Primary Molar		Total
	No	**%**	**No**	**%**	
Ferric Sulphate (Group A)	19	63.3	11	36.7	30
MTA (Group B)	19	63.3	11	36.7	30
Total	38		22		60

Clinical assessment for FS and MTA was 100% for period of 3 and 6 months and thus results were statistically not significant (p = 1) (Table 2). Radiographic assessment for MTA for period of 3 and 6 month was 100 % whereas; it was 96.6% for ferric sulphate (Table3). After statistical analysis the results were statistically not significant (p = 0.98).

Table 2:- Clinical assessment by various clinical signs observed for pain, swelling and Sinus/ fistula in pulpotomized primary molars for 3 and 6 month follow up

	Total	**No. of primary molars without pain**	**Percentage of primary molars without pain**	**No. of primary molars without swelling**	**Percentage of primary molars without swelling**	**No. of primary molars without sinus/fistula**	**Percentage of primary molars without sinus/fistula**

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Ferric Sulphate (Group A)	30	30	100 %	30	100 %	30	100 %
MTA (Group B)	30	30	100 %	30	100 %	30	100 %

By Chi Square Test p = 1.0, Not Significant

Table 3:- Radiographic appearance of pulp observed for internal resorption, furcation radiolucency, periapical radiolucency in primary molars for 3 and 6 month follow up

	Total	**No. of primary molars without internal resorption**	**Percentage of primary molars without internal resorption**	**No. of primary molars without furcation involvement**	**Percentage of primary molars without furcation involvement**	**No. of primary molars without periapical radiolucency**	**Percentage of primary molars without periapical radiolucency**
Ferric Sulphate (Group A)	30	29	96.6 %	30	100 %	30	100%
MTA (Group B)	30	30	100 %	30	100%	30	100%

By Chi Square Test p = 0.98, Not Significant

DISCUSSION

This study intended to examine clinical and radiographic success rate in primary molars and to compare the findings between ferric sulphate (FS) (Group A) and mineral trioxide aggregate (MTA) (Group B).

Comment [TS16]: Name of group not necessary to mention in discussion

Comment [TS17]: 1.The discussion should state why (3-6) months were selected.
2. Why only these two materials selected.
3. Why primary molars.

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Criteria for selection of primary molars for our study was vital carious pulp exposures, no clinical symptoms or evidence of pulp degeneration such as pain on percussion, history of swelling or sinus tracts, no radiographic signs of internal or external resorption and no furcation radiolucency (Agamy et al., 2004). It is important to assess the history of pain and other clinical signs and symptoms including intensity of bleeding from amputation site, to aid in diagnosing radicular pulp tissue. Thus it reiterates the importance of early and accurate diagnosis of pulpal status (Duggal et al., 2002).

Comment [TS18]: This is not discussion

Clinically the success rate was 100% with both the groups at all observation. When assessed for various clinical signs analysis showed that not a single case had failure. Many authors in their clinical study reported favorable results with ferric sulphate pulpotomy, however they had compared their results with formocresol pulpotomy (Ibricevic and Al-Jame, 2003), (Smith et al., 2000), (Casas et al., 2003), (Havle et al., 2013), (Neamatollahi et al., 2006).

Our results revealed comparison of FS (Group A) and MTA (Group B) which showed that the difference was not statistically significant. Clinically they were 100% successful. The clinical success of Ferric Sulphate (FS) in this study could be attributed to right case selection technique protocol and appropriate use of medicament. In addition to this better antibacterial property of ferric sulphate (FS) contributed to success (Cinar et al., 2012).

Ferric sulphate generates plug by agglutination of blood protein that seals blood capillaries. Though controversies considering internal root resorption as pulpotomy failure in different studies have been observed, other authors considered it as normal due to absence of radiographic changes after thirty four months (Fuks et al., 1997).

Failure of pulpotomy is normally detected radiographically. The first sign of failure may be

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internal resorption adjacent to pulpal medicament. Radiographically in our study internal resorption observed in ferric sulphate (Group A) was considered as failure as per methodology. Radiographic success rate of ferric sulphate (FS) pulpotomy evaluated in this study was 96.6% with one failure at the end of three months. Result of FS pulpotomies in our study confirmed the findings of previous studies that recorded one tooth failure at the end of three months (Fei et al., 1991). Some authors reported internal resorption in 40% cases treated with ferric sulphate (Vargas et al., 2005).

Internal resorption is the result of odontoclastic activity and suggests that the tooth is retaining some degree of vitality and function over time. Although the cause of internal resorption is unknown, there is a speculation that whatever the precipitating factor, it produces vascular changes in the pulp that involves an inflammation and formation of granulation tissue (Smith et al., 2000).

In the current study ZOE was chosen as base material over treated pulp stumps. The use of zinc oxide and eugenol may have shown irritation resulting to chronic inflammation and necrosis with ferric sulphate (FS) (Group A).The clot is the only entity separating the zinc oxide eugenol from vital tissue which may not act as barrier to radicular pulp. Therefore ZOE may not be an ideal base for ferric sulphate pulpotomies due to inflammatory tissue (Smith et al., 2000).

Previous investigation of ZOE as a pulpotomy agent or as a base for pulpotomies suggests that ZOE can cause pulp inflammation with a risk for subsequent internal resorption (Holan et al., 2005). ZOE as a base in direct contact with pulpal floor plays important role in the healing process (Garcia-Godoy et al., 1987). Taking into account the type of failure (internal resorption) and time period in which failure occurred, it may be due to undiagnosed chronic

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inflammation. Despite of promising findings regarding the use of ferric sulphate, further studies under the following aspects i.e. longer follow up period and greater number of sample is important.

Study showed radiographic failure amongst FS (Group A) (figure 8) pertaining to the first primary molar which had not depicted any clinical failure.

Three months after the treatment average success rate was 100% in MTA (Group B). Findings of study coincide with many other authors (Malekafzali et al., 2011), (Eidelman et al., 2001), (Sonmez et al., 2008) (Kabaktchieva et al 2009), (Naik and Hegde, 2005), (Haghgoo and Abbasi, 2010)

The success rate of MTA (Group B) in this study was, clinically as well as radiographically, with all the thirty primary molars, 100% successful. Favourable treatment outcome of MTA in comparison to FS could be because of MTA having excellent sealing ability, biocompatibility, alkalinity and ability to regenerate the hard tissue. Effects of MTA on amputated pulpal tissue seem to suggest that the material preserves the pulp tissue and promotes the regeneration of hard tissue (Agamy et al., 2008).

There are reports of complete bridge formation when MTA was used as endodontic material (Torabinejad and Chivian, 1999), (Eidelman et al., 2001), (Salako et al., 2003) and pulp canal obliteration was a common radiographic finding (Subramaniam et al., 2009). However in the present study no dentin bridge formation, pulp canal obliteration was seen radiographically which may be due to short follow up period i.e. three months. Results of present study are in accordance with previous short follow up study (Naik and Hegde, 2009).

Advantage of MTA (Group B) over FS (Group A) and its greater success rate in this study attributed to physical property, biocompatibility and sealing ability of material. MTAs advantages might be related to its sealing ability to prevent bacterial penetration and to its

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high level biocompatibility (Godhi et al., 2011). One of the factors limiting the routine use of MTA is the high cost of the material.

It is well established fact that healing of dental pulp is directly related to the capacity of both the pulp dressing and definitive restorative material which should provide a biological seal against microleakage along the entire restoration interface. Despite the difference in the radiographic success of ferric sulphate (Group A) and MTA (Group B), in this spilt mouth clinical study both the materials have promising biological properties.

Comment [TS19]: The author should state the limitation of the study.

Comment [TS20]: The conclusion is too much wordy please revise it to be more specific.

Conclusion

Following conclusions were drawn from the present study

- No significant difference was seen between ferric sulphate (Group A) and MTA (Group B) as medicaments for use following pulpotomy. The result achieved in the present study following application of MTA was promising when compared to ferric sulphate.
- Radiographic success rate was lower for Ferric sulphate (Group A) than that of MTA (Group B) with occurrence of one internal resorption seen with first primary molar.
- Overall success rate at recall should be assessed radiographically to monitor any pathologic changes along with the clinical evaluation.
- Vital amputation of the pulp with MTA is a reliable biological method for pulp treatment of primary teeth and could be recommended for clinical practice.
- Despite the promising finding regarding the use of ferric sulphate, there is need for further study with longer follow up period and greater number of teeth treated with ferric sulphate to determine long term effects on primary teeth.
- Well-designed randomized clinical trial with adequate sample size and follow up times are required to confirm the superiority of Mineral Trioxide Aggregate.

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Ethical approval

Ethical clearance was obtained from institutional review board (IEC/Rep/STRP/03101)

Data and material availability

All data associated with study are presented in paper.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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