Microbiologic Evaluation of Cotton and Polytetrafluoroethylene (PTFE) Tape as Endodontic Spacer Materials in Primary Molars An *in Vivo* Study

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Objective: *PTFE tape, which is commonly used as plumber's tape is an inorganic, non-fibrous, ribbon like material. The aim of this study was to evaluate PTFE tape as endodontic spacer material and to compare it with commonly used spacer material that is cotton, in primary teeth.* ***Study Design:*** *Seventeen children undergoing pulpectomy of lower second primary molar bilaterally were included in the study. Cotton and PTFE tape were placed as spacers on each side randomly. Samples were taken from the access cavity at baseline and after seven days to check for microbial leakage. Spacer materials were also checked for microbial contamination.* ***Results:*** *The results revealed that there was a significant increase in the bacterial colony count after seven days in cotton group. The access cavities were also positive for microbial leakage in the cotton group where the spacers showed positive growth. In PTFE group only two samples showed microbial contamination of spacer and out of two only one sample showed contamination of access cavity along with spacer.* ***Conclusion:*** *Within the limitations of this study, it can be concluded that PTFE tape performed better than cotton as endodontic spacer material. Thus, PTFE tape can be recommended as an endodontic spacer material as an alternative to cotton in primary teeth.*

Key words: *Endodontic spacer, PTFE tape, temporary restoration, Primary teeth, Pulpectomy, Microbial leakage.*

INTRODUCTION

Natural primary teeth are known to be the best space maintainers. The purpose of pulp therapy in primary teeth is to maintain function, esthetics, arch length symmetry and integrity of primary dentition until normal exfoliation.[1] Pulpectomy can be performed in single visit or in multiple visits, the indications of each varies. Whenever a chronic infection, abscess, sinus or fistula exists or the pulp is necrotic, multiple visit pulpectomy is indicated. The use of temporary restorations is mandatory when pulpectomy is performed in multiple visits so as to prevent contamination of root canal system between the appointments.[2] The state of sterility must be maintained in between the appointments until a definitive coronal restoration is placed following root-canal obturation.

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Previous studies have shown that thickness of temporary restorative material is an important factor in preventing microbial leakage from the oral cavity.[3] Along with it, the type of spacer beneath the temporary restoration, may also contribute to microbial leakage.[4] Endodontic spacers are the materials which are placed beneath the temporary restorations in between the endodontic appointments or between endodontic and restorative appointments. Spacers are used to 1) facilitate easy removal of temporary restorative materials without running risk of unnecessary removal of intact tooth structure or even worse perforating the floor of pulp chamber 2) Prevent these materials from entering into canals and causing canal blockade 3) aid in relocation of chamber and canals.[5]

Cotton is the most commonly used spacer beneath the temporary restorative materials.[6] However, the use of cotton can introduce complications which can seriously compromise the intended seal. First, it may significantly reduce the thickness of the temporary restoration and hence can lead to increased microbial leakage. Second, fibers of cotton can get incorporated within the temporary restorative material and can reach on external surface of the material. Also, while removing, the fibers of the cotton pellet may inadvertently adhere to the access cavity walls and may serve as a wick. Third, it may compromise the stability of the restoration by acting as a cushion, allowing displacement during masticatory loading. Fourth, it could compromise the adaptation of the temporary cement during placement. Finally, there is an increased risk of leakage through exposed lateral canals.

So to overcome all these, many practitioners have tried other materials such as foam pellets and Polytetrafluoroethylene (PTFE) tape, as spacers.[4,7] The ideal spacer material should be inert, inorganic, readily available, inexpensive, easy to use, autoclavable, and easy to place and to remove. PTFE tape, which is commonly used as plumber's tape satisfies all these criterias.[4] PTFE tape is an inorganic, non-fibrous, ribbon like material. It is inorganic, which reduces the potential for bacterial uptake by wicking. It is non fibrous, thus reducing the chances of it getting impregnated within the temporary restorative material. It is non spongy, thus allowing better support to the overlying temporary restorative material.[4]

Thus there is a need to evaluate PTFE tape as an alternative material to commonly used spacer that is cotton. Previously, study on PTFE tape as endodontic spacer has shown good results in vitro in permanent teeth.[4] Therefore, the aim of this study is to evaluate PTFE tape as endodontic spacer material, *in vivo* in primary teeth.

MATERIALS AND METHOD

The present *in vivo* study was carried out in the Department of Pedodontics and Preventive Dentistry in association with Department of Oral pathology and Microbiology, Bapuji Dental College and Hospital, Davangere.

This was an experimental, in vivo, intergroup study. Prior consent was taken from the patient's parents/ guardian for the placement of spacers. Ethical clearance to conduct the study was obtained from the Institutional Ethical Review Board.

Inclusion criteria:

- Children aged between 4-11 years.
- Bilateral mandibular second primary molar teeth, undergoing pulpectomy, obturated with Metapex, with little or no evidence of furcational radiolucency on intraoral periapical radiograph.
- Tooth with Minimal root resorption, as seen radiographically.

Exclusion criteria:

- Medically compromised patients or patients who were on antibiotics.
- Any tooth exhibiting fracture line(s) that might have permitted bacterial leakage into the canal.

Cotton and PTFE tape were placed as endodontic spacer materials over the obturated canals beneath the temporary restoration. The placement of spacers on each side was done by randomization.

The groups used in the study:

- GROUP 1: Cotton as endodontic spacer.
- GROUP 2: PTFE tape as endodontic spacer.

Evaluation of microbial contamination

After obturation with Metapex (META BIOMED CO.LTD, Korea) under rubber dam isolation, pulp chamber was irrigated using 1% sodium hypochlorite followed by saline. First sample was taken from the access cavity by gently scrapping it with a sterile sharp spoon excavator. Sample thus collected was subsequently placed into brain heart infusion broth. The purpose of this sample was to verify the sterility of pulp chamber and access cavity at this stage. Sterilized Cotton pellets and PTFE tape(Diamond, India, ISO 9001:2000, 12 mm) of standardized size (2.5 inches) were then placed as spacers on each side randomly.[4] Above the spacers Cavit G (3M ESPE, Germany) temporary restorative material of standardized thickness (3mm) was placed.[8] Patients were recalled after 1 week.

After 1 week, under rubber dam isolation, provisional restoration was removed carefully by aseptic technique using micromotor (NSK, Japan) and using sterile tweezer spacer materials were transferred to brain heart infusion broth. After this, the samples were centrifuged at 2500 rpm for 10 minutes in a centrifuge machine for homogenization of samples. A 0.1 ml of sample was taken and inoculated on blood agar plates to check for microbial growth and bacterial colony count. Plates were incubated for 24-36 hours at 37˚c in an incubator. The plates were then examined and the number of bacterial colonies were counted using digital colony counter in terms of cfu/ml of the innoculum.[9]

Evaluation of microbial leakage

Cotton and PTFE tape were also evaluated for the microbial leakage. After the removal of spacer material, a sample was also taken from the inner surfaces of access cavity using a sterile sharp spoon excavator to determine the contamination from spacer material to access cavity. The collected sample was centrifuged using centrifuge machine. The sample thus collected was sent for microbiological examination to check for microbial growth on blood agar plates. A 0.1 ml of sample was taken and inoculated on blood agar plate. Plates were incubated at 37˚c for 24-36 hours, the number of bacterial colonies were counted using digital colony counter in terms of cfu/ml of the innoculum. The results obtained were tabulated and subjected to appropriate statistical analysis.

RESULTS

The results thus obtained were statistically analyzed by Wilcoxon signed rank test.

Comparison of baseline and seven days microbial contamination on cotton spacer and microbial leakage in access cavity

In group 1 study participants where cotton was used as an endodontic spacer material no microbial colony could be observed at baseline but over a period of seven days there was a significant increase in microbial growth over the spacer material. (fig.1) Also, for group 1, there was a significant amount of microbial leakage in the access cavity. Thus, microbial contamination was present on both cotton spacer as well as in the access cavity. Also, there was a significant difference in the mean colony count on cotton as compared to that in the access cavity (Table 1 and graph 1).

Comparison of baseline and seven days microbial contamination on PTFE spacer and microbial leakage in access cavity

In group 2 study participants where PTFE tape was used as an endodontic spacer material, no microbial colony could be observed at baseline and also over a period of seven days there was no significant increase in microbial growth over the spacer material (Fig 2).

Table 1: Comparison of baseline and 7 days microbial contamination on cotton spacer and microbial leakage in access cavity

Colony count (cfu/ml)	N	Mean(SD)	Median(Q1-Q3)	Z	p-value
Baseline colony count	17	0	0(0-0)	-	-
Colony count after 7 days on cotton	17	1820.59(982.78)	1820(1335-2205)	3.408	0.001 [p<0.05S]
Colony count after 7 days in the access cavity	17	759.41(419.44)	890(560-1000)		

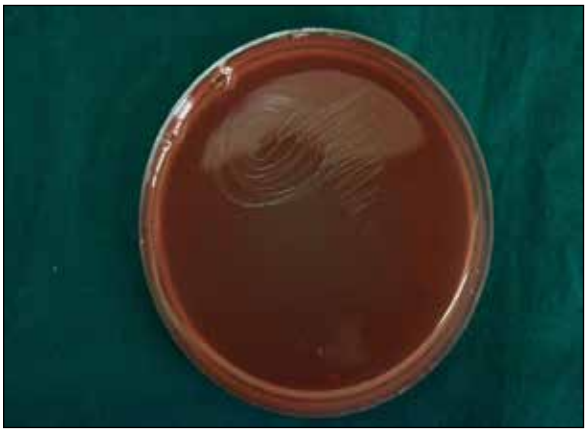
Table 2: Comparison of baseline and 7 days microbial contamination on PTFE spacer and microbial leakage in access cavity

Colony count (cfu/ml)	N	Mean(SD)	Median(Q1-Q3)	Z	p-value
Baseline colony count	17	0	0(0-0)	-	-
Colony count after 7 days on PTFE	17	45.29(128.16)	0(0-0)	1.342	0.18(NS)
Colony count after 7 days in the access cavity	17	11.76(48.50)	0(0-0)		

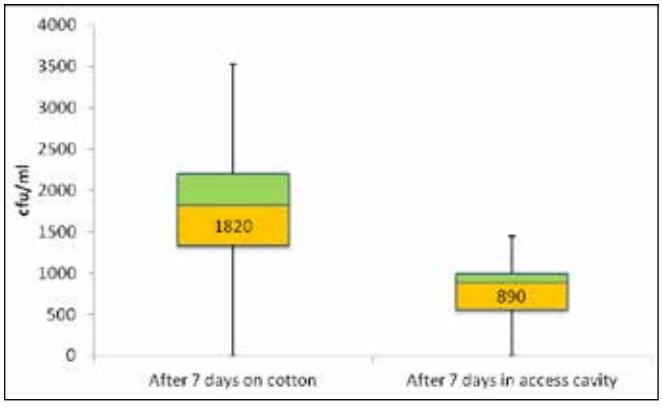
S: significant, NS: non significant [p < 0.05S, p>0.05NS]

Figure 1: Microbial colony formation seen in cotton group after seven days

Figure 2: No microbial growth in PTFE group after seven days



Graph 1 : Comparison of baseline and 7 days microbial contamination on cotton spacer and microbial leakage in access cavity



Over a period of seven days there was no significant increase in microbial growth into the access cavity. Also, there was no significant difference in the colony count on PTFE as compared to that in the access cavity (Table 2)

Comparison of microbial contamination on cotton and PTFE tape after seven days

There was a significant difference in the colony count on cotton as compared to that of PTFE tape and PTFE tape showed less microbial contamination as compared to cotton as spacer material (Table 3 and graph 2).

Comparison of microbial leakage in the access cavity for cotton and PTFE after seven days

There was a significant difference in colony count in the access cavity for cotton as compared to PTFE tape and PTFE tape showed less microbial leakage into the access cavity as compared to cotton as spacer material (Table 4 and graph 3).

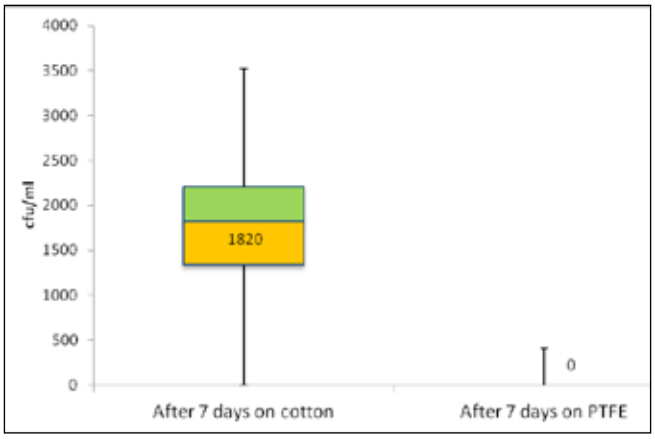
Table 3: Comparison of microbial contamination on cotton and PTFE tape after 7 days

Group no.	Colony count (cfu/ml)	N	Mean(SD)	Median(Q1-Q3)	Z	p-value
Group 1	Colony count after 7 days on cotton	17	1820.59(982.78)	1820(1335-2205)	3.40	0.001 [p<0.05S]
Group 2	Colony count after 7 days on PTFE	17	45.29(128.16)	0(0-0)		

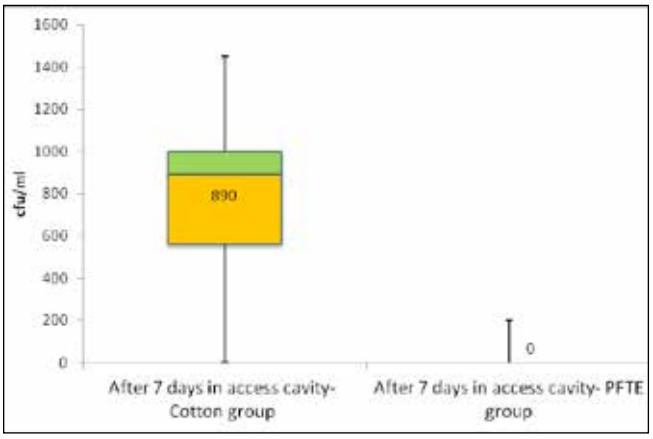
Table 4: Comparison of microbial leakage in the access cavity for cotton and PTFE after 7 days

Group no.	Colony count (cfu/ml)	N	Mean(SD)	Median(Q1-Q3)	Z	p-value
Group 1	Colony count after 7 days in access cavity	17	759.41(419.44)	890(560-1000)	3.29	0.001 [p<0.05S]
Group 2	Colony count after 7 days in access cavity	17	11.76(48.50)	0(0-0)		

Graph 2: Comparison of microbial contamination on cotton and PTFE tape after 7 days



Graph 3: Comparison of microbial leakage in the access cavity for cotton and PTFE after 7 days



DISCUSSION

It is important to maintain the primary dentition in a non pathologic and healthy condition for space maintenance, proper mastication, esthetics, phonetics and prevention of aberrant habits. Pulpectomy is a procedure in which there is complete removal of necrotic pulp from the root canals of primary teeth and filling them with an inert resorbable material so as to maintain the tooth in the dental arch.

Pulpectomy can be carried out in single visit or multiple visits. When pulpectomy is performed in multiple visits, temporary restorations are used to seal the access cavity to prevent contamination of root canal system in between the visits. Beneath the temporary restorations spacers are placed to facilitate the removal of provisional restorative material, to prevent these materials from entering into the root canals and also to aid in relocation of the chamber and the canals.[4]

Cotton is the most commonly used spacer material beneath the temporary restorations in the interappointment period.[6] Many clinicians use cotton pellets as medicament carrier. The removal of the cotton fibers can be challenging because they frequently get trapped on the cavity walls, potentially compromising the integrity of the definitive restoration. If a definitive restoration is not provided relatively soon after endodontic therapy, masticatory forces may cause wear or abrasion of the surface of the provisional restoration, thereby reducing its thickness to below the desired 3.5 mm. This may result in the exposure of the entrapped cotton fibers to the oral environment, which could lead to the initiation of coronal microleakage from the oral cavity.[4]

So to overcome all this, many practitioners have tried other materials such as foam pellets and Polytetrafluoroethylene (PTFE) tape, as spacers.[4,7] PTFE is inorganic and non-fibrous which may enhance its effectiveness as spacer. Also, it is inert, autoclavable and easily available.[4] Stean has reported several uses of PTFE tape in dentistry. He categorized dental uses of PTFE tape into three types- 1) mechanical barrier applications 2) surgical uses 3) fit checker.[10]

The protocols used in this study were similar to those of other studies that have evaluated leakage of Cavit restorations.[11,12] The length of PTFE tape was standardized to approximately 2.5 inches and the cotton used was also standardized for each sample. A periodontal probe was used to measure the depth of the access cavity after placement of cotton or PTFE tape to ensure that it could accommodate an approximate thickness of 3mm provisional restorative material as based upon previous studies.[8] The 7-day time point was selected based on previous *in vitro* and *in vivo* studies.[3,13] Split mouth design was considered to provide similar oral conditions for both the groups and eliminate interpersonal oral hygiene bias. Obturated canals were considered to prevent any microbial leakage from canals to access cavity and thus any bacteria present on the spacer materials or in the access cavity will be due to coronal leakage only. Also obturation with Metapex was done as it is considered as nearly

ideal obturating material for primary root canals.[14] Micromotor was used for removal of temporary restorative material after 7 days to prevent wetting of spacers and the access cavity by airrotor and to prevent possible contamination.

The results showed that cotton spacer samples were positive for microbial contamination after 7 days and 15 out of 17 cotton spacer samples were positive for microbial contamination. The access cavities were also positive for microbial leakage in the cotton group where the spacers showed positive growth. This demonstrates that there was definite microbial leakage and contamination under cotton when it was used as spacer beneath temporary restorative material. These findings are in accordance with the study done by Newcomb et al in which they evaluated the effect on the sealing of a zinc oxide-calcium sulfate based temporary filling material when fibers of the internal cotton passed through the filling material and reached the external surface of the temporary filling. The results demonstrated that even a very small amount of cotton trapped between the wall of the tube and the filling material dramatically reduced the sealing quality of the temporary restoration.[15]

In our study, the possible reasons for microbial contamination in the cotton group could be due to organic and fibrous nature of cotton which can cause entrapment of fibers within the provisional restorative material and may promote wicking as well as bacterial uptake from oral cavity to the access cavity.

In PTFE group only 2 samples showed microbial contamination of spacer and out of which 1 sample showed contamination of spacer as well as access cavity and another one showed only spacer contamination but not the access cavity contamination. These findings are in further accordance with the previous in vitro study done by Avina paranjpe et al in which they used cotton or PTFE tape as spacers under a standardized thickness of provisional restorative material (Cavit). They concluded that even under optimal conditions, cotton spacers may cause leakage into the access cavities. Cotton fibers may serve as a route for bacterial contamination of the access cavities and root canal space. In contrast, PTFE tape did not provide an avenue for bacterial contamination.[4]

In our study, the possible reasons for non contamination of PTFE tape could be due to its easy handling characteristics, particularly its unique property of not adhering to any part of the access cavity. This ensures that the tape can be removed easily in one piece, leaving behind an access cavity free of any remnant of spacer. Also, the tape is inorganic and non fibrous thus preventing the bacterial uptake and eliminating the chances of getting impregnated within the temporary restorative material.

This is the first *in vivo* study on endodontic spacers in primary teeth and in our study PTFE tape showed better results as compared to cotton as spacer material. These findings are important to Pediatric dentist as one of the main objectives when pulpectomy is performed in multiple visits is the difficulty in effectively sealing off the root canal system from the oral cavity between visits. Thus PTFE tape can be used as spacer material beneath the temporary restorations during interappointment period to eliminate the potential problem of interappointment contamination or flare up. Based upon the results of this *in vivo* study we strongly recommend the use of PTFE tape as endodontic spacer in primary teeth during inter appointment period.

CONCLUSIONS

Within the limitations of this study, following conclusions are drawn :

1. Spacer material contamination is associated with microbial leakage in the access cavity during interappointment period.
2. PTFE tape as a spacer material showed minimal or no microbial contamination as compared to cotton spacer beneath the temporary restoration.
3. Microbial leakage in the access cavity was minimal when PTFE tape was placed as spacer beneath temporary restoration.

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