In vitro microbiologic evaluation of PTFE and cotton as spacer materials

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Objective: The aim of this study was to microbiologically evaluate the efficacy of cotton and polytetrafluoroethylene (PTFE) tape used as spacer materials. **Method and Materials:** Twenty-six extracted human molars were restored using either cotton or PTFE tape as a spacer under a standardized provisional restorative material (Cavit). The teeth were incubated for 7 days in a culture of *Streptococcus gordonii* or in liquid media alone. The spacers were removed and tested for bacterial contamination. The access cavities were also evaluated for bacterial contamination. **Results:** Nine of 10 teeth with cotton spacers and 1 of 10 teeth with PTFE spacers were positive for *S gordonii* growth. The 9 teeth in the cotton group also showed contamination of the access cavities. **Conclusions:** 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. *(Quintessence Int 2012;43:xxx–xxx)*

Key words: cotton, endodontics, PTFE, spacer

Provisional restorative materials are often used in endodontics between endodontic appointments or between endodontic and restorative appointments. Previous studies have demonstrated that the thickness of the provisional restorative material is an important factor in preventing leakage from the oral cavity. Webber et al[1] showed that a minimum depth of 3.5 mm is required to prevent leakage of Cavit (3M ESPE) in the access cavity. Parris et al[2] demonstrated leakage of provisional restorative materials and subsequent bacterial contamination of cotton pellets after only 1 week. These results were confirmed by Krakow et al.[3] More recent studies have demonstrated that microbial leakage may occur if the thickness of the Cavit is less than 3 mm or in cases with a complex access preparation.[4] In addition to the restorative material used, the type of spacer may also contribute to microbial leakage. Vail and Steffel[5] demonstrated that regardless of how the cotton spacers are placed, it is still possible for cotton fibers to connect the oral cavity to the access cavity. Newcomb et al[6] found that small amounts of cotton trapped between the wall of a glass tube and the restorative material could dramatically reduce the sealing quality of the provisional restoration. Cotton is the most commonly used spacer beneath provisional restorative materials.[5] Cotton is used to *(1)* facilitate the removal of provisional materials, *(2)* prevent these materials from entering the canals, and *(3)* aid in the relocation of the chamber and canals. While this procedure is clinically convenient, the organic and fibrous nature of cotton may promote wicking and bacterial uptake. This could cause microbial leakage into the access cav-

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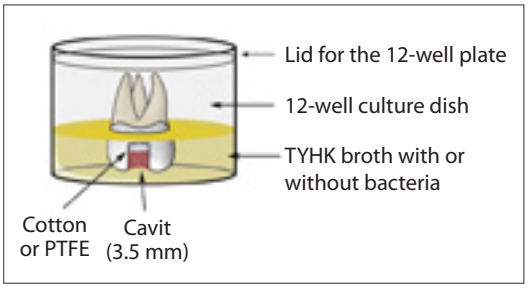

Fig 1 Schematic representation of the experimental setup.

ity, thus affecting the treatment prognosis. Cotton pellets have been shown to have specific advantages and disadvantages.[7] Since the use of cotton pellets is controversial, many practitioners have tried other materials such as foam pellets[6] and polytetrafluoroethylene (PTFE) tape[8] as spacers. The ideal spacer material should be inert, inorganic, readily available, inexpensive, easy to use, autoclavable, easily visible, and easy to place and remove. Further, the spacer should take up minimal volume and support the overlying restoration. PTFE tape, which is commonly known as "plumber's tape," satisfies all of these criteria. Unlike cotton, PTFE tape is a ribbon-like and nonfibrous material. This ensures that the overlying provisional restoration is not impregnated with the spacer material. PTFE tape is inorganic, which reduces the potential for bacterial uptake by wicking, and non-spongy, allowing better support of the overlying provisional material. There is a need to evaluate the effectiveness of currently used spacers in comparison with alternative materials such as PTFE tape. Currently, however, there are no published studies comparing the use of PTFE and cotton. Therefore, the aim of this study was to evaluate the extent of microbial leakage of cotton and PTFE tape used as spacers in an in vitro microbiologic model.

METHOD AND MATERIALS

Twenty-six maxillary and mandibular human molars with intact crowns were used for this study. Teeth with restorations that could potentially permit marginal leakage into the access chambers were excluded, as were any teeth exhibiting fractures that could permit bacterial penetration through the fracture lines. All procedures were performed by the same operator. Teeth were isolated with rubber dam and disinfected using the following protocol[9]: First, tooth surfaces were disinfected with 30% hydrogen peroxide until the bubbling stopped. The tooth and rubber dam were then coated with an iodine tincture. An access cavity was made using a new sterile no. 4 round bur. All canal orifices were visually located. The tooth surfaces and access opening were swabbed with 5% sodium thiosulphate solution to inactivate iodine, and the pulp chambers were irrigated with 5.25% sodium hypochlorite followed by sterile saline to remove any pulp tissue remnants and other debris inside the chamber.

The teeth were autoclaved to eliminate any bacteria that could potentially cause false positive results and reexamined under a microscope to exclude any teeth that exhibited cracks. To ensure that teeth were not contaminated prior to the experiment, the pulp chambers were swabbed with sterile cotton pellets, which were subsequently placed into the bacterial growth medium TYHK broth (trypticase, yeast extract, hemin, vitamin K) and incubated anerobically. Teeth with positive growth in the TYHK broth as determined by broth turbidity were eliminated from the study.

The length of the PTFE tape was standardized to approximately 2.5 inches, and two no. 1 cotton pellets were used per tooth during the experiment. The cotton pellets and PTFE tape were sterilized prior to use. A periodontal probe was used to measure the depth of the access cavity after placement of the cotton or PTFE tape to ensure that it could accommodate a minimum thickness of 4 mm of the provisional restorative material (Cavit).[10] After restoration, the coronal portions of the teeth were immersed in 2 mL of TYHK media in a 12-well plate for 7 days (Fig 1). The media level was maintained coronal to the cementoenamel junction and designed to keep the broth from exposure to the furcal canals or exposed dentin. The broth was inoculated with bacteria for

the experimental groups, while the control groups were immersed in TYHK broth alone without the introduction of bacteria. The bacteria inoculant used was *Streptococcus gordonii*, a nonpathogenic commensal bacterium that is an integral member of the human oral flora[11] and has been recovered from root canal samples.[12] *S gordonii* has been used previously in leakage studies.[13] The teeth were randomly assigned to one of the following four groups:

- Group 1: Control (3 teeth)—teeth with cotton placed in TYHK broth only.
- Group 2: Control (3 teeth)—teeth with PTFE tape placed in TYHK broth only.
- Group 3: Experimental group (10 teeth)—teeth with cotton placed in TYHK broth containing 10^8/mL *S gordonii* bacteria.
- Group 4: Experimental group (10 teeth)—teeth with PTFE tape placed in TYHK broth containing 10^8/mL *S gordonii* bacteria.

After 7 days, the coronal tooth structures of all teeth were disinfected by swabbing with 70% ethanol and irrigating the external surface of the tooth with approximately 5 mL of 6% sodium hypochlorite followed by 5 mL of sterile saline. The Cavit restorations were removed using the same aseptic techniques as described previously. The cotton or PTFE spacers were carefully removed and placed into 1 mL of TYHK broth media in an Eppendorf tube. These samples were agitated vigorously by vortexing to dislodge adherent bacteria. The TYHK broth and spacer were placed on TYHK agar plates and incubated anerobically for 48 hours. *S gordonii* contamination of the spacer material was evaluated by the presence of colonies on the agar plates. The examiner who performed these evaluations was blinded to the study. After removal of the spacer material, the inner surfaces of the access cavities were checked for contamination by swabbing with sterile cotton pellets as done preoperatively. The pellets were placed in 5 mL of TYHK broth and incubated anerobically for 48 hours. *S gordonii* contamination of the access cavity was evaluated by observing turbidity of the broth.

RESULTS

Bacterial contamination of the cotton and PTFE spacers was evaluated after 7 days. Nine of 10 samples from group 3 (cotton) showed the presence of colonies on agar plates, indicating the uptake of *S gordonii*. In contrast, only 1 of 10 samples from group 4 (PTFE) showed the presence of colonies on agar plates.

The negative controls from groups 1 and 2 showed no growth on the agar plates. Nine samples from group 3 and no samples from group 4 showed contamination of the access cavities as assessed by turbidity of the liquid broth. The same teeth that were positive for spacer contamination as seen by colonies on the agar plates were also positive for access cavity contamination, demonstrating that the cotton spacers may serve as a conduit for bacteria from the surface into the access cavity.

DISCUSSION

Cotton pellets have traditionally been used as the between-appointment spacers of choice underneath provisional restorative materials.[5] Many endodontists use cotton pellets as a carrier for medicaments. After endodontic therapy is completed, cotton pellets are often used as spacers above the gutta percha–filled canals and beneath the provisional materials to facilitate the easy removal of the restoration and guide the clinician to the canal orifices. 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. In some instances, such as in mandibular anterior teeth with a conservative access cavity, removal of the cotton pellet can be quite difficult. 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.[1] 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. PTFE is nonfibrous, which may enhance its effectiveness as a spacer. There have been no in vitro microbiologic studies comparing cotton and PTFE as spacer materials.

The protocols used in this study are similar to those of other studies that have evaluated leakage of Cavit restorations.[10,14] However, it is important to note that this study focused on the advantages of PTFE over cotton as a spacer. Some studies have examined leakage of restorative materials in obturated teeth.[15,16] However, the present authors chose not to use obturated teeth since the primary aim was not to evaluate leakage through the restorative material but to delineate the advantages and disadvantages of the two spacer materials. Cavit was used in this study because it is routinely used by endodontists[5] and because previous in vitro studies have shown it to perform better than other materials.[14,17]

The results showed that cotton spacer samples were positive for microbial contamination after 7 days. The 7-day time point was selected based on previous in vitro and in vivo studies.[1,18] The access cavities/dentin were also positive for microbiologic contamination. This demonstrates that even under optimal conditions, including at least 3.5 mm of Cavit and no occlusal loading, microbial leakage into the access cavity still occurred in this in vitro microbiologic model. Only 1 of 10 samples in the PTFE group showed a positive culture. The sample demonstrated a positive culture from the spacer itself but not dentin contamination, which could mean that the sample became contaminated sometime after the incubation period. The majority of the PTFE samples did not demonstrate positive cultures. This result could be attributed to the inorganic nature of the PTFE tape, which may inhibit bacterial movement beyond the PTFE. However, this aspect of PTFE needs to be investigated further. Another important aspect of PTFE tape is 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 surface debris. Some practitioners also advocate the use of a sponge as a spacer. However, provisional restorative materials placed over spongy spacer materials may be more susceptible to breakdown from occlusal forces. Since PTFE is compressible and firm when compressed, placement of a provisional restoration over PTFE could result in added support. Based on the results of the present study, the use of PTFE is strongly recommended over that of cotton as an endodontic spacer material. However, several limitations of the study should be noted: (1) Only Cavit was used, which limits the applicability of the results to other filler materials; (2) the study did not employ thermocycling,[19] which may have reflected the oral environment better and provided different results; and (3) no occlusal forces were simulated. In vivo studies may be required to validate these in vitro results.

CONCLUSION

This study compared the effectiveness of cotton and PTFE tape used as spacer materials. The PTFE tape performed better than cotton in this in vitro study.

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