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Orthodontic Marking Pencils: A Potential Source of Cross-Contamination

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The purpose of infection control in a dental office is to prevent the transmission of disease by considering every patient, staff member, and instrument to be a potential carrier; by reducing the number of potentially pathogenic microorganisms to the point where they do not pose an infectious threat; and by eliminating the possibility of cross-contamination.1 In practice, orthodontists generally focus their attention on the sterilization of pliers, handpieces, and other instruments.2,3 Orthodontic marking pencils are not usually considered as a possible link in the chain of infection.4

The present study was designed to determine whether orthodontic marking pencils can pick up and transfer bacteria from patient to patient during typical orthodontic procedures.

Materials and Methods

Nine bacterial species–*Streptococcus viridans, Streptococcus fecalis, Streptococcus mitior, Streptococcus sanguis, Streptococcus mutans* serotype C, *Staphylococcus aureus, Escherichia coli, Enterobacter fecalis,* and *Proteus vulgaris*–were grown to logarithmic phase in trypticase soy broth.

Sharpened orthodontic marking pencils were sterilized with ethylene oxide gas, then dipped to a standard depth into 100-microliter drops of each culture except *S. mutans*. Each pencil tip was aseptically excised, and bacteria were harvested after vigorous agitation in water using a vortex mixer. Following incubation for 24 hours at 36.5°C, bacteria were counted by making tenfold serial dilutions and plating aliquots on trypticase soy agar.

A second experiment tested the effectiveness of conventional methods used to decontaminate marking pencil tips. After being dipped in a culture of either *S. mitior* or *S. sanguis*, the tips were wiped with either sterile gauze or gauze treated with IodoFive disinfectant. The tips were then allowed to dry under a sterile hood for five or 20 minutes prior to the counting of bacteria as described above.

The third experiment assessed whether contaminated archwires can transfer bacteria to marking pencils. Orthodontic archwires 9cm long and .030" in diameter were either dipped for a few seconds or incubated overnight in *S. viridans* or *S. mutans* bacterial broth cultures. A single mark was then made on each archwire with a sterile pencil tip, as in normal clinical practice. The tips were removed and evaluated for the presence of bacteria.

Finally, we measured the transfer of bacteria to marking pencil tips in a clinical setting. Archwires in 10 patients were marked with sterile pencils in two places each, as would normally be done. The tips were removed and treated as described above. The bacterial cultures from the tips were prepared either aerobically or anaerobically.

Each experiment was conducted three times, and means of the triplicate tests were calculated.

Results

The first experiment showed that a single touch of a marking pencil tip was sufficient to pick up and retain as many as 350,000 bacteria (Table 1). Because the cultures used for the experiments did not contain a standard number of colony-forming units, it would be impossible to compare the transmission of the different types of bacteria.

Although wiping with sterile gauze appeared to remove at least a majority of bacteria at first, both types of bacteria increased in number after 20 minutes under the sterile hood (Table 2). Uncontaminated control pencil tips showed no bacteria after either five or 20 minutes under the hood, eliminating the possibility of airborne contamination. *S. sanguis* bacteria appeared to be more susceptible to disinfection with IodoFive than *S. mitior* bacteria were. However, the number of *S. mitior* bacteria decreased between five and 20 minutes of drying.

There was considerable variation in the number of bacteria transferred by contact with contaminated archwires (Table 3). In fact, the *S. mutans* cultures incubated overnight produced no bacteria.

Bacteria could be measured from the pencils used to mark archwires in six of the 10 patients tested (Table 4). The percentage of contaminated pencils was the same for aerobic and anaerobic cultures, although two of the anaerobic cultures produced lower numbers of bacteria.

Discussion

The results of this study show that conventional wiping of orthodontic marking pencils is ineffective in removing infectious microorganisms. A 20-minute drying interval was selected to represent an average time between patients in an orthodontic office.2-4 The pencils wiped with sterile gauze actually increased in bacterial count over this time period. It is possible that microscopic grooves, crevices, or pits on the pencil surface may protect some of the bacteria from drying or disinfection. In addition, wiping the tip may smear some of the surface material over these crevices and seal in the bacteria.

Increased drying time did correlate with a decrease in bacteria on the tips wiped with IodoFive disinfectant, but the *S. mitior* bacteria were still not totally eliminated. The greater susceptibility of *S. sanguis* to disinfection could be due to a difference in properties between the two microorganisms or to a lower number of bacteria present at the start of the experiment.

The possibility of bacterial survival for even longer than 20 minutes cannot be disregarded, since organisms such as the agent for tuberculosis and some bacterial and fungal spores can survive for months under certain conditions.5,6 Viral cross-contamination must also be taken into account; although HIV and hepatitis viruses are rapidly killed by drying and disinfection, their elimination from crevices on pencil tips cannot be guaranteed. HIV, which is not cell-associated, can remain infectious for 15 days in biological fluids.1

Our investigation also demonstrates that marking pencils can transfer bacteria from contaminated archwires. The variation in bacterial counts can be explained by a number of factors, including the morphology of the pencil tips, the amount of the tips contacting the wire surfaces, coincidental contact with uncontaminated areas of wire, and inconsistent experimental techniques. Clinical variables include the influence of saliva and the patients' oral hygiene and diets.

Conclusion

Conventional orthodontic marking pencils cannot be autoclaved. Gas sterilization, as used in this study, is effective in killing bacteria, but is also costly and difficult, making it impractical for orthodontic offices. One article has suggested alcohol-containing permanent markers as a safe and effective alternative to pencils, but this report also noted that the pens become increasingly ineffective in eliminating bacteria the longer they are used.7 Because alcohols are intermediate disinfectants that do not kill spores or certain viruses, the permanent markers may be unreliable infection-control devices.

Soaking or spraying the tips of marking pencils with disinfectants could be more effective than wiping, but this method is unlikely to gain acceptance from practitioners. The only sure way to avoid potential cross-contamination is to use the inexpensive disposable markers available from orthodontic supply companies. □

TABLES

TABLE 1
NUMBER OF BACTERIA ON PENCIL TIPS AFTER CONTACT WITH BACTERIAL CULTURES

S. viridans	183,333
S. fecalis	353,333
S. mitior	90,900
S. sanguis	55,533
S. aureus	185,666
E. coli	61,666
E. fecalis	47,333
P. vulgaris	35,333

Table. 1

TABLE 2
NUMBER OF BACTERIA ON PENCIL TIPS AFTER WIPING

	Drying Time	*S. mitior*	*S. sanguis*
Sterile gauze	5 minutes	0	15,000
	20 minutes	10,366	26,666
IodoFive	5 minutes	41,833	0
	20 minutes	1,000	0

Table. 2

TABLE 3
NUMBER OF BACTERIA ON PENCIL TIPS AFTER MARKING CONTAMINATED ARCHWIRES IN VITRO

	Dipped in Culture	Incubated Overnight
S. viridans	1,000	11,000
S. mutans	2,433	0

Table. 3

TABLE 4
NUMBER OF BACTERIA ON PENCIL TIPS AFTER MARKING ARCHWIRES IN VIVO

Aerobic Cultures	
Patient 1	0
Patient 2	>10,000
Patient 3	>10,000
Patient 4	0
Patient 5	>10,000
Anaerobic Cultures	
Patient 6	120
Patient 7	2,700
Patient 8	0
Patient 9	>10,000
Patient 10	0

Table. 4

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7 Cureton, S.L.; Best, N.H.; and Runyan, D.A.: Disinfection of permanent markers, J. Clin. Orthod. 30:646-649, 1996.

FOOTNOTES

1 Bacterial species: American Type Culture Collection, Rockville MD.

2 Trypticase soy broth: Fisher Scientific Co., Pittsbough, PA.

3 Marketing pencils: RMO, Inc., P.O. Box 17085, Denver, CO 80217.

4 IodoFive: Registered trademark of Cottrell Ltd., 7399 S. Tucson Way, Englewood, CO 80112.