

The effects of decreasing surface tension on the flow of irrigating solutions in narrow root canals

Marwan Abou-Rass, D.D.S., M.D.S., Ph.D.,* and Frank J. Patonai, Jr., D.D.S.,**
Los Angeles, Calif.

UNIVERSITY OF SOUTHERN CALIFORNIA SCHOOL OF DENTISTRY

There is little information in the endodontic literature regarding the effects of surface tension on the penetration of irrigating solutions into the canals. Surface tension pertains to the spread of solutions and must be considered important in root canal therapy.¹

The irrigating solution must be brought into intimate contact with the dentin wall and the debris. The intimacy of this contact depends on the wettability of the solutions on the solid dentin.²

O'Brien³ and others have shown the wettability of the solutions to be important to the penetration of these solutions into the small spaces formed by the dentin. It is probable, therefore, that the wettability of endodontic irrigating solutions is of primary importance in their penetration of the main and lateral canals and predentin dentinal tubules.

In general, the wettability of a solution depends on its surface tension. Zoethout and Tuttle⁴ define surface tension as a condition of intramolecular attraction at the surface of a liquid in contact with a solid tending to pull the molecules inward from that surface. When that intramolecular attraction is destroyed, the surface tension is decreased. This may be accomplished by the use of heat or the addition of a surfactant.

PURPOSE

The purpose of this study is to evaluate the effect of reducing the surface tension of root canal irrigants on their flow properties.

MATERIALS AND METHODS

Materials

The five irrigating solutions used in this study were distilled water, 70 percent isopropyl alcohol, 2.6

*Associate Professor and Chairman, Department of Endodontics.

**Clinical Assistant Professor, Department of Endodontics.

Table 1. Surface tension values

	Plain (dynes/cm.)	Surfactant (dynes/cm.)
1. Distilled water	75.5	65.0
2. Alcohol 70%	27.8	22.4
3. Sodium hypochlorite 2.6%	76.7	67.2
4. Sodium hypochlorite 5.25%	79.1	69.8
5. EDTA	39.7	33.7

percent sodium hypochlorite, 5.25 percent sodium hypochlorite, and ethylenediaminetetra-acetic acid (EDTA).

The surface tension was reduced by adding the chemical polysorbate 80.

Renografin-60 was used as a radiopaque guide into the canals. It was mixed with the solutions to facilitate radiographic interpretation. This material has been used medically as a tracing element to detect diseased or blocked internal organs.

Methods and measurements

Control group. The surface tension of each solution was measured by the ring method. Five readings were taken for each solution, and the average was recorded (Table I).

Fifty extracted mandibular molars were used. The distal root was removed to enhance the standardized radiographic examination of the mesial roots in the buccolingual view. All radiographs were obtained using the same time and angle of exposure. After the contents of the pulp chamber were removed, a No. 15 file was passed through the canals to verify canal patency without any instrumentation.

The teeth were divided into five groups of ten teeth each. All the teeth were radiographed before the experiment. Wax was added to the apex of each tooth to contain the irrigation solution.

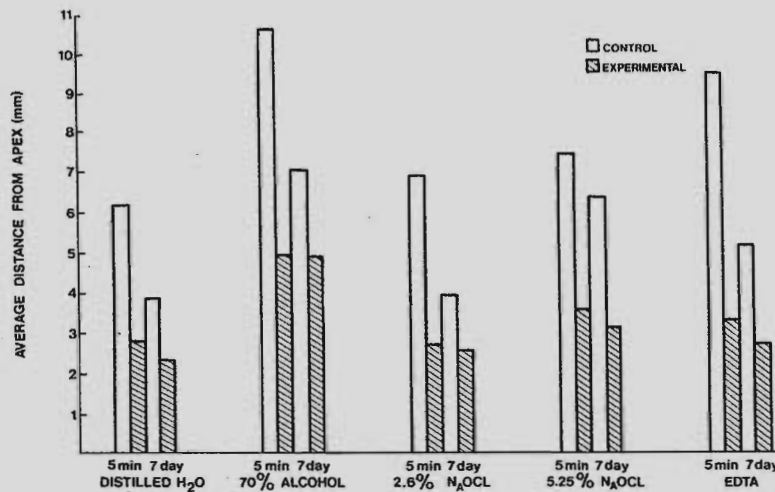


Fig. 1. Bar graph comparing control versus surfactant averages at 5-minute and 7-day intervals.

Table II. Results of degree of irrigation flow as measured by distance from apex to solution level

Solution	5-minute control (mm.)	5-minute experimental (mm.)	7-day control (mm.)	7-day experimental (mm.)
Distilled water	6.3	2.6	3.9	2.2
Alcohol 70%	10.7	4.7	6.8	4.4
Sodium hypochlorite 2.6%	6.4	2.6	3.9	2.4
Sodium hypochlorite 5.25%	7.7	3.6	6.4	3.1
EDTA	9.6	3.4	5.3	2.9

Each 3 ml. of irrigation solution was mixed with 1 ml. of Renograffin-60 and shaken vigorously. The solution was then placed in the pulp chambers of the teeth. None of the solutions were injected in the canal.

The teeth were stored in an incubator at 37° C. for five minutes. Radiographs were then taken to check the radiopacity of the solutions. A millimeter ruler measured the penetration of each solution as disclosed by the opaque medium on the x-ray film. This measurement showed the distance between the level of opaque solution and the apex.

A cotton pellet was then placed in the chamber and the access opening was sealed with Cavit. The teeth were again stored in the incubator for 7 days. At the end of that time radiographs were obtained and measured.

After the control solutions were measured, the boxing wax, cotton, and Cavit were removed from each tooth. The teeth were flushed with tap water, and a 5 ml. syringe was used to remove the control solutions. The canals were then dried with paper points and an air syringe, and radiographs were taken to ensure removal of all control solutions and opaque medium.

Experimental group. The solutions of distilled

water, 70 percent alcohol, 2.6% sodium hypochlorite, 5.25 percent sodium hypochlorite, and EDTA were mixed with polysorbate 80, and 1 ml. of this surfactant was dissolved in 10 ml. of each solution. The surface tension of each was recorded. Then 1 ml. of Renograffin-60 was added to 3 ml. of each solution.

The procedures used in the control group were repeated in the experimental group.

The average distance from the apex was recorded for all teeth. A comparison was made between the control and experimental solutions at 5 minutes and 7 days. These average results were recorded on a bar graph in Fig. 1.

The data were analyzed by the Binomial Distribution Test.*

RESULTS

The results of the surface tension measurements are recorded in Table I. In each case the surfactant lowered the surface tension of the irrigating solutions between 15 and 20 percent. These figures were the results of the difference in surface tension values

*P equal to or less than 0.025 was considered statistically significant and P equal to or greater than 0.001 was considered statistically highly significant.

between the control and experimental solutions divided by the value of the control solution.

As Table II shows, the addition of surfactant has resulted in increasing the degree of every irrigant flow in the root canal. The reduction of surface tension made the irrigation solution flow or penetrate closer to the apex. Most significant findings were observed after a 5-minute application of the solution. The surfactant increased the penetration flow an average of 4 to 6 mm. A less significant flow was observed after a 7-day period (Fig. 1).

DISCUSSION

The results of this study show that lowering the surface tension of an irrigant will increase its flow into the root canal.

Polysorbate 80 has a pH of 7.0 and is used as an emulsifier and dispersing agent for medicine products for internal use. Therefore, it is a biologically acceptable material.

Further, the experimental solution was more penetrating than the control solution at 5 minutes and in some cases at 7 days.

In observing the average of the control solutions and comparing the 5-minute average with the 7-day average, it was noted that the control solutions penetrated an average of 2.88 mm. more after remaining in the canal for 7 days. This compared with an average of only 0.37 mm. after addition of the surfactant. In each case, however, the experimental solution penetrated an average of 1.88 mm. deeper at the end of 5 minutes than the control had at the end of 7 days.

Therefore, it may be concluded that leaving the experimental solution in the canals for 5 minutes would be more efficacious and practical on a clinical level, since the solution did not flow significantly in 7 days.

CONCLUSION

The addition of polysorbate 80 to distilled water, alcohol, sodium hypochlorite, and EDTA produced the following effects: (1) It reduced the surface tension of these solutions 15 and 20 percent. (2) It increased the flow of these solutions into the root canal after a 5-minute application, whereas there was no significant increased flow at 7 days.

REFERENCES

1. Naumovich, D.B.: Surface tension and pH of Drugs in Root Canal Therapy, *ORAL SURG.* 16:965, 1963.
2. Glantz, P.O., and Hansson, L.: Wetting of Dentine by Some Root Canal Medicaments, *Odontol. Revy* 23:205, 1972.
3. O'Brien, W.J., Craig, R.G., and Peyton, F.A.: Capillary Penetration Between Dissimilar Solids, *J. Coll. Inter. Sci.* 26:500, 1968.
4. Zoethout, W.D., and Tuttle, W.W.: *Textbook of Physiology*, ed. 13, St. Louis, 1958, The C.V. Mosby Company.

Reprint requests to:

Dr. Marwan Abou-Rass
Department of Endodontics
University of Southern California School of Dentistry
P.O. Box 77951
925 West 34th St.
Los Angeles, Calif. 90007

Copyrights Dr. Marwan Abou-Rass.
mar@abourass.com
PAADI.org