Differences in disinfection protocols for root canal treatments between general dentists and endodontists

A Web-based survey

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ABSTRACT

Background. The purpose of this study was to determine whether differences exist in disinfection protocols between endodontists and general dentists.

Methods. The authors sent an invitation to participate in a Web-based survey to 950 dentists affiliated with the Spanish Board of Dentistry. Participants responded to 9 questions about irrigation protocols and other factors related to disinfection during root canal therapy.

Results. A total of 238 (25.05%) study participants successfully completed and returned the surveys. Among these participants, 50% were general dentists and 50% were endodontists. The authors found no statistically significant differences in respondents’ first choice of an irrigant solution (that is, sodium hypochlorite), but they noted statistically significant differences in the protocols used by general dentists and by endodontists in relation to the concentration of sodium hypochlorite (P = .0003), the use and type of irrigant used to remove the smear layer (P = .0003), the use of adjuncts to irrigation (P = .0003), the enlargement of the apical preparation when shaping a necrotic tooth (P = .001), and the maintenance of apical patency throughout the debridement and shaping procedure (P = .04).

Conclusions. General dentists and endodontists embrace different disinfection protocols. The results of the survey demonstrated that endodontists keep up to date with protocols published in the literature, whereas general dentists use protocols learned during their dental training. Both groups of clinicians should be aware of the importance of disinfection techniques and their relationship to treatment outcomes.

Practical Implications. Controlling microorganisms during a root canal treatment, especially in cases with necrotic pulp, is essential to improve treatment outcomes. Clinicians should update their protocols and also consider referring patients to a specialist when their protocols are based on traditional techniques, especially in those cases with necrotic pulp.

Key Words. Disinfection; endodontist; general dentist; instrumentation; irrigation; root canal.
significant challenge to the disruption of a microbial complex with a high organization level and defensive mechanisms.

In 1956, Strindberg focused on the influence that microorganisms have on the outcome of endodontic therapy. Of 258 patients recalled, Strindberg observed that in cases with apical periodontitis, the percentage success rate decreased by 23%. The investigators of more recent studies have demonstrated that this pattern has remained consistent over time. Recalls of 816 patients after 5 years demonstrated that the percentages were virtually identical (92.3% and 82.7% for vital cases and teeth with apical periodontitis, respectively) to those obtained by Strindberg 55 years previously. These results are in agreement with Friedman and colleagues who reported that when there was a preoperative presence of inflammation in the apical tissues, the treatment outcomes decreased by 10% to 25%.

Therefore, current disinfection protocols strategically impact treatment outcomes. In this study, we analyzed those factors that had a significant effect on disinfection of the root canal system. Investigators have reported scientific correlations with endodontic treatment outcomes and the following factors: type of irrigant, irrigant concentration, smear layer removal, apical enlargement, apical patency, adjuncts to irrigation, type of intracanal medication, and the circumstances within which medication was used.

Alley and colleagues reported that root canal treatments were more successful when performed by endodontists, compared with general dentists. However, the reality is that general dentists provide the most endodontic therapy to dental patients. The results of a 2005-2006 survey conducted by the American Association of Endodontists (AAE) showed that an estimated 15.1 million root canal treatments were performed annually. General dentists performed 10.9 million procedures (72%), whereas endodontists performed 4.2 million procedures (28%).

The investigators of previous studies surveyed endodontists about the irrigant solutions or activation techniques they used. Considering the fact that general dentists perform the most root canal treatments, it is clinically relevant to analyze their disinfection protocols. The aim of this study was to evaluate current disinfection protocols among Spanish general dentists and endodontists as well as to determine the influence of the clinician’s specialization level on protocols and strategies.

METHODS

We e-mailed an invitation to participate in a Web-based survey (using www.EncuestaFacil.com) to 950 dentists affiliated with the Spanish Board of Dentistry. We asked participants to answer 9 questions that had an emphasis on disinfection and, more specifically, on irrigation. We provided multiple-choice questions with an option for write-in answers and numeric rankings where appropriate (Figure 1). We sent the e-mail only once to all participants with the condition that they respond to the survey within an 8-week time frame.

Data analysis included descriptive statistics. We analyzed comparisons between the irrigation protocols used by general dentists and endodontists by using the Fisher exact test when the variable was dichotomous (for example, apical enlargement depending on pulpal vitality status) or by using the χ² test if the variable was not dichotomous. We calculated the odds ratios (OR) and the 95% confidence intervals (CI) for those irrigation protocols that differed significantly between the 2 groups of professionals.

RESULTS

Participants successfully completed a total of 238 surveys; therefore, the overall completion rate was 25.05%. Among the participants, 119 were general dentists (50%) and 119 were endodontists (50%). The table displays the results for each question of the survey.

We found no significant differences between the groups of clinicians in their choice of the primary irrigant solution, nor in their use of chlorhexidine as a secondary irrigant, as well as the concentration of chlorhexidine they used. Of the respondents, 93.3% (111) of the general dentists and 98.3% (117) of the endodontists used sodium hypochlorite (NaOCl) as the first choice of irrigant. When asked about the use of chlorhexidine as a secondary irrigant, 45.4% (54) of general dentists and 55.4% (66) of endodontists reported that they used chlorhexidine as a secondary irrigant without statistical differences. In relation to concentration of chlorhexidine, 68.5% (81) of generalists and 75.8% (90) of endodontists used a 2% concentration of chlorhexidine.

We found statistically significant differences, however, when we compared the following factors:

- Percentage of NaOCl used (P = .0003). Although almost 50% of the general dentists preferred to use a concentration of NaOCl lower than 2.5%, most endodontists (77.3%; 92) used a concentration of NaOCl greater than 2.5% (OR = 3.24; 95% CI, 1.9-5.7) (Figure 2).

- Type of irrigant used to remove the smear layer (P = 5.39 × 10⁻⁵). Five percent of endodontists did not remove the smear layer, in comparison with 26.9% (32) of general dentists who did not remove the smear layer (OR = 8.39; 95% CI, 3.1-22.4). In fact, as shown in the table, although the preference among endodontists

## Questionnaire

1. What is the percentage of time that you spend performing root canal treatments in your clinical practice?
   - A) Less than 20%
   - B) 21%-60%
   - C) More than 60%
   - D) 100%

2. Which is your irrigant of choice during a randomized controlled trial?
   - A) Sodium hypochlorite (NaOCl)
   - B) Chlorhexidine
   - C) Ethylenediaminetetraacetic acid (EDTA) or citric acid
   - D) Other

3. If you use sodium hypochlorite, what concentration do you use?
   - A) < 0.5%
   - B) 0.6%-2.5%
   - C) 2.6%-5%

4. If you use chlorhexidine, what concentration do you use?
   - A) 0.2%
   - B) 2%
   - C) Other

5. Which is the irrigant of your choice for smear-layer removal?
   - A) EDTA or citric acid in a solution
   - B) EDTA in gel (Glyde [Dentsply] or similar)
   - C) Other
   - D) I do not use any substance to remove the smear layer.

6. Do you use any adjunct to irrigation?
   - A) Sonic or subsonic activation (for example, Endoactivator [Dentsply])
   - B) Passive ultrasonic activation
   - C) Apical negative pressure (EndoVac [SybronEndo])
   - D) Others
   - E) I do not use any adjunct to irrigation

7. Do you enlarge the apical diameter of necrotic teeth more than in vital cases?
   - A) Yes
   - B) No

8. Do you maintain the apical patency with files of small diameter?
   - A) No
   - B) Only in necrotic cases
   - C) Yes

9. Do you use an intracanal medication between appointments? If your response is positive, please specify which medication you use:
   - A) Always
   - B) Just in necrotic teeth
   - C) Never
   - D) Others. Specify in which situation and the medication used:

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**Figure 1.** Questionnaire sent to participants.

was citric acid or 17% ethylenediaminetetraacetic acid (EDTA) solution, general dentists who reported removing smear layer preferred using a gel-based material rather than a solution of EDTA. The overall response of the participants to the question about the use of adjuncts to irrigation was not encouraging. Endodontists reported a significantly higher rate of use...
(OR = 5.86; 95% CI, 3.3-10.4); however, 40.3% (48) of endodontists and almost 80% of general dentists reported not using any adjunct for better irrigation (Figure 3). As shown in the table, among those who used adjuncts to irrigation, the respondents preferred to use passive ultrasonic irrigation (PUI). Other responses to this question included the use of sonic or subsonic activation. Only 1 general dentist and none of the endodontists reported using apical negative pressure (ANP) devices exclusively, although some participants indicated that they used ANP devices in combination with other devices depending on the clinical situation.

- Enlargement of the apical preparation when shaping a necrotic tooth (Fisher exact test, $P = .001$). Whereas 59.7% (71) of endodontists enlarged the apical preparation to a larger size when treating a necrotic tooth, only 37.0% (44) of the general dentists recognized the need to remove more contaminated dentin (OR = 3.28; 95% CI, 1.9-5.6) (Figure 4).

- Maintaining apical patency throughout the shaping procedure ($P = .04$). Most of the endodontists (85.7%; 102) maintained apical patency throughout the shaping procedure in both vital and necrotic teeth (OR = 2.71; 95% CI, 1.4-5.2). Among general dentists, 68.9% preserved patency. A small number of endodontists did not try to maintain apical patency in all teeth (5%; 69) or in vital teeth (9.2%; 11), compared with 16.8% (20) of general dentists who never maintained apical patency and 14.3% (17) who maintained apical patency only when treating necrotic teeth.

There was no significant difference in the overall use of intracanal medication. Only 17.6% (21) of the general dentists and 13.4% (16) of the endodontists never used intracanal medication. However, additional questions related to the topic revealed differences in the type of medication ($P = .009$). Interestingly, whenever endodontists used intracanal medication, they significantly preferred calcium hydroxide (OR = 2.44; 95% CI, 1.4-4.3) rather than other intracanal medications that general dentists also used, as shown in the table.

**DISCUSSION**

We conducted this research study to determine the differences in the current trends in disinfection protocols during root canal treatments between Spanish endodontists and general dentists. The results of our study demonstrate a significant void in the application and understanding of established disinfection principles, especially related to adjuncts to irrigation.

On the basis of their physical principles and their effect on fluid dynamics, root canals operate as closed systems. Irrigant solutions are supposed to be delivered through the root canal orifice, reach working length and anatomic aberrations, and exit from the same root canal orifice. Considering the presence of air within the root

<table>
<thead>
<tr>
<th>TOPICS</th>
<th>CATEGORIES</th>
<th>TYPE OF PRACTITIONER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Irrigant of Choice</strong></td>
<td>Sodium hypochlorite</td>
<td>General Dentist, NO. (%)</td>
</tr>
<tr>
<td></td>
<td>Chlorhexidine</td>
<td>111 (93.3)</td>
</tr>
<tr>
<td></td>
<td>EDTA*</td>
<td>6 (5.0)</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>1 (0.8)</td>
</tr>
<tr>
<td><strong>Sodium Hypochlorite Concentration†</strong></td>
<td>&lt; 0.5%</td>
<td>9 (7.6)</td>
</tr>
<tr>
<td></td>
<td>0.6%-2.5%</td>
<td>43 (36.1)</td>
</tr>
<tr>
<td></td>
<td>&gt; 2.5%</td>
<td>61 (51.3)</td>
</tr>
<tr>
<td></td>
<td>No response</td>
<td>6 (5.0)</td>
</tr>
<tr>
<td><strong>Chlorhexidine Concentration</strong></td>
<td>0.2%</td>
<td>17 (14.3)</td>
</tr>
<tr>
<td></td>
<td>2%</td>
<td>37 (31.1)</td>
</tr>
<tr>
<td></td>
<td>No response</td>
<td>65 (54.6)</td>
</tr>
<tr>
<td><strong>Irrigant for Smear Layer‡</strong></td>
<td>EDTA or citric solution</td>
<td>29 (24.4)</td>
</tr>
<tr>
<td></td>
<td>EDTA gel</td>
<td>53 (44.5)</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>4 (3.4)</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>32 (26.9)</td>
</tr>
<tr>
<td></td>
<td>No response</td>
<td>1 (0.8)</td>
</tr>
<tr>
<td><strong>Adjunct to Irrigation‡</strong></td>
<td>Sonic or subsonic activation</td>
<td>3 (2.5)</td>
</tr>
<tr>
<td></td>
<td>Passive ultrasonic irrigation</td>
<td>17 (14.3)</td>
</tr>
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<td></td>
<td>Apical negative pressure devices</td>
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</tr>
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<td></td>
<td>None</td>
<td>95 (79.8)</td>
</tr>
<tr>
<td></td>
<td>Several methods</td>
<td>3 (2.5)</td>
</tr>
<tr>
<td><strong>Increased Apical Enlargement in Necrotic Cases‡</strong></td>
<td>Yes</td>
<td>44 (37.0)</td>
</tr>
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<td></td>
<td>No</td>
<td>75 (63.0)</td>
</tr>
<tr>
<td><strong>Apical Patency‡</strong></td>
<td>Always</td>
<td>82 (68.9)</td>
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<tr>
<td></td>
<td>Necrotic</td>
<td>17 (14.3)</td>
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<td></td>
<td>No</td>
<td>20 (16.8)</td>
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<td><strong>Intracanal Medication</strong></td>
<td>Always</td>
<td>50 (42.0)</td>
</tr>
<tr>
<td></td>
<td>In necrotic teeth</td>
<td>34 (28.6)</td>
</tr>
<tr>
<td></td>
<td>Never</td>
<td>21 (17.6)</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>14 (11.8)</td>
</tr>
<tr>
<td><strong>Type of Intracanal Medication‡</strong></td>
<td>Nothing</td>
<td>22 (18.5)</td>
</tr>
<tr>
<td></td>
<td>Calcium hydroxide</td>
<td>68 (57.1)</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>28 (23.5)</td>
</tr>
</tbody>
</table>

* EDTA: Ethylenediaminetetraacetic acid.
† NA: Not applicable.
‡ Statistically significant difference.
canals, this description of fluid dynamics is physically impossible.24

NaOCl and all other irrigant solutions work when they have direct contact between the solution and the space to be disinfected. Thus, to predictably and efficiently disinfect contaminated root canals, clinicians should understand the root canal’s morphological and physical limitations and how to overcome these challenges. By having this knowledge, clinicians should be able to improve patients’ endodontic outcomes, particularly in cases with pulp necrosis and apical periodontitis, in which the control of microorganisms is essential.5,11

In recent years, investigators have evaluated several activation techniques used to improve fluid dynamics within closed systems. The results of their studies demonstrated the limitations of traditional positive pressure irrigation (that is, syringe and needle) and the benefits obtained by using new activation systems.25,26

Apical negative pressure irrigation, PUI, and sonic and subsonic activation can significantly improve fluid dynamics and the disinfection process.3,13,14,27,28 The results of our study are similar to the results of a study by Dutner and colleagues,3 who reported that clinicians poorly implement adjuncts for irrigation. By understanding the challenges, acknowledging the limitations, and selecting an effective activation system, clinicians can overcome the limitations of traditional positive pressure irrigation.

Researchers commonly mail questionnaires to reach professionals and assess their attitudes toward general participation rate.33 On the basis of study results by Man and colleagues35 who found no difference in participation rates when electronic reminders were sent, we e-mailed the questionnaire only once to potential participants.

The main drawback of Web-based surveys is the low response rate relative to the large number of professionals who receive the questionnaires.30,34 Our study’s overall response rate was 25.05%. Other investigators reported similar completion rates (24.0%–28.5%) in the results of their studies that assessed trends among endodontists or general dentists in the United States.21,35 Other researchers found higher response rates among participants in studies for which the investigators had contacted respondents by mail or telephone.20,22 Investigators also found that Web-based questionnaires produce more reliable data than questionnaires using traditional approaches.36 In addition, the results of one study indicated that a low response rate to a Web-based survey does not entail a nonresponse error; however, a reduction in the sample size creates a censoring that results in a greater sample error.37

Our study’s result regarding the use of NaOCl as the primary therapeutic irrigant by 98.3% of Spanish endodontists is consistent with the data obtained from endodontists in the United States21 and Australia.12 In contrast, the preferred concentration of NaOCl differed between general dentists and endodontists. General dentists preferred a concentration lower than 2.5%, whereas endodontists used a higher concentration of NaOCl. A possible explanation for this finding might be

Figure 2. Percentage concentration of sodium hypochlorite (NaOCl) used by general dentists and endodontists.
that general dentists are more concerned about NaOCl accidents increasing with higher concentration usage.\textsuperscript{38} In all likelihood, the experiential skill of endodontists reduces the fear of having this type of accident, given endodontists’ knowledge of product and protocols that obviate this concern. The other possible explanation is that endodontists are more aware of the resistance that biofilms show against having lower concentrations of NaOCl in some studies,\textsuperscript{39,40} whereas general dentists may not be as well informed.

The results of previous studies demonstrated an increased tendency among endodontists in United States to remove the smear layer, from 50% in 2001\textsuperscript{22} to 77% in 2011.\textsuperscript{11} The results of our study revealed that 95% of endodontists and 73.1% of general dentists understand the importance of removing the smear layer. This is an encouraging finding.

Although the efficacy of NaOCl, EDTA, and other solutions has demonstrated excellent results in in vitro studies with open systems, investigators of research studies using closed systems reported having poorer but more realistic results in the apical area and anatomic complexities.\textsuperscript{43} The reason, as documented in the literature, is related to the severe limitation of traditional positive irrigation, owing to fluid dynamics within the root canal system.\textsuperscript{44} In our study, nearly one-half of the endodontists (40.3%) and most of the general dentists (79.8%) did not routinely use any adjuncts. These numbers correspond with the results of a 2014 study by Savani and colleagues.\textsuperscript{35} Among the preferred devices, most endodontists and general dentists in our study chose PUI instead of sonic activation or an ANP device such as EndoVac (SybronEndo). These results correspond with the findings of Dutner and colleagues\textsuperscript{21} and demonstrate that improving fluid dynamics is not a well-established protocol among clinicians regardless of their specialization level.

Maintenance of apical patency throughout the debridement and shaping procedure was highest among endodontists (85.7%). This is a significant and positive finding when considering the high level of evidence presented by Ng and colleagues\textsuperscript{16} regarding the correlation of maintaining apical patency and positive treatment outcomes.

In our study, 59.7% of the endodontists considered enlargement of the apical diameter when performing root canal treatments in a necrotic tooth adjunctive to their disinfection protocols, whereas only 37% of general dentists understood the importance of removing contaminated dentin. A 2012 randomized clinical trial\textsuperscript{17} showed that an enlargement of 3 International
Organization for Standardization sizes greater than the first apical binding file raised the outcome rate of primary endodontic treatment in mandibular first molars.

In 1992, Dietz and Dietz reported that 80% of root canal treatments were done by general dentists in the United States; the remaining 20% were done by endodontists. In 2006, the AAE reported a slight improvement, with 28% of endodontists being responsible for endodontic care. Herein lies the importance of this study: our results demonstrated that endodontists and general dentists differed in their disinfection protocols. Endodontists assimilated the latest scientific evidence into their treatment, whereas general dentists did not effect change with the same degree of alacrity. Adjuncts to irrigation have been developed to overcome the physical and anatomic challenges of the pathways of the root canal space and to improve root canal disinfection and treatment outcomes. To elevate the overall percentage of positive therapeutic outcomes, dental professionals must expose general dentists to the most current disinfection protocols through a myriad of educational avenues, as general dentists perform most endodontic procedures.

CONCLUSIONS

In conclusion, this study’s results demonstrate the following implications:

- General dentists and endodontists currently embrace different disinfection protocols.
- Endodontists keep up to date with protocols published in current literature, whereas general dentists use protocols learned during their dental training.
- The importance of disinfection techniques and their relation to treatment outcomes needs to be emphasized with both general dentists and endodontists.

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