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Endodontic infection control routines among general dental practitioners in Sweden and Norway: a questionnaire survey

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ABSTRACT

Objective: The purpose of this study was to investigate endodontic infection prevention and control routines among general dental practitioners in Sweden and Norway.

Materials and methods: A questionnaire was sent by email to 1384 general dental practitioners employed in Sweden and Norway. The participants were asked questions concerning different aspects of infection prevention and control during endodontic treatment; use of rubber dam, sealing of rubber dam, antibacterial solutions, and use of hand disinfectant and gloves.

Results: The response rate was 61.4% (n: 819). 96.9% reported routinely using rubber dam during endodontic treatment. 88.3% reported always, or sometimes, sealing the area between rubber dam and tooth. Most disinfected the endodontic operative field, but the antibacterial solutions used varied. 11.9% did not use gloves at all during treatment, and 10.5% did not use hand disinfectant during treatment.

Conclusions: Most of the general dental practitioners took measures to establish and maintain asepsis during endodontic treatment, which infers an awareness of the importance of endodontic infection prevention and control. But the results were self-reported and there may be a gap between claimed and actual behaviour. Further studies using observation methodologies are needed to assess how infection control routines are performed in everyday clinical practice.

Introduction

Apical periodontitis is caused by microbial infection of the root canal [1]. The main aim of endodontic treatment is to remove the infection and prevent infection of the root canal system. Strict aseptic procedures and high technical standards are essential for successful treatment outcomes [2]. Aseptic and antiseptic routines are considered a fundamental principle in endodontics since the introduction of microorganisms into the root canal during treatment can occur when the aseptics are not properly maintained [3].

There are studies which show that not all root canal infections are attributable to the patient’s own microflora but are rather of exogenous origin [3–5], which indicates a failure to avoid contamination during endodontic treatment.

The European Society of Endodontology has formulated quality guidelines for endodontic treatment that define the acceptable standard of care in endodontics [6]. However, studies have reported that most dentists do not follow these guidelines [7,8]. Internationally, considerable variation has been shown in the quality of clinical endodontic procedures performed by general dental practitioners (GDPs). Studies have shown poor aseptic control; low usage of rubber dam, and an underestimation of how microbiological factors influence the prognosis for root canal treatment [7–9].

Although new and improved techniques for instrumentation and root filling have been introduced over the last couple of decades, no reduced amount of apical periodontitis is seen in the population [10,11]. Root fillings made by specialists, or at dental student clinics under the supervision of specialists, have a better outcome than treatments that are carried out in general dental care [12–14]. There is a difference between what is achievable and what is achieved by GDPs, and we can only speculate about the reasons for this. Cross-sectional analysis of endodontic treatments carried out in the general practice of dentistry [10,11,15] suggests that dentists, in general, may have a problem eliminating microorganisms in infected root canals. It may be assumed that not only by optimizing the root-filling quality in general practice but also by improving the aseptic and antiseptic approach, the treatment outcome, as well as general oral health, would improve.

The occurrence and complications from healthcare-associated infections is a well-recognized health problem. The World Health Organization states that infection control practices, and especially hand hygiene, are very cost-effective.
interventions to prevent infections and reduce the risk of antibiotic resistance [16]. But research suggests that healthcare professionals clean their hands much less often than they say they do [17,18] and it has been shown that healthcare professionals’ hand hygiene is poor even when they know they are being observed [18].

In order to know if any changes are needed to improve the endodontic infection control in general dental care, we first need to find out what infection control routines the GDPs use in their everyday clinical work.

**Aim**

The aim of this study was to assess the self-reported routines regarding endodontic infection prevention and infection control among GDPs.

**Materials and methods**

An invitation to participate in the present questionnaire survey was sent by email to all GDPs working in the public dental care in Västra Götaland County (n: 635) and Skåne county (n: 349) in Sweden, all GDPs employed by a private dental care chain in Sweden (n: 169), and to all GDPs working in the public dental care in Trøndelag, Møre og Romsdal, and Telemark county in Norway (n: 231). The questionnaire was written in Swedish and translated into Norwegian. The questionnaire was reviewed by a statistician at the University of Gothenburg and piloted by 3 GDPs, after which the questionnaire was modified in accordance with their comments, mostly by being re-worded to clarify the questions.

The questionnaire consisted of 16 questions concerning different aspects of infection control measures during endodontic treatment, e.g. the use of rubber dam and isolation methods, the choice of antibacterial agents and canal irrigants, and routines regarding usage of alcohol-based hand disinfectant and medical examination gloves (Supplementary material). The questionnaire also contained questions regarding the GDPs’ age, gender and year of graduation. The questionnaire was accompanied by an explanatory covering letter.

The questionnaire was distributed to the recipients using esMaker (Entergate AB, Sweden) during three periods: December 2015–January 2016 to the GDPs working in Västra Götaland County and the private dental care chain, October 2016–November 2016 to the GDPs in Norway, September 2017–October 2017 to the GDPs in Skåne County. The survey was fully anonymous. Two reminders were sent to all recipients with an interval of two weeks in between.

**Statistical analysis**

The collected data were analyzed using the statistical package SPSS version 24 (SPSS Inc., Chicago, IL). A non-response analysis was carried out. Blanks and invalid answers were counted as missing values. Only valid responses were included in the descriptive analysis, where absolute and relative frequencies were determined. Simple descriptive statistics were used together with Pearson’s chi-squared test and Fisher’s exact test. Data were considered significant with $p < .05$ and all tests were two-tailed.

**Results**

Of the original 1384 questionnaires, 51 could not be delivered because the recipient had relocated or retired. Of the remaining 1333 questionnaires, 499 were not returned, and 15 questionnaires were returned blank or with information that the recipient was not a GDP, did not work clinically or did not perform any endodontic treatments. The overall response rate was 61.4%. The questions were answered by 98–100% of the participants. The non-response analysis showed an even gender and age distribution compared to the full target sample.

Most respondents (88%) worked in public dental care. Fifteen per cent of the respondents worked in Norway, 85% in Sweden. There were no significant differences between the countries, or counties, regarding the distribution of gender, age or years in the profession. Median year of birth was 1976, median year of graduation was 2005 and most respondents were female (Table 1).

Most GDPs reported routinely using rubber dam during endodontic treatment (Table 2), but three of those commented that there were occasions when they did not use a rubber dam. Some differences were noticed between Norway and Sweden: 86.4% of the Norwegian GDPs used rubber dam routinely, compared to 98.7% of the Swedish GDPs ($p < .001$); 11% of the Norwegian GDPs reported isolating the tooth with cotton rolls, compared to 0.7% in Sweden ($p < .001$); 6.6% of the Norwegian GDPs did not use rubber dam at all, compared to 0.4% in Sweden ($p < .001$).

Regarding sealing of the area between rubber dam and tooth (Table 2), some significant differences could be noted: 33.1% of the Norwegian GDPs did not attempt to seal the area between rubber dam and tooth, compared to 6.3% of the Swedish GDPs ($p < .001$); GDPs who had less work experience (graduated after 2006) were more likely to seal the area between rubber dam and tooth compared to the GDPs with longer work experience ($p < .001$); female GDPs were also more likely to seal the area between rubber dam and tooth than male GDPs ($p = .002$).

Most GDPs disinfected the operative field (Table 2), but differences could be noted between Sweden and Norway: 80.2% of all the Swedish GDPs used 30% H$_2$O$_2$, compared to 2.4% of the Norwegian GDPs ($p < .001$) and 62.9% of the Norwegian.

GDPs solely used 0.5% chlorhexidine (CHX) in 70% alcohol to disinfect the operative field, while 78.4% of the Swedish

<table>
<thead>
<tr>
<th>Age</th>
<th>Graduation year</th>
<th>Gender</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>72–65</td>
<td>&lt;1975</td>
<td>Female</td>
<td>31</td>
<td>3.8</td>
</tr>
<tr>
<td>76–85</td>
<td>1986–1995</td>
<td>Prefer not to say</td>
<td>133</td>
<td>13.9</td>
</tr>
<tr>
<td>86–95</td>
<td>1996–2005</td>
<td>147</td>
<td>18.1</td>
<td></td>
</tr>
<tr>
<td>96–1000</td>
<td>36.6</td>
<td>390</td>
<td>48.0</td>
<td></td>
</tr>
</tbody>
</table>
dentists used a combination of 30% H2O2, and either 5–10% iodine tincture or 0.5% CHX in 70% alcohol solution.

All the respondents irrigated with sodium hypochlorite (NaOCl) during instrumentation, with 0.5–1% NaOCl being most frequently used. 3.5% of the respondents used NaOCl of a higher concentration. 67.2% of the GDPs always used additional antibacterial irrigants before obturation of the tooth at one-visit treatments. 46.9% of the Swedish GDPs used 5% iodine potassium iodide (IKI) as an additional irritant at one-visit treatments, compared to 0.8% of the Norwegian dentists (p < .001). Within Sweden, there was a significant difference in the use of 5% IKI; 68% of the GDPs who had received their basic training at the University of Gothenburg used 5% IKI, compared to 28.8% of the Swedish GDPs who had attended other universities (p < .001). 95.9% of the GDPs reported always using an intracanal dressing between appointments, and the majority of those (99.4%) used calcium hydroxide paste.

Although most reported using hand disinfectant and gloves (Table 3), some significant differences were noted: 97.5% of the Norwegian GDPs used gloves during the entire course of the treatment, compared to 49.8% of the Swedish dentists (p < .001). 13.7% of the Swedish GDPs reported not using gloves at all, compared to 1.6% of the Norwegian GDPs (p < .001); 16.1% of GDPs in Norway reported not using hand disinfection during treatment, compared to 9.4% in Sweden (p = .025). All of those who did not use gloves reported using hand disinfectant during treatment, while 16.9% of those who reported using gloves during the entire course of the treatment did not use hand disinfectant (p < .001). 75.6% reported that the clinic they worked at had specific clinical routines regarding endodontic aseptics, though 7.6% reported that although the clinic had routines, they did not follow those routines.

Table 2. Isolation and disinfection routines during endodontic treatment.

<table>
<thead>
<tr>
<th>Isolates the tooth with</th>
<th>n</th>
<th>%</th>
<th>Sealing rubber dam</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nothing</td>
<td>4</td>
<td>0.5</td>
<td>No</td>
<td>83</td>
<td>10.3</td>
</tr>
<tr>
<td>Rubber dam</td>
<td>781</td>
<td>96.9</td>
<td>Always</td>
<td>421</td>
<td>51.9</td>
</tr>
<tr>
<td>Cotton rolls</td>
<td>18</td>
<td>2.2</td>
<td>Sometimes</td>
<td>294</td>
<td>36.4</td>
</tr>
<tr>
<td>Othera</td>
<td>3</td>
<td>0.4</td>
<td>Do not use rubber dam</td>
<td>11</td>
<td>1.4</td>
</tr>
<tr>
<td>Methods used to sealb</td>
<td>n</td>
<td>%</td>
<td>Disinfection of operative field</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Dental floss</td>
<td>359</td>
<td>31.6</td>
<td>30% H2O2</td>
<td>426</td>
<td>53.2</td>
</tr>
<tr>
<td>Oraseal</td>
<td>334</td>
<td>40.8</td>
<td>3% H2O2</td>
<td>83</td>
<td>10.1</td>
</tr>
<tr>
<td>Liquid rubber floss</td>
<td>226</td>
<td>27.6</td>
<td>0.5% CHX in 70% alcohol</td>
<td>456</td>
<td>55.7</td>
</tr>
<tr>
<td>Otherc</td>
<td>161</td>
<td>19.7</td>
<td>5–10% iodine tincture</td>
<td>320</td>
<td>36.6</td>
</tr>
<tr>
<td>Do not seal</td>
<td>74</td>
<td>9.0</td>
<td>0.5–1% NaOCl</td>
<td>25</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Otherd</td>
<td>36</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Do not disinfect</td>
<td>10</td>
<td>1.2</td>
</tr>
</tbody>
</table>

aSaliva ejector and/or liquid rubber dam.
bMultiple answers possible.
cMainly glass ionomer or composite.
dMainly 75–95 % alcohol-based disinfectant.

Table 3. Use of gloves and hand disinfectant during endodontic treatment.

<table>
<thead>
<tr>
<th>Gloves</th>
<th>n</th>
<th>%</th>
<th>Hand disinfectant</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>During entire course of the treatment</td>
<td>463</td>
<td>57.0</td>
<td>No</td>
<td>85</td>
<td>10.5</td>
</tr>
<tr>
<td>Before operative field has been disinfected</td>
<td>235</td>
<td>28.9</td>
<td>Yes</td>
<td>727</td>
<td>89.5</td>
</tr>
<tr>
<td>After operative field has been disinfected</td>
<td>18</td>
<td>2.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do not use gloves</td>
<td>97</td>
<td>11.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discussion

The reported use of rubber dam was high in this survey compared to other reports. This could be attributable to the wording of the question: ‘do you routinely isolate the tooth during endodontic treatment?’ The interpretation could be that they do it most of the time – but not always. Another possibility is that the GDPs who chose to take part in this survey may have been more interested in the subject than those who did not respond.

The use of rubber dam varies between countries. The differences found between Norway and Sweden in use of rubber dam are quite consistent with what has been observed in other studies. In a survey conducted by Myrhaug et al. [19], 60% of the Norwegian GDPs reported that they always used rubber dam, 21% reported that they often used rubber dam, and 7% reported that they never used rubber dam during endodontic treatment. While in Sweden, Koch et al. [20] found that more than 90% of Swedish GDPs use rubber dam routinely during endodontic treatment. In comparison, about 30% of the Danish GDPs said that they often use rubber dam [21], and 19–25% of Scottish and English dentists use rubber dam regularly [7,22].

The issue of endodontic operative field disinfection has not attracted many studies thus far [23]. Since GDPs internationally show low compliance regarding the use of rubber dam, it may be understandable if the question of disinfection of the operative field has been given a low priority, but none the less, international guidelines clearly states that the rubber dam and tooth should be disinfected before entering the pulp cavity [6]. Most of the GDPs reported that they disinfect the operative field, but the methods used vary. The Swedish GDPs mainly used methods influenced by Möller’s thesis, in which a combination of 30% H2O2 and 5% iodine tincture was shown to reduce the number of contaminating bacteria to a non-cultivable level [24]. Most of the
Norwegian GDPs solely used 0.5% chlorhexidine in 70% alcohol for endodontic field disinfection and it is unclear if that method is sufficient to establish an aseptic operative field. It is, of course, also difficult to know how thoroughly executed and effective the disinfection procedures are when adapted to the GDPs’ everyday clinical practice, since studies on operative field disinfection have generally been carried out at specialist clinics and have been based on thorough disinfection protocols that require extensive efforts in terms of time spent [23].

Most of the GDPs used 0.5–1% NaOCl for irrigation and calcium hydroxide paste as intracanal dressing, which is what is taught at the dental faculties in both countries. The differences between Norway and Sweden regarding operative field disinfection also mirror what is taught at the dental faculties in the two countries. This indicates that the dental faculties have the opportunity to instil a long-lasting awareness of the importance of infection control that may affect the GDPs’ everyday clinical routines throughout their entire professional careers. Noteworthy is that most of the GDPs who worked at clinics that had specific clinical routines regarding endodontic aseptics followed these routines, which shows the importance of having updated endodontic infection control routines at the local dental clinics.

One out of ten GDPs did not use hand disinfection at all during treatment, which may indicate poor hand hygiene and risk of contamination [16,25]. Many reported using gloves, either during the entire course of the treatment or during part of the treatment. Commonly used medical examination gloves are not sterile and there is a risk of contamination of gloves during treatment that can cause inoculation of bacteria into the root canal [25,26]. If the dentist uses gloves, the gloves will need to be changed frequently during the endodontic treatment to avoid contamination [25]. Also, in between each glove change, the hands should be disinfected [16]. Some questions remain regarding the reported use of gloves since it is not clear whether they changed gloves during treatment or if they used the same pair of gloves throughout the entire course of the treatment.

Although most of the GDPs reported taking measures to prevent contamination during treatment, there may still be a gap between self-reported behaviour and actual behaviour. Respondents may answer questions in ways that make them look good and this can make them over-report or under-report, depending on the situation [27]. It is, for example, well known that self-reported hand-hygiene practice should be viewed with caution since actual practice is not predicted by self-reported measures of practice [18].

Conclusions

The responses from the GDPs suggests an awareness of the importance of endodontic infection control and a knowledge of what measures are to be taken to establish and maintain aseptics during endodontic treatment. But the actual implementation of hand hygiene practices and endodontic operative field aseptics cannot be solely assessed by means of a questionnaire and will need to be followed up with observation methodologies and interviews.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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