

Compliance with Key Practices of Root Canal Treatment Varies by the Reward System Applied in Public Dental Services



SIGNIFICANCE

This paper sheds light on RCT practices in everyday clinical work. Assessment of practices in public dental services revealed variation in treatments performed, indicating differences in compliance with guidelines for good clinical practice both by type of tooth and by type of reward scheme applied for dentists.

ABSTRACT

Introduction: To assess clinical practices in root canal treatments (RCTs) performed by general dental practitioners under 2 different reward schemes applied in public dental services. **Methods:** This study used a retrospective design with tooth as the observation unit. The data included all teeth ($n = 547$) with nonsurgical primary RCT completed in 2016. Electronic documents included treatment details and radiographs. RCT assessment covered 4 key items: taking pre- and postoperative radiographs, using a rubber dam, measuring working length. Assessed dichotomies indicated whether practices were adequate. Dentists' reward schemes were "salaried" and "fee-for-service." Chi squared tests analyzed frequency differences. **Results:** RCTs formed 2 groups by the reward scheme: 305 RCTs were performed by salaried dentists and 242 by fee-for-service dentists. Preoperative radiographs were diagnosable for 76.1% and postoperative radiographs, for 95.1% of all RCTs. Rubber dam use was documented for 28.9% of the RCTs, more frequently when performed by salaried than by fee-for-service dentists (43.9% vs 9.9%, $P < .001$). Working length measurement was documented for 72.9% of the RCTs, more frequently for RCTs performed by salaried than by fee-for-service dentists (85.2% vs 57.4%, $P < .001$). All 4 key items were assessed as adequate in 19.0% of all RCTs, more frequently when performed by salaried than by fee-for-service dentists (29.5% vs 5.8%, $P < .001$). **Conclusions:** Deficiencies in RCTs, particularly underuse of rubber dams call for further research to understand the reasons for noncompliance with good clinical practice guidelines. (*J Endod* 2021;47:1592–1597.)

KEY WORDS

General dental practitioners; public dental services; reward scheme; root canal treatment; rubber dam

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Endodontic associations in Europe and in the United States have given guidelines for maintaining and updating practices for root canal treatment (RCT). The main keystones of instructions for good clinical RCT practices comprise a preoperative radiograph, isolation of the tooth by a rubber dam, determination of working length, and a postoperative radiograph of the root filling^{1,2}.

Research analyzing implementation of clinical practices, the major topic being use of rubber dams, has applied questionnaire-based data revealing varying RCT practices^{3,4}. Regrettably, serious underuse of rubber dams appears to be true worldwide, as shown in reviews^{5,6} and in a recently published opinion that the rubber dam is not used enough⁷. A questionnaire-based study from the United Kingdom reports that as few as 9% to 33% of dentists use rubber dams always or frequently and 44% to 66% never³. In another study, 19% of dentists claimed to use rubber dams routinely and 44.5% never⁸. In Ireland, 27% to 40% of general dental practitioners (GDPs) reported using rubber dam always, and 26% to 39% never⁹. In the United States, 44% to 47% of dentists described using rubber dams consistently, and 15% reported never using them^{4,10,11}. A Danish study showed a notable improvement in practices as the proportion of dentists reporting often applying rubber dams increased from 4% in 2003 to 29% in 2013¹². A recent study from Lithuania noted that 12% of GDPs used rubber dams always or often, and 66% never used them¹³. In contrast to other countries, in Sweden and Norway, 96.9% of GDPs reported routinely using rubber dams¹⁴.

The rest of the keystones and core issues of good RCT practice have been less studied. In the United Kingdom, 89% of dentists reported using a radiograph to determine working length, whereas more than 75% reported routinely taking a postoperative radiograph to check the root filling³. In Denmark, 15% of dentists in 2003 and 54% in 2013 reported the use of an apex locator¹².

Implementation of RCT has rarely been studied using patient documents. In Finland, a previous study of public dental services provided to young adults, analyzed the process of RCT in 1994 by scrutinizing documents of 144 completed RCTs¹⁵. The report revealed a paucity in practices; in 34% of RCT cases a preoperative radiograph and in 52% a postoperative radiograph was taken, and for 62% of RCTs, the measurement of working length was verified. The findings "indicated a discrepancy between consensus guidelines and everyday practice."¹⁵

This study assessed clinical practice in RCTs performed by GDPs under 2 different reward schemes in public dental services. We hypothesized that the implementation of RCTs complies with selected keystones designed in guidelines of good clinical practice and is similar regardless of the reward scheme.

MATERIALS AND METHODS

Ethical Consideration

The City of Porvoo, Department of Social Services and Healthcare, Finland, approved the study protocol (Dno. 1472/33-18). Data are based on electronic patient documents including radiographs. The document-based information is stored in a database using running numbers for identification of the patients to ensure confidentiality.

Setting

All inhabitants in Finland are entitled to public health care services in their community of residence. Dental services are free of charge for those younger than 18 years and highly subsidized for all adults. In public health care services, all dentists who are hired, receive a fixed monthly salary plus incentives paid by the numbers of coded items of treatments given. Patients' flow to public services has considerably increased in the 2000s¹⁶, forcing many public sector units to seek added services from private providers by offering vouchers to patients. To purchase additional services from the private sector, the public sector units run an official proposal with fixed fees by service item. The public dentist initiates the use of voucher-based service by referring the patient to private dentists via their companies that are admitted to the bilateral

agreement with the public sector unit. The private dentists will receive a fee-for-item reward for services they provide. For patients, the fees are the same regardless of the treatment sector. The patient documentation of voucher-paid treatments is included in the electronic database, maintained by the public sector management.

Study Design and Data Collection

The study was carried out using a retrospective design, with the observation unit being a tooth. The data included teeth receiving nonsurgical primary RCT performed by GDPs in public dental services (PDS) in the city of Porvoo, Finland. No sampling was done, and the data included all nonsurgical primary RCTs completed in 2016. The patient documents were in electronic form, including written and coded recordings and radiographs. The documentation of treatment is obligatory, and the operators are required to record all measures legally by detail to verify the treatment given.

For our data, the documents were scrutinized by one of the authors (SL), a staff member of the Porvoo PDS. A total of 547 completed nonsurgical primary RCTs met the inclusion criteria and were analyzed here. RCT teeth were identified using the ISO 3950 system, and later categorized as anteriors (incisors and canines), premolars, and molars.

Four key items, obligatory for good clinical practice, were chosen from the guidelines given by the European Society of Endodontology and the American Association of Endodontists^{1,2}: preoperative radiograph showing the full root(s) and 2 to 3 mm of the periapical region, isolation of the tooth using a rubber dam to prevent transfer between the RCT and oral cavity, determination of working length using an electronic and/or radiographic device to record the preparation length of root canals, and postoperative radiograph,

showing 2 to 3 mm of the periapical region to check the quality of the root filling. Each item was assessed to determine whether it was implemented adequately. The dichotomies used for radiographs were "diagnosable" and "inaccessible," and for determination of working length "documented" and "not documented." The isolation method of the tooth was initially recorded in 3 categories: "rubber dam," "matrix band," and "not documented," first used in the descriptive analyses, and further analyzed using the dichotomy of "using" or "not using" a rubber dam. For each RCT tooth, the number of positive dichotomies described the adequacy of the RCT.

Further background for completed RCTs was gathered regarding the dentist's reward scheme. Those dentists hired by the PDS in Porvoo belonged to the "salaried" scheme, whereas the other group included private dentists who had a bilateral contract and were rewarded according to the "fee-for-service" scheme. No further information on the dentists could be collected due to strict privacy rules. The patient's personal information included sex and age at the first RCT visit.

Statistical Methods

Descriptive statistics included frequency distributions, means, and standard deviations (SDs). Differences in frequencies of the subgroups were analyzed using χ^2 tests, whereas differences in mean values were assessed using 1-way analysis of variance. Analyses and graphics were performed with Survo MM software version 3.4.1 (Survo Systems, Helsinki, Finland).

RESULTS

The nonsurgical primary RCTs ($n = 547$) formed 2 groups according to the reward scheme: 305 RCTs (55.8%) were performed

TABLE 1 - Characteristics of Nonsurgical Primary Root Canal Treatments (RCTs) Performed in Public Dental Services and According to the Dentist's Reward Scheme

Characteristics of RCT teeth	RCT teeth All, n (%)	RCT teeth by dentist's reward scheme		P Value
		Salaried, n (%)	Fee-for-service, n (%)	
Total	547 (100.0)	305 (55.8)	242 (44.2)	
Type of tooth				<.001
Anterior	89 (16.3)	68 (22.3)	21 (8.7)	
Premolar	143 (26.1)	96 (31.5)	47 (19.4)	
Molar	315 (57.6)	141 (46.2)	174 (71.9)	
Patient's sex				.825
Women	300 (54.8)	166 (54.4)	134 (55.4)	
Men	247 (45.2)	139 (45.6)	108 (44.6)	
Patient's age (y)				.885
Mean (SD)	43.5 (16.8)	43.4 (18.1)	43.6 (15.0)	
Median; Range	43.8; 9.1–85.4	43.4; 9.1–85.4	44.3; 16.7–77.4	

TABLE 2 - Obligatory Radiographs During Nonsurgical Primary Root Canal Treatments (RCTs) Performed in Public Dental Services and According to the Dentist's Reward Scheme

Type and adequacy of radiographs	All RCT teeth	RCT teeth by dentist's reward scheme		P value
	n (%)	Salaried, n (%)	Fee-for-service, n (%)	
	n = 547	n = 305	n = 242	
Preoperative				.016
Diagnosable	416 (76.1)	220 (72.1)	196 (81.0)	
Inaccessible	131 (23.9)	85 (27.9)	46 (19.0)	
Postoperative				.707
Diagnosable	520 (95.1)	289 (94.8)	231 (95.5)	
Inaccessible	27 (4.9)	16 (5.2)	11 (4.5)	

by salaried dentists and 242 RCTs (44.2%) RCTs by dentists with a fee-for-service reward (Table 1). Molars dominated in both groups and were less frequent in RCTs performed by salaried dentists than by fee-for-service dentists (46.2% vs 71.9%, $P < .001$). Patients' age ranged from 9.1 to 85.4 years, the mean being 43.5 (SD 16.8) years, and slightly more than half of patients were women. No difference was found in patients' age by operator's reward scheme.

Status of radiographs taken during RCT is shown in Table 2. Diagnosable preoperative radiographs were available for 76.1% of the RCTs, less frequently in treatments performed by salaried dentists than by fee-for-service dentists (72.1% vs 81.0%, $P = .016$). Diagnosable postoperative radiographs were available for 95.1% of all RCTs, with no difference by dentist's reward scheme. Of all radiographs, 2% to 3% were undiagnosable, as they did not cover the apical area. For the rest of the RCTs, pre- and postoperative radiographs were absent and thus

inaccessible. No difference was found in the frequency by type of tooth (not shown in Table 2).

Table 3 shows the frequencies of isolation methods used. The use of rubber dams was documented for 28.9% and use of matrix band, for 12.2% of the RCTs, whereas for 58.9% of RCTs no documentation existed. Teeth were isolated using rubber dams more frequently when RCTs were performed by salaried dentists than by fee-for-service dentists (43.9% vs 9.9%, $P < .001$), and this difference was significant for each type of tooth. Use of rubber dam was most frequent for anterior and least frequent for molar RCTs (39.3% vs 23.2%, $P = .005$), the corresponding figures for RCTs performed by fee-for-service dentists being 19.0% and 10.3% ($P = .062$). Use of matrix band as the isolation was more frequent for RCTs performed by fee-for-service dentists than by salaried dentists (21.5% vs 4.9%, $P < .001$).

TABLE 3 - Isolation Methods During Nonsurgical Primary Root Canal Treatments (RCTs) Performed in Public Dental Services and According to the Dentist's Reward Scheme and the Type of Tooth

Isolation method by type of tooth	All RCT teeth	RCT teeth by dentist's reward scheme		P Value
	n (%)	Salaried, n (%)	Fee-for-service, n (%)	
All RCT teeth	n = 547	n = 305	n = 242	<.001
Rubber dam	158 (28.9)	134 (43.9)	24 (9.9)	
Matrix band	67 (12.2)	15 (4.9)	52 (21.5)	
Not documented	322 (58.9)	156 (51.1)	166 (68.6)	
Anteriors	n = 89	n = 68	n = 21	.021
Rubber dam	35 (39.3)	31 (45.6)	4 (19.0)	
Matrix band	5 (5.6)	5 (7.4)	0 (0.0)	
Not documented	49 (55.1)	32 (47.0)	17 (81.0)	
Premolars	n = 143	n = 96	n = 47	<.001
Rubber dam	50 (35.0)	48 (50.0)	2 (4.3)	
Matrix band	17 (11.9)	5 (5.2)	12 (25.5)	
Not documented	76 (53.1)	43 (44.8)	33 (70.2)	
Molars	n = 315	n = 141	n = 174	<.001
Rubber dam	73 (23.2)	55 (39.0)	18 (10.3)	
Matrix band	45 (14.3)	5 (3.5)	40 (23.0)	
Not documented	197 (62.5)	81 (57.4)	116 (66.7)	
P value by type of tooth	.005	.280	.062	

Working length measurement was documented for 72.9% of the RCTs (Table 4). Measurements were more frequent for RCTs performed by salaried dentists than by fee-for-service dentists (85.2% vs 57.4%, $P < .001$) and in anteriors than in molars (79.8% vs 68.9%, $P = .043$).

Adequate implementation of all 4 key items obligatory for good RCT practice was found in 104 RCTs (19.0%). A total of 235 (43.0%) RCTs had 3, 166 (30.3%) had 2, and 40 (7.3%) had 1 key item completed. All 4 key items were absent in 2 (0.4%) RCTs, in 1 canine and 1 premolar, both in the mandible. Figure 1 shows distributions (%) of performed RCTs according to the number of adequately accomplished key items per RCT, separately by the reward system. Accomplishment of the key items was more frequent for RCTs performed by salaried dentists than by fee-for-service dentists ($P < .001$). This difference was prominent for RCTs with full completion of the key items: 29.5% vs 5.8%.

DISCUSSION

The focus of this study was on nonsurgical primary RCTs performed by GDPs in everyday practice in PDS. The main findings were deficiencies in compliance with the guidelines of good clinical practice and differences in the execution of RCTs according to the reward scheme. Consequently, these findings gave no support to our hypotheses.

The 4 key items that we selected to analyze are obligatory to maintaining good clinical practice^{1,2}. Our selection was targeted to the following prerequisites: pre- and postoperative radiographs that are needed for proper starting of RCTs and valid judgment of root fillings made; use of rubber dams that is obligatory for patient safety and avoidance of harmful contamination from oral microbes; and determination of working length that is essential for ensuring optimal boundaries in shaping of root canals. Compliance with taking postoperative radiographs was almost complete, as 95.1% of the RCTs had documented findings. For the rest of the 4 key items, shortcomings were revealed. Compliance was somewhat insufficient with preoperative radiographs (76.1% of RCTs) and with measurements of working length (72.9% of RCTs). The most regrettable deficiency was found in use of rubber dams, documented in only 28.9% of all RCTs. In addition, the absence of the detailed recording of the RCTs was at its greatest regarding the use of rubber dams. Despite the different method of data collection indicating incomparability, our findings are broadly in line with most of the questionnaire-based studies^{3-5,8,9,11,12}.

TABLE 4 - Working Length Measurement During Nonsurgical Primary Root Canal Treatments (RCTs) Performed in Public Dental Services and According to the Dentist's Reward Scheme

Working length measurement	All RCT teeth	RCT teeth by dentist's reward scheme		P value
	n (%)	Salaried, n (%)	Fee-for-service, n (%)	
All RCT teeth	n = 547	n = 305	n = 242	<.001
Documented	399 (72.9)	260 (85.2)	139 (57.4)	
Not documented	148 (27.1)	45 (14.8)	103 (42.6)	
Anteriors	n = 89	n = 68	n = 21	.087
Documented	71 (79.8)	57 (83.8)	14 (66.7)	
Not documented	18 (20.2)	11 (16.2)	7 (33.3)	
Premolars	n = 143	n = 96	n = 47	<.001
Documented	111 (77.6)	84 (87.5)	27 (57.4)	
Not documented	32 (22.4)	12 (12.5)	20 (42.6)	
Molars	n = 315	n = 141	n = 174	<.001
Documented	217 (68.9)	119 (84.4)	98 (56.3)	
Not documented	98 (31.1)	22 (15.6)	76 (43.7)	
P value by type of tooth	.043	.749	.664	

A closer pertinent finding proved that use of rubber dams in RCTs performed by fee-for-service dentists was as infrequent as in a large questionnaire-based study among GDPs in Lithuania¹³.

The data from the Porvoo PDS cover all nonsurgical primary RCT teeth that had root canals filled in during 2016, thus being a strength of this study. Accordingly, the presented proportions are not sample-based estimates, but parameters for the entire PDS. Although generalization of the present findings to nationwide PDS warrants caution, the findings provide a useful starting point for comparisons. To our knowledge, just one earlier study¹⁵ has reported findings based on patient documentation, collected equivalently to our data, albeit without reward data because at that time all operators were

salaried. A limitation of our study is that, apart from the current reward system applied, other characteristics of operators were inaccessible.

Evaluation of the selected 4 keystone RCT items was based on recordings made on patient documents during the treatment. This is an additional strength of the data analyzed here, because the recordings form a legal document and thus verify the details of the treatment given. The RCT execution could be confirmed from the patient document recordings and the 4 keystones objectively evaluated as being either adequate or inadequate. Unfortunately, the details of RCT were in part insufficiently recorded, thus proving negligence to abide by the instructions for good clinical practice. Despite incomplete patient documentation, our data enlarged the knowledge of the reality of the implementation

of RCT and opened a new path to assess details of RCT practices, whereas most of the earlier studies were based only on questionnaires addressed to dentists to mainly inquire about their opinions, attitudes, and practices in rubber dam use.

Molar teeth dominated RCT in both sectors and were clearly more frequent in those performed by fee-for-service dentists than by salaried dentists. This indicates that salaried dentists were keen to offer a voucher to patients diagnosed with need of RCT in a molar tooth. Referring of molar RCTs to fee-for-service dentists may indicate challenges faced by salaried dentists who may consider the tightly scheduled clinical hours insufficient to perform time-consuming molar RCTs. Reasons for referring patients to fee-for-service dentists are unknown but may be due to continuous pressure to achieve the most cost-effective outcome when having sense of the lack of time available, and of demands and difficulties with molar RCTs, and fear of ending up with mistakes or failure¹⁷.

Generally, implementation of RCT is tightly defined and supervised until a dentist's graduation^{18,19}. Afterward, during the clinical years, no compulsory auditing of practices is carried out, but guidelines given by endodontic associations are available to keep one's expertise voluntarily updated. A recent review analyzed this dilemma and stated that "there is a clear discrepancy in what GDPs are taught in dental school and what they practice after graduation."⁶ Further, a report from the United Kingdom discussing risk management in clinical endodontic practice, stated that "the standards of treatment have been shown to have fallen short of acceptable guidelines."²⁰

The reluctance to adhere to adequate RCT practices has been widely reported and discussed²¹. Among others, the American Association of Endodontists has given an explicit position statement on dental dams stating that "Only dental dam isolation minimizes the risk of contamination of the root canal system by indigenous oral bacteria"²². Despite this definitive statement and strict instructions about the rubber dam to be the only adequate method of isolation^{1,2}, strikingly, many dentists used isolation methods below standard or gave no information of the use of any isolation. In our study, the patient documents revealed the use of matrix band for 12% of RCTs, whereas no other substandard methods were documented. In England, 29.4% of GDPs reported the use of cotton rolls,²³ and in the United States, 12% of practitioners reported using cotton rolls all the time and 47% at least sometimes¹¹. Our data are insufficient in solving the dilemma, thus calling for new studies focusing on dentists'

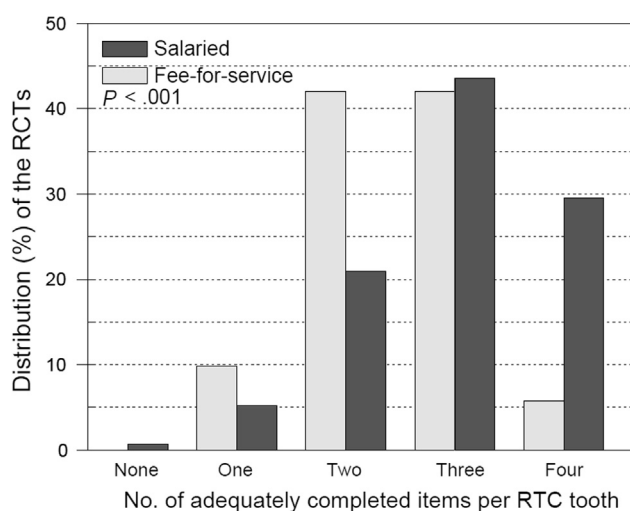


FIGURE 1 – Distributions (%) of performed nonsurgical primary root canal treatments (RCTs) by the number of adequately completed items per RCT, separately according to the dentist's reward scheme (salaried and fee-for-service). For each RCT, 4 key items were assessed.

actual clinical work and observing the underlying reasons for ignoring the clinical RCT practice guidelines. Dentists should warn patients about the risks associated with endodontics to obtain valid consent, as suggested by a director for the Centre for Endodontics in London, UK²⁰. Adherence to good clinical practice instructions and to detailed recording of treatments would also secure both public and private sector dentists against legal claims of possible errors.

Among dentists specialized in endodontics, a broad consensus exists on guidelines given by endodontic associations for good endodontic practice. The question arises as to why GDPs so often question and even underestimate the guidelines for good clinical practice of RCTs and what tools and aids should be used to encourage GDPs to provide good endodontic care. Constructive suggestions shown here may help GDPs to

strengthen their compliance with the RCT guidelines. Detailed recordings²⁴ of RCT and related checklists would be useful tools to help dentists to receive and maintain 100% compliance with the guidelines. Furthermore, incentives offered when use of the rubber dam is verified, may support compliance. Service management as well as individual patients could use our 4-item list as a tool for monitoring achievement of the keystones of the RCT process.

CONCLUSION

Deficiencies found in RCT, particularly underuse of rubber dams, call for further research to understand the reasons for noncompliance with good clinical practice guidelines and thus update RCT practices to their adequate adherence.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Sini Leinonen: Conceptualization, Investigation, Resources, Data curation, Writing – original draft. **Miira M. Vehkalahti:** Conceptualization, Methodology, Formal analysis, Visualization, Writing – review & editing.

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The authors deny any conflicts of interest related to this study.

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