



Dentists' practice patterns of treatment for deep occlusal caries: Findings from a dental practice-based research network

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ABSTRACT

Objectives: This study quantified and compared practice patterns of treatment for deep occlusal carious lesions among Japanese dentists, and tested the hypothesis that dentist characteristics are significantly associated with the decision to choose an indirect pulp capping (IPC), a form of selective carious tissue removal that involves leaving a thin layer of demineralized tissue over the pulp, that is then covered with a protective liner.

Methods: This cross-sectional study was conducted using a questionnaire survey of dentists affiliated with the Dental Practice-based Research Network Japan (n = 297). Dentists were asked to indicate what percentage of time they use three treatment options when treating patients with deep occlusal caries and possible mild pulpitis on a posterior tooth. Response options were “1. Stop before removing all caries and perform an IPC”, “2. Remove all caries and proceed with a direct pulp cap”, and “3. Remove all caries and proceed with endodontic-related procedures”. Percentages of options 1–3 were compared by multiple comparison. Associations between dentist characteristics and a higher percentage of IPC provision (option 1) were analyzed via logistic regression.

Results: Responses were obtained from 206 dentists. Median percentages (interquartile ranges) of options 1, 2 and 3 were 30% (10–59%), 10% (0–30%), and 40% (19–80%), respectively. The differences between option 3 and options 1 and 2 were significant (p < 0.001). In logistic regression analysis, a higher frequency of obtaining evidence from English-language scientific articles was significantly associated with a higher percentage of IPC, with an odds ratio of 2.28 (95%CI: 1.14–4.54).

Conclusions: Endodontic-related procedures remain the most frequent treatment option for deep occlusal caries. Frequent use of evidence-based information in English-language scientific articles was associated with Japanese dentists' preference toward IPC.

Clinical Significance: Japanese dentists would most frequently choose endodontic-related procedures, followed by IPC and direct pulp capping for treatment of patients with deep occlusal caries with possible mild pulpitis on posterior teeth. Significant association was identified between use of evidence-based information in the English-language scientific literature and Japanese dentists' preference for IPC.

1. Introduction

Minimal Intervention Dentistry (MID) is a concept which emerged in the first policy statement on MID in the early 2000's [1,2]. The aim of MID is to maintain as much healthy tooth structure as possible and keep teeth functional for life. This idea is supported as the contemporary way

to manage dental caries by the FDI World Dental Federation [3].

Regarding the MID approach to treating deep dentine caries, the broad evidence obtained to date supports indirect pulp capping (IPC) [4,5], stepwise removal [6,7], and selective removal to soft dentin [8] (formerly known as partial carious tissue removal) [9]. IPC is a form of selective carious tissue removal that involves leaving a thin layer of

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demineralized tissue over the pulp, that is then covered with a protective liner [9]. In contrast, nonselective removal to hard dentin [8] (formerly known as complete excavation or complete carious tissue removal) is considered overtreatment and no longer advocated [10].

Despite these advances in the treatment of deep occlusal carious lesions, Schwendicke and Göstemeyer reported that dentists' practice patterns of those lesions vary between European countries, US, and Brazil and that around half of dentists rejected evidence-based carious tissue removal [11]. A previous questionnaire study by Norton et al. [12] suggested that only 22% of US dental practitioners affiliated with the US National Dental Practice-based Research Network (National Dental PBRN: <http://nationaldentalpbrn.org>) would provide IPC 25% or more of the time when treating patients with deep occlusal caries and possible mild pulpitis on a posterior tooth in cases where the caries radiographically extends to the pulp. Harment et al. used the same questionnaire and reported that 61% of dental faculty members and 55% of graduating students of one US School of Dentistry indicated that they would provide IPC 25% or more of the time [13]. These results suggest that there may be substantial treatment variation among US dentists when they treat deep occlusal caries.

The establishment of the Dental Practice-based Research Network Japan (JDPBRN) has created the opportunity for international comparisons. Previous studies by the US National Dental PBRN [14–19] and JDPBRN [20–26] revealed substantial variation between dentists' practice patterns regarding caries treatment [14,15,20,23], caries risk assessment [17,18,24], dietary counseling [21], caries prevention [16,22,25] and TMD-related pain [19,26]. For example, previous studies by the two PBRNs revealed substantial treatment variation regarding occlusal primary caries among dentists. Studies using a series of clinical photographs of the occlusal surface of a mandibular first molar documented wide variation in the proportion of dentists who would intervene surgically into enamel when the caries is located in the inner half of the enamel; for adult patients—8% in Scandinavian countries, 77% in the US [15], and 48% in Japan [23]. These results show that dentists' practice patterns for treatment of occlusal primary caries differ among populations. To our knowledge, however, no international comparison of practice patterns of treatment for deep occlusal caries has been reported yet.

Therefore, the purposes of this study were to : (1) quantify and compare practice patterns in the treatment of deep occlusal carious lesions among Japanese dentists and (2) test the hypothesis that dentist characteristics are significantly associated with the decision to choose IPC procedures.

2. Materials and methods

2.1. Study design

We conducted a cross-sectional study using a web-based questionnaire survey in Japan between January 2017 and November 2017. The questionnaire is available at <http://www.dentalpbrn.jp/image/EPG20questionnaire.pdf>. This study was performed in full accordance with the World Medical Association Declaration of Helsinki. All participants provided informed consent prior to participation in this study.

2.2. Participants

This study queried dentists working in outpatient dental practices who were affiliated with JDPBRN to investigate research questions and to share experiences and expertise (n = 297). The JDPBRN [20] is a consortium of dental practices with a broad representation of practice types, treatment philosophies and patient populations and has a shared mission with the US National Dental PBRN [27]. The network regions of the JDPBRN represent all seven regions of Japan (Hokkaido, Tohoku, Kanto, Chubu, Kansai, Chugoku-Shikoku and Kyushu) [20–26]. Participants were recruited from the JDPBRN website and mailings among

Table 1
Question Items on Practice Patterns of Treatment for Deep Occlusal Caries¹².

Question items
Question: In a patient with deep caries (occlusal) and a possible mild pulpitis on a posterior tooth where the caries radiographically appears to extend to the pulp, what percentage of the time do you: (Percentages should add to 100%)
Option 1: Stop before removing all caries and perform an indirect pulp cap
Option 2: Remove all caries and proceed with a direct pulp cap
Option 3: Remove all caries and proceed with endodontic-related procedures

those who indicated that they perform some measure of restorative dentistry at their practices.

2.3. Questionnaire items

2.3.1. Practice patterns of treatment for deep occlusal caries

We used the same question items used in the previous studies [12,13], shown as Table 1. Dentists were asked to indicate what percentage of the time they used three treatment options when treating patients with deep occlusal caries and possible mild pulpitis on a posterior tooth in which the caries radiographically appears to extend to the pulp. Response options were “1. Stop before removing all caries and perform an indirect pulp cap”, “2. Remove all caries and proceed with a direct pulp cap”, and “3. Remove all caries and proceed with endodontic-related procedures”. The percentages of the options should sum to 100%.

2.3.2. Dentist characteristics

Dentist characteristics consisted of three categories: 1) dentists' individual characteristics (years since graduation from dental school and gender), 2) practice characteristics (type of practice and busyness, city population [government-ordinance designated city with population over 700,000 or not]), and 3) preference for obtaining evidence (internet, non-academic journal, textbook, English-language scientific articles, and clinical practice guideline).

2.4. Statistical analysis

We performed descriptive statistics for the percentages of options 1 (IPC), 2 (direct pulp capping) and 3 (endodontic-related procedures). Subsequently, percentages of options 1–3 were compared by multiple comparison using the Steel-Dwass test. Associations between characteristics of dentists and a higher percentage (\geq median) of IPC provision (option 1) were analyzed via multiple logistic regression with reporting of odds ratios (OR) and confidence intervals (95%CI). Because the logistic regression model included 10 dentist characteristics as predictor variables, more than 100 event occurrences could be adequate according to the 1:10 rule (ten events per variable) [29–31]. With the use of the median value as a cut off threshold of the outcome (higher percentage of IPC provision), a total of 200 participants would be anticipated as a study size. In addition, the sample size of 200 would provide sufficient precision to detect a true odds ratio of approximately 2.26, assuming that the prevalence of the predictor variable was 50%, and the proportion of events was 0.50 in one of the groups. Regarding practice busyness, participants were asked to self-report according to the following classification: ‘too busy to treat all people requesting appointments’ or ‘provide care to all, but the practice is overburdened’ (categorized as ‘busy’), or ‘provide care to all, but the practice was not overburdened’ or ‘not busy enough’ (categorized as ‘not busy’). Concerning preference for obtaining evidence, we categorized ‘Frequently’ or ‘Occasionally’ as ‘Higher frequency’ and ‘Never’ or ‘Rarely’ as ‘Lower frequency’. All analyses were performed using SPSS Statistics® (version 19.0, IBM Corporation, Somers, NY, USA), except the Steel Dwass test analysis (EZR v.1.36) [28], with statistical significance set at $p < 0.05$.

Table 2
Demographic characteristics of participants (n = 206).

	Mean ± SD or Number (%)
< Dentist characteristics >	
Years since graduation from dental school (N = 205)	20.2 ± 11.6
Gender (N = 206)	
Male	162 (78.6)
Female	44 (21.4)
< Practice characteristics >	
City population (N = 206)	
Government-ordinance-designated city	94 (45.6)
Non-government-ordinance-designated city	112 (54.4)
Type of practice (N = 206)	
Employed by another dentist	72 (35.0)
Self-employed without partners and without sharing of income, costs, or office space	134 (65.0)
Practice busyness (N = 206)	
Busy	103 (50.0)
Not busy	103 (50.0)
< Preference for obtaining evidence >	
Internet (N = 206)	
Higher frequency (Frequently/Occasionally)	188 (91.3)
Lower frequency (Never/Rarely)	18 (8.7)
Non-Academic Journal (N = 206)	
Higher frequency (Frequently/Occasionally)	135 (65.5)
Lower frequency (Never/Rarely)	71 (34.5)
Textbook (N = 206)	
Higher frequency (Frequently/Occasionally)	195 (94.7)
Lower frequency (Never/Rarely)	11 (5.3)
English-language scientific journal articles (N = 206)	
Higher frequency (Frequently/Occasionally)	65 (31.6)
Lower frequency (Never/Rarely)	141 (68.4)
Clinical Practice Guideline (N = 206)	
Higher frequency (Frequently/Occasionally)	120 (58.3)
Lower frequency (Never/Rarely)	86 (41.7)

3. Results

3.1. Demographic characteristics of participants

Responses were obtained from 206 dentists (response rate = 69%). Demographic characteristics of the study participants are shown in Table 2. Regarding dentists' individual characteristics, the mean number of years since graduation from dental school was 20.2 ± 11.6 (mean ± standard deviation). Participants were predominantly male (N = 162, 79%). Concerning type of practice, 35% (n = 72) of participants were employed by another dentist. With regard to preference for obtaining evidence, the proportions of participants who obtained evidence with higher frequency from the internet, non-academic journals, textbooks, English-language scientific articles, and clinical practice guidelines were 91% (n = 188), 66% (n = 135), 95% (n = 195), 32% (n = 65), and 58% (n = 120), respectively.

3.2. Practice patterns of treatment for deep occlusal caries

Because responses to options 1–3 were not normally distributed, we handled them as nonparametric. Median percentages (interquartile ranges) of options 1 (IPC), 2 (direct pulp capping) and 3 (endodontic-related procedures) were 30% (10–59%), 10% (0–30%), and 40% (19–80%), respectively. The proportion of participants who chose option 1 ≥ 25% was 52% (107 of 206). Multiple comparison by the Steel Dwass test showed that the differences between option 3 and options 1 and 2 were statistically significant (p < 0.001) and that the proportion of participants who chose option 1 was significantly higher than that of option 2 (p < 0.001).

Table 3
Factors associated with dentist's provision of indirect pulp capping.

Predictor variable	OR	95% CI		p value
		Lower	Upper	
< Dentist's individual characteristics >				
Years since graduation from dental school*	1.02	0.99	1.05	0.250
Gender (reference: male)	1.75	0.83	3.68	0.143
< Practice characteristics >				
City population (reference: non-government-ordinance-designated city)	1.18	0.63	2.20	0.608
Type of practice				
Employed by another dentist	1			
Self-employed without partners and without sharing of income, costs, or office space	1.66	0.75	3.68	0.213
Practice busyness (reference: not busy)	1.01	0.55	1.83	0.982
< Preference of obtaining evidence >				
Internet (reference: Lower frequency)	0.79	0.42	1.50	0.472
Non-academic journal (reference: Lower frequency)	1.48	0.78	2.80	0.235
Textbook (reference: Lower frequency)	5.27	0.997	27.85	0.0504
English-language scientific articles (reference: Lower frequency)	2.28	1.14	4.54	0.019
Clinical practice guideline (reference: Lower frequency)	1.21	0.64	2.29	0.556

CI, confidence interval.

Overall predictive accuracy is 64.9%.

*Continuous variable.

Outcome variable: Percentages of indirect pulp capping provision (option 1) were dichotomized using the median (30%) as a cut off value.

3.3. Factors affecting the decision to choose an indirect pulp capping procedure

The results of multiple logistic regression analysis are shown in Table 3. Among all of the predictor variables, a higher frequency of obtaining evidence from English-language scientific articles was significantly associated with a higher percentage of IPC, with an OR of 2.28 (95%CI: 1.14–4.54).

4. Discussion

In this study, the differences between option 3 and options 1 and 2 were statistically significant, which suggests that endodontic-related procedures remain the most frequent treatment option for deep occlusal caries with possible mild pulpitis. In logistic regression analysis, a higher frequency of obtaining evidence from English-language scientific articles was significantly associated with a higher percentage of IPC, which suggests that frequent use of evidence-based information in English-language scientific articles may increase Japanese dentists' preference for IPC.

The patient case used in this study represents mild pulpitis, and the pulpal symptoms are expected to be reversible. Therefore, on the basis of the minimal intervention (MI) concept proposed by the FDI [1,3], option 3 “endodontic-related procedures” is not considered appropriate. We also think option 2 “direct pulp capping” is not appropriate since it can be considered as a sequential series of processes of non-selective removal to hard dentine (formerly known as complete excavation or complete carious tissue removal) [8–10]. IPC (option 1) is a form of selective carious tissue removal and has been categorized as an MI therapy [9], together with stepwise removal and, more recently, selective removal to soft or firm dentin. Among these three options, we therefore consider that a higher frequency of choosing option 1 should be recommended in this case study, particularly with regard to MID concept.

In terms of international comparison, the proportion of participants who would provide IPC (option 1) 25% or more of the time was 52%.

According to the results of previous studies using the same question in 2009–2010, 22% of US dental practitioners affiliated with the National Dental PBRN would provide IPC (option 1) to 25% or more; while in a study conducted in 2014, 61% of the dental faculty members and 55% of graduating students at a university school of dentistry in the US [13] would provide IPC (option 1) to 25% or more. Although there are differences in the survey execution periods, the Japanese dentists' treatment thresholds may be said to fall somewhere between US dental practitioners and the University's faculty members and students.

Multiple logistic regression analysis suggested that a frequent use of evidence from English-language scientific articles was significantly associated with a higher percentage of IPC, whereas a frequent use of other information sources such as internet, non-academic journals, textbooks and clinical practice guidelines was not. Previous studies by the US National Dental PBRN suggested that 41% of dental practitioners rated "printed peer-reviewed journals" as the most influential sources of information, while 8% rated "Web searches" and 1% rated "printed non-peer-reviewed journals" [32], and also indicated that dentists who are motivated to gain additional skills and have achieved high-level postgraduate certifications, rely on a broader set of informational resources and show a distinctive preference for peer-reviewed sources [33]. Another previous study revealed that 87% of UK dentists reported having changed their practice as a result of reading a research article [34]. Further, it has been pointed out that most German dentists' websites are not fully accurate with regard to periodontitis [35] and that the problem with textbooks as a source of evidence is that the information may be substantially out of date at the time of publication [36]. Taken together, the results of this study suggest that frequent use of evidence-based information in English-language scientific articles may help improve Japanese dentists' decision making about IPC.

The participants of this study represented a reasonably diverse range of dental practices from the seven major geographical areas of Japan. The age and gender distribution of this study sample was similar to the actual distribution in Japan (Male 77%, mean age: 51.1) [37], supporting the generalizability of the findings. However, several study limitations warrant mention. First, participants were not selected by random sampling and 31% of them were non-respondents, which may have caused a degree of selection bias. Second, because the results were based on dentists' self-reported answers, a degree of information bias may be present; data about treatment options derived from dentist memory might have been subject to recall bias. As we did not specify the type of teeth (i.e., permanent or primary teeth), this may have caused instrument bias and affected dentists' decisions to choose IPC. Third, given the cross-sectional nature of this study, a causal relationship between preference for obtaining evidence and dentist provision of indirect pulp capping cannot be established. Finally, although we found a statistically significant association between the frequent use of evidence from English-language scientific articles and dentists' preference for the IPC provision, it is unknown whether Japanese dentists' knowledge of English affects their use of English-language articles, or instead whether this is a marker for their intensity of interest in knowing about the latest scientific evidence in general, which may cause confounding bias. An additional possibility is that we observed the association because of confounding due to the possibility that Japanese dentists who read such articles may be more-sophisticated clinically. In addition, we need to conduct further studies to clarify which kinds of English-language scientific articles (e.g., online vs printed version or evidence level) would be most useful to increase dentists' preference for the IPC provision.

In conclusion, endodontic-related procedures remain the most frequent treatment option for deep occlusal caries with possible mild pulpitis despite the dissemination of the concept of MID. Frequent use of evidence-based information in English-language scientific articles may improve Japanese dentists' decision-making about IPC. Further studies to fill the evidence-practice gap in the treatment of occlusal deep caries are needed.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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