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Patient age and dentists' decisions about occlusal caries treatment thresholds

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Abstract

Objectives—This study was performed to (1) quantify dentists' treatment thresholds for occlusal primary caries; (2) determine if patient's age affects dentists' decisions to surgically treat these carious lesions; (3) test the hypothesis that patients', dentists', and practices' characteristics are significantly associated with surgical enamel intervention.

Methods—The study used a cross-sectional design consisting of a questionnaire survey in Japan. This study queried dentists working in outpatient dental practices who were affiliated with the Dental Practice-Based Research Network Japan (JDPBRN), which aims to allow dentists to investigate research questions and share experiences and expertise (n=282). Participants were asked whether they would surgically intervene in a series of cases depicting occlusal caries. Each case included a photograph of an occlusal surface displaying typical characteristics of caries penetration, and written descriptions of adult and pediatric patients at high caries risk.

Results—In a case of a carious lesion within inner enamel, the proportion of dentists who indicated surgical intervention was significantly higher in the adult patient (48%) when compared to the pediatric patient (34%) ($p < 0.01$). Logistic regression analysis showed that using a dental explorer for the diagnosis of primary occlusal caries, type of practice, practice busyness, and

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percentage of patients who self-pay were significantly associated with dentists' decisions to intervene surgically into the inner enamel carious lesion.

Conclusions—These findings demonstrate that over one-third of participants chose to intervene surgically into inner enamel carious lesions, and patients' age affects dentists' decisions about when to intervene surgically (clinicaltrials.gov registration number NCT01680848).

Keywords

dental caries; risk assessments; dentist's practice pattern; diagnosis; evidence-based dentistry; clinical research

Introduction

The diagnosis and treatment of primary dental caries are common procedures in general dental practice and are topics of extensive research.[1-2] Small-scale studies have shown that substantial variation exists among clinicians in restorative treatment thresholds.[3-8] At present, the only thresholds that can be definitely identified as inappropriate are those that call for surgical treatment when non-cavitated caries is confined to enamel, due to the potential for enamel lesions to arrest or reverse.[9]

Previous studies by the Dental Practice-Based Research Network (DPBRN) and Dental PBRN Japan (JDPBRN), which included practitioners from the United States, Scandinavia, and Japan revealed substantial variation among dentists in restorative treatment thresholds based on radiographic interproximal lesion depth. When the interproximal cavity is located in the enamel, findings for intervention proportions were as follows: Scandinavia 0%-21%, the United States 40%-75%,[10] and Japan 47%-74%,[11] depending on patients' caries risk status on various clinical scenarios.

Regarding occlusal enamel carious lesions, several studies using a series of clinical photographs of the occlusal surface of a mandibular first molar have 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—6% in Sweden,[4] 3%-8% in Scandinavian countries and 63%-77% in the US.[12] These results show that the treatment thresholds of occlusal primary caries differ among populations. However, no studies conducted in Japan have quantified differences in dentists' treatment thresholds for occlusal carious lesions, nor have they investigated differences between adult and pediatric patients.

The purposes of this study were to (1) quantify Japanese dentists' restorative treatment thresholds for occlusal primary caries; (2) determine if patient's age affects dentists' decisions to surgically treat these carious lesions; (3) test the hypothesis that patients', dentists', and practices' characteristics are significantly associated with surgically enamel intervention.

Materials and Methods

Study Design

We conducted a cross-sectional study consisting of a questionnaire survey in Japan between May 2011 and February 2012. We used the same questionnaire used in the previous studies.[10,13] Four dentists and clinical epidemiologists translated these questionnaires into Japanese. The translated version of this questionnaire is available at http://www.dentalpbrn.org/uploadeddocs/Study%201(Japanese%20Version).pdf. Dentists were asked about assessment of caries diagnosis and treatment, treatment thresholds by hypothetical scenarios with clinical photographs, and patient and dentist background data.[11]

The network regions of the JDPBRN represent all seven districts in Japan (Hokkaido, Tohoku, Kanto, Chubu, Kansai, Chugoku-Shikoku, and Kyushu). Similarly to the DPBRN,[12,14] every region has a Regional Coordinator who distributed and gathered the questionnaires. Dentists were asked to complete the questionnaire by hand and return to the assigned Regional Coordinator in a pre-addressed envelope. Upon receipt, the Regional Coordinator reviewed the questionnaire for completeness.

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=282). Participants were recruited from the JDPBRN website and mailings among those who indicated that they perform some measure of restorative dentistry at their practice. All participants provided informed consent prior to participation in this study.

The JDPBRN is a consortium of dental practices with a broad representation of practice types, treatment philosophies, and patient populations, having a shared mission with DPBRN,[14] which subsequently evolved to become the National Dental PBRN (http://NationalDentalPBRN.org). The recent establishment of the JDPBRN created an opportunity to make international comparisons.[11]

Hypothetical Scenarios with Clinical Photographs and Patient Background Data

Participants indicated their treatment decision from options presented for cases described in the questionnaire. A series of four clinical photographs of the occlusal surface of a mandibular first molar, together with a description, were presented portraying increasing depths of cavitation (Figure 1). We inquired about the treatment decision for each case with high caries risk under two different patient age scenarios (30 and 12 years old). The exact wording of each case scenario is provided in Figure 1. The same photographs were used in the previous studies with the following descriptions, [4,12,15] showing occlusal surfaces with increasing caries severity: Case 1 had a white or discolored enamel surface, no cavitation. No radiographic signs of caries. Case 2 had minor loss of tooth substance with a break in the enamel surface or discolored fissures with grey/opaque enamel and/or caries confined to the enamel. No radiographic signs of caries. Case 3 had moderate loss of tooth substance and/or caries in the outer 1/3 of the dentin according to the radiograph. Case 4 had considerable loss of tooth substance and/or caries in the middle 1/3 of the dentin according to the

radiograph (Figure 1).[4,12,15] Cases 1 and 2 were enamel lesions located in the outer and inner enamel, respectively. Case 3 and 4 were dentin lesions located in the outer and middle thirds of the dentin. [4,12,15] For each case and each scenario, the respondent provided treatment codes in a "check all that apply" format (see Figure 1).

Variable Selection

To identify characteristics associated with occlusal restorative treatment threshold, theoretical models employed in previous studies were used.[10,11,16,17] In addition, explanatory variables were extracted, consisting of four categories: dentists' individual characteristics (years since graduation from dental school, race/ethnicity, gender), practice setting (type of practice and busyness, patient waiting time for restorative dentistry, city population [government-ordinance designated city with population over 700,000 or not]), patients' characteristics (dental insurance coverage, percent of patients who self-pay, age and racial/ethnic distributions), and procedure-related characteristics (percent of patient contact time spent each day doing restorative procedures, aesthetic procedures, and extractions; whether or not caries risk is assessed as a routine part of treatment planning; percent of patients examined using a dental explorer for primary occlusal caries diagnosis, and receiving diet counseling).

Statistical Analysis

Description of treatment thresholds—Treatment recommendations were classified into the following categories: I) no treatment (a. no treatment today, follow the patient regularly), II) preventive treatment (b. in-office fluoride, c. recommend non-prescription fluoride, d. prescription for fluoride, e. use sealant or unfilled resin over tooth, f. chlorhexidine treatment), III) minimally-invasive treatment (g. minimal drilling and sealant, h. minimal drilling and preventive resin restoration, i. air abrasion and a sealant, j. air abrasion and preventive resin restoration), and IV) restorative treatment (k. amalgam restoration, l. composite restoration, m. indirect restoration). The overall variable had values with the following definitions: 1) no treatment– if only option I was endorsed, 2) preventive only – if only option II was endorsed, 3) minimally-invasive – if option III was endorsed, 4) restorative treatment– if only option IV was endorsed. We also determined the numbers (percentage) of dentists who would do "non-surgical treatment" (1. no treatment and 2. preventive only) or "surgical treatment" (3. minimally-invasive and 4. restorative treatment) for each case, 1 through 4. Chi-square tests were performed to assess the association between treatment thresholds and patient age.

Factors affecting decision to intervene into inner enamel lesions

Descriptive analysis was conducted via univariate regression analysis for explanatory variables associated with dentists' use of a surgical treatment for inner enamel (Case 2). Subsequently, multiple logistic regression analysis was conducted to examine the relationship between explanatory variables and the decision to perform surgical treatment into inner enamel. Odds ratios were calculated together with the 95% confidence intervals (CIs). All analyses were performed using SPSS Statistics® (version 19.0, IBM Corporation, Somers, NY, USA), with statistical significance set at $p < 0.05$.

Results

Demographic information of participants

Questionnaires were distributed to 282 dentists; 189 (67%) were ultimately collected. Demographic characteristics of study participants are shown in Table 1.[11] The mean number of years elapsed since graduation from dental school was 18.5±9.9; participants were predominantly male (N=154, 82%). Race/ethnicity was almost entirely Asian (N=186, 99%). With regard to type of practice, 41% (n=77) of participants were employed by another dentist. Regarding practice busyness, 40% (N=72) of dentists were able to provide care to all, but the practice was overburdened, while 33% (N=59) provided care to all, but the practice was not overburdened. Most dentists (N=159, 84%) used a dental explorer to diagnose primary occlusal caries. The percentage of patients who self-pay was 9%.

Treatment thresholds

Table 2 shows the distributions of treatment recommendations. In the adult-patient scenario, the percentage of participants who would do surgical treatment increased in the following order: Case 4 (98%)>Case 3 (76%)>Case 2 (48%)>Case 1 (14%). The same order was reported in the pediatric model: Case 4 (97%)>Case 3 (65%)>Case 2 (34%)>Case 1 (9%).

In Case 2, the percentages of participants who would do surgical treatment for adult and pediatric patients were 48% (N=88) and 34% (N=63), respectively, and 76% (N=140) and 65% (N=121) in Case 3. The proportion of dentists who indicated surgical intervention was significantly higher for the adult patient model than for the pediatric patient model in both Case 2 ($p<0.01$) and Case 3 ($p<0.05$).

Factors affecting decision to surgically intervene in occlusal inner enamel lesions

The results of multiple logistic regression analysis are shown in Table 3. In the Case 2 adult patient model, three factors were significantly associated with the decision to intervene surgically in enamel (odds ratios [95%CI]): type of practice 0.26 (0.11-0.62), percentage of patients who self-pay 1.04 (1.01-1.07), practice busyness 3.72 (1.05-13.19). In the Case 2 pediatric patient model, two factors were significantly associated with dentists' decision to intervene surgically in inner enamel (odds ratio [95% CI]): type of practice 0.38 (0.15-0.93) and using a dental explorer for a primary occlusal caries diagnosis 8.32 (1.84-37.71).

Discussion

In this study, most dentists chose not to restore an enamel lesion in the absence of dark brown pigmentation (as shown in Case 1). Approximately one-third to half of participants chose to intervene surgically when the image pictured minor loss of tooth substance with a break in the enamel surface or discolored fissures with grey/opaque enamel (Case 2) and most dentists (two-thirds to three-fourths) when the image pictured moderate loss of tooth substance and/or caries in dentin (Case 3). Almost all participants chose to intervene surgically when considerable loss of tooth substance with caries involving dentin was visible (Case 4).

In the presence of enamel surface integrity, caries lesions present in the enamel and/or dentin can be managed via remineralization therapies,[18, 19] although the extent of remineralization is limited by the caries risk of the individual environment, as explained in the concept of caries balance.[20, 21] Consensus has been reached regarding the potential for non-cavitated enamel lesions to reverse, and the restorative intervention of non-cavitated caries confined to enamel is inappropriate.[9] Therefore, the authors think interventions to the enamel lesion shown in Case 1 and 2 are not necessary.

According to the result of the same scenario survey (N=519) by US DPBRN,[12] the percentage of dentists who indicated surgical treatment in patients with high caries risk in Cases 1, 2, and 3 were 25% (N=129), 77% (N=394), and 94% (N=482), respectively. However, in that study, subgroup analysis revealed that almost all dentists in Scandinavia chose not to restore lesions that were limited to enamel; restorative treatment was indicated predominantly for occlusal surfaces that involved dentin. Previous study in Scandinavia has reported a similar finding.[4] Given these reports, the Japanese dentists treatment thresholds may be said to fall somewhere between US and Scandinavia levels. Current treatment strategy in Scandinavia is based on diagnosis of caries activity, identification of the main causal and predisposing factors in individual cases, and assessment of caries risk.[12] This Scandinavian situation is a result of dental school education about cariology, current restrictive criteria for placement of the first restoration in Scandinavian dental practices, and high and predictable recall frequency among Scandinavians.[12,22]

Results of multiple logistic regression analysis suggested that type of practice, percentage of patients who self-pay, practice busyness, and using a dental explorer for primary occlusal caries diagnosis were significantly associated with the decision to surgically intervene in enamel lesion (Case 2). A previous study by the US DPBRN using the same scenario also revealed that decisions to intervene surgically were associated with type of practice.[12] Further, usage of a dental explorer was associated with decisions to surgically intervene into proximal enamel carious lesions.[11] Taken together, these findings suggest that further dissemination of information on the appropriate use of dental explorers may help reduce surgical intervention into enamel.

In general, practitioners may treat patients who do not follow directions fully and who may not return for several years, thereby making a re-mineralization approach less effective.[20, 21] That may be the reason why dentists feel hesitant to take a non-surgical approach with patients exemplified by the 12 year-old patient scenario. However, in the present study, the proportion of dentists who indicated surgical intervention into enamel was significantly higher for the adult patient than the pediatric one. Elderton's empirical work about the restorative cycle may underly why the profession is concerned about the adverse effects of intervening surgically before it becomes necessary.[23] Previous studies suggested that dentists intervened earlier in the adult patient than the pediatric patient[24, 25] in the 1980's. In addition, in the early 1990's, the concept of minimally invasive dentistry advanced rapidly.[26, 27] Therefore, it is possible that the participants believed that delayed surgical intervention among pediatric patients may improve first molar longevity.

This study featured a relatively wide variety of participants, with respondents hailing from all over Japan. The age and gender distribution of this study sample was similar to the actual distribution in Japan,[28] thereby enhancing the generalizability of the findings. However, the study findings should be evaluated with caution. Firstly, participants were not selected by random sampling. Secondly, given the cross-sectional nature of our study, causative relationships between factors and use of an enamel-based surgical treatment threshold were difficult to assess. Lastly, a clinical photograph and a patient scenario cannot replicate all of the nuances that can be perceived in a real tooth and a patient caries risk status; we therefore cannot state with certainty that the decision-making context provided by this questionnaire entirely duplicated the real-world clinical context.

In conclusion, over one-third of participants chose to intervene surgically into occlusal enamel. The translation of research findings to clinical practices is a complex matter.[29, 30] In an effort to improve their clinical decision-making regarding occlusal enamel intervention, results of this study will be communicated to dentists and the effect of this dissemination will be evaluated for their impact on routine clinical practice.

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Clinical relevance statement

Despite advances in cariology, variations in treatment threshold regarding when to intervene into occlusal carious lesion still exist among dentists. Patients' age affects dentists' decisions about when to intervene surgically.

Figure 1.

Level of lesion severity/depth for occlusal lesion

Questions 1 and 2:

For each question, circle the letters which correspond to the treatment codes you would recommend for each of the four cases. You may circle more than one treatment code per case.

1. Suppose the patient is a 30 year old female with no relevant medical history. She has no complaints and is in your office today for a routine visit. She has been attending your practice on a regular basis for the past 6 years, and has 12 teeth with existing dental restorations, heavy plaque and calculus, multiple Class V white spot lesions, and is missing five teeth.

2. Suppose the patient is a 12-year old child with no relevant medical history. The patient is in your office today for the first time for a routine visit. She has 5 restorations and moderate plaque. A rubber dam cannot be used.

Treatment codes:

a. No treatment today, follow the patient regularly, b. In-office fluoride, c. Recommend non-prescription fluoride, d. Prescription for fluoride, e. Use sealant or unfilled resin over tooth, f. Chlorhexidine treatment, g. Minimal drilling and sealant, h. Minimal drilling and preventive resin restoration, i. Air abrasion and a sealant, j. Air abrasion and preventive resin restoration, k. Amalgam restoration, l. Composite restoration, m. Indirect restoration

Table 1

Distribution of dentists', practices', patients', and dental procedures' Characteristics of Participants (Kakudate et al., 2012)

	Number (%) or Mean±SD
Dentist's Individual Characteristics	
Years since graduation from dental school (year) * *(N=185)*	18.5±9.9
Race/ethnicity, n (%)(N=188)	
Asian	186 (98.9)
White	1 (0.5)
Native Hawaiian or Other Pacific Islander	1 (0.5)
Gender (male), n (%) (N=187)	154 (82.4)
Practice Setting	
Practice busyness, n (%)(N=181)	
Too busy to treat all people requesting appointments	19 (10.5)
Provided care to all, but the practice was overburdened	72 (39.8)
Provided care to all, and the practice was not overburdened	59 (32.6)
Not busy enough	31 (17.1)
Waiting time for restorative dentistry (min) * *(N=182)*	12.7±10.3
City population (government-ordinance-designated city), n(%) (N=189)	76 (40.4)
Type of practice, n(%) (N=188)	
Employed by another dentist	77 (41.0)
Self-employed without partners and without sharing of income, costs, or office space	105 (55.9)
Self-employed without partners but share costs of office and/or assistants, etc.	3 (1.6)
Self-employed as a partner in a complete partnership	3 (1.6)
Patient's Characteristics	
Dental insurance coverage (%) * *(N=183)*	88.5±20.3
Percent of patients who self-pay (%) * *(N=183)*	8.6±16.6
Patient age distribution *	
1-18 years old (%) *(N=183)*	16.1±13.2
19-44 years old (%) *(N=188)*	24.8±11.0
45-64 years old (%) *(N=183)*	30.4±11.2
65+ years (%) *(N=183)*	28.5±17.4
Racial/ethnic distribution *	
White (%) *(N=184)*	0.3±1.2
Black or African-American (%) *(N=184)*	0.04±0.2
American Indian or Alaska Native (%) *(N=184)*	0.01±0.07
Asian (%) *(N=185)*	98.9±7.4
Native Hawaiian or Other Pacific Islander (%) *(N=184)*	0.02±0.2
Others (%) *(N=184)*	0.7±7.4
Dental Procedure Characteristics	

	Number (%) or Mean±SD
Percent of patient contact time spent each day doing restorative procedures (%) * *(N=183)*	28.7±14.2
Percent of patient contact time spent each day doing aesthetic procedures (%) * *(N=185)*	4.5±7.2
Percent of patient contact time spent each day doing extractions (%) * *(N=183)*	8.8±6.2
Caries risk is assessed as a routine part of treatment planning, n(%)(N=189)	49 (25.9)
Percent of patients in whom a dental explorer was used for a primary occlusal caries lesion, n(%) (N=189)	
0% (never)	30 (15.9)
1%-24%	51 (27.0)
25%-49%	12 (6.3)
50%-74%	20 (10.6)
75%-99%	29 (15.3)
100% (every time)	47 (24.9)
Percentage of patients who receive diet counseling (%) * *(N=183)*	21.4±27.2

* Mean±SD

Table 2

Distribution of treatment options chosen by dentists for Cases 1 through 4 for adult and pediatric patient scenarios

	Case 1		Case 2		Case 3		Case 4	
	30 years (n=185)	**12 years (n=185)**	**30 years (n=185)**	**12 years (n=186)**	**30 years (n=184)**	**12 years (n=185)**	**30 years (n=183)**	**12 years (n=183)**
No treatment	103 (56%)	73 (39%)	41 (22%)	28 (15%)	14 (8%)	12 (6%)	1 (1%)	0 (0%)
Preventive only	57 (31%)	96 (52%)	56 (30%)	95 (51%)	30 (16%)	52 (28%)	3 (2%)	6 (3%)
Minimally-invasive	18 (10%)	12 (6%)	57 (31%)	47 (25%)	66 (36%)	77 (42%)	24 (13%)	37 (20%)
Restorative	7 (4%)	4 (2%)	31 (17%)	16 (9%)	74 (40%)	44 (24%)	155 (85%)	140 (77%)
Non-surgical treatment *	160 (86%)	169 (91%)	97 (52%)	123 (66%)	44 (24%)	64 (35%)	4 (2%)	6 (3%)
Surgical Treatment **	25 (14%)	16 (9%)	88 (48%)	63 (34%)	140 (76%)	121 (65%)	179 (98%)	177 (97%)
p-value †		0.19		$P<0.01$		$P<0.05$		0.75

* Non-surgical treatment: No treatment and Preventive only

** Surgical treatment: Minimally-invasive and Restorative

† Chi-square test

Table 3

Factors affecting dentists' decision to surgically intervene into inner enamel lesions according to patients' age

Variable	Adult patient scenario				Pediatric patient scenario			
	OR	*95% CI*		*p value*	*OR*	*95% CI*		*p value*
		Lower	Upper			Lower	Upper	
Type of practice								
Employed by another dentist	1				1			
Self-employed without partners and without sharing of income, costs, or office space	***0.26***	***0.11***	***0.62***	***0.002***	***0.38***	***0.15***	***0.93***	***0.034***
Percentage of patients who self-pay*	***1.04***	***1.01***	***1.07***	***0.021***	1.03	1.00	1.07	0.057
Practice busyness, n (%)								
Too busy to treat all people requesting appointments	1				1			
Provided care to all, but the practice was overburdened	1.37	0.39	4.78	0.620	2.22	0.47	10.44	0.310
Provided care to all, and the practice was not overburdened	***3.72***	***1.05***	***13.19***	***0.042***	4.35	0.90	20.94	0.067
Not busy enough	1.58	0.38	6.49	0.528	1.92	0.35	10.59	0.452
Using a dental explorer for a primary occlusal caries diagnosis* (reference: no use)	1.64	0.57	4.69	0.360	***8.32***	***1.84***	***37.71***	***0.006***

CI, confidence interval

C statistic (area under the receiver operating characteristic [ROC] curve) is 0.73 in the adult patient model, and 0.70 in the pediatric patient model.

Statistically significant odds ratios are highlighted in bold italic font.

*Adjusted for gender, years elapsed since graduation from dental school, waiting time for restorative dentistry, city population, patient age distribution, and percentage of patient contact time spent each day doing restorative, aesthetic and extractions procedures, conducting caries risk assessment, and percentage of patients who receive diet counseling in both adult- and pediatric-patient models

*Continuous variable