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Factors Involved in Caries Experience of Dentally-fearful Patients

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Background: The aim of this study was to investigate the factors that associate the decayed, missing due to caries, and filled teeth (DMFT) index of patients with dental anxiety during dental treatment discontinuation.
Methods: A total of 110 patients who complained of fear and anxiety toward dental treatments and who re-visited following treatment discontinuation were enrolled in the study. Patient and dental data considered to be related to caries were digitally collected from medical and dental records. The decayed (D), missing (M), and filled (F) scores, and the DMFT index before and after discontinuation were compared using Wilcoxon signed-rank tests, and the associated factors were evaluated using the Poisson and multiple regression analyses.
Results: The D score and DMFT index augmented significantly during the discontinuation period, and the F score reduced. There was no significant change in the M score. The change in the D score was associated by the pre-discontinuation D score and the number of experiences of intravenous sedation, and the change in the F score was associated by the duration of treatment discontinuation, the DMFT index before discontinuation, and the number of experiences of intravenous sedation. The upsurge in the DMFT index was associated by the experience of intravenous sedation, the D and M scores, and the DMFT index before discontinuation.
Conclusion: Discontinuation of dental treatment was proven to be associated with the incidence of caries in dentally-fearful patients.

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Key words: age factors, anesthesia, dental caries, DMF index, fear, intravenous sedation

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Introduction

Dental fear in children is regarded as developmental normativity, but extreme fear can lead to dental anxiety (DA) or dental phobia (DP) in adults. Generally, extreme DA at a level that affects daily and/or social life can be regarded as DP[1]; however, the boundary between these conditions has not been clear. The prevalence of DA and/or DP (DADP) has been reported to be in the range of 4–30% [2,3,4].

Many patients with DADP experience fear and anxiety regarding dental treatments, irrespective of whether the procedure is painful. Patients with a particularly strong fear tend to avoid dental treatment unless it is an emergency and are often unable to continue the dental treatment [5]; they often seek improvement of only the main symptoms, and discontinue treatments even in the middle of initial procedures. It inevitably takes a long time for patients with DADP to return for dental treatments after a treatment interruption [6], and their oral health may therefore continue to deteriorate during treatment disruption [7]. Only when their tooth pain and discomfort outweigh their fear and anxiety, patients with DADP return to the dental clinic [8]. Once the cause of the symptoms is eliminated, these patients again discontinue dental treatments because their fear again outweighs their willingness to comply.

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Thus, the outcome of the treatments remains inadequate.

Patients with DADP not only require a longer treatment time, but are also more sensitive to pain [9]. This can result in misdiagnosis or over-treating [1]. Thus, DADP, which causes various stresses for both patients and dentists, remains a troublesome condition [10].

Patients with DADP with little interest in oral hygiene are more likely to have social problems than those with good oral hygiene [11,12] and are likely to have many carious teeth [13]. If such patients repeatedly discontinue treatment, the number of carious teeth will naturally be higher, which greatly impairs the oral health and reduces the quality of life of these patients.

Clarifying the associated factors dental changes in dentally-fearful patients permits dentists to eliminate the factors deliberately and to provide disease-specific dental treatments. In addition, the identification of associated factors can help analyze the pathophysiology of patients with DADP. Consequently, we herein aimed to identify the factors in dentally-fearful patients associated with their caries experience during dental treatment interruption.

Materials and Methods

This retrospective observational study was conducted in accordance with the Declaration of Helsinki, and the study protocol was reviewed and approved by the Research Ethics Committee of Nagasaki University Hospital, Japan (application No. 19081931-2). Passive consent was obtained by means of an opt-out option on the website and bulletin board of the hospital. This article follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Patients

This study examined a cohort of patients aged 15–89 years who were treated at the Department of Special Care Dentistry, Nagasaki University Hospital, Nagasaki, Japan, between January 1, 2009 and August 31, 2019, and who had complained of fear of dental treatments during their initial medical interview. Study participants were identified based on the dental records in the database of the department. In addition, the research subjects were selected using the chief complaint at the time of the first visit, but they had not been diagnosed with DADP as a psychiatric diagnosis. All dentally-fearful patients with permanent dentition who re-visited the hospital for dental treatment after self-decided discontinuation of treatment were included. The exclusion criteria were incomplete dental records and intellectual disabilities or dementia with an inability to recognize the importance and value of dental treatment. Data were digitally extracted and subsequently collated in an Excel file (Microsoft® 365 Excel for Mac).

Variable (stated in STROBE)

The collected data included both patient and dental data. Patient data included sex, age of the patient at the initial visit, presence or absence of the gagging reflex, medical history of asthma and diabetes, discontinuation duration (months) until re-visit, whether they visited other conventional dental clinics during the discontinuation period, experience of nitrous oxide and oxygen inhalation or intravenous sedation, and number of experiences of intravenous sedation. Dental data included the total number of residual teeth at the last consultation date before discontinuation.

A tooth was considered as decayed (D) if a carious lesion was found, as missing (M) if the reason for loosening the tooth was caries, and as filled (F) if there was a restoration in the tooth. The decayed, missing, and filled tooth (DMFT) index of caries experience at the last consultation date and at the time of re-visiting for evaluation were calculated. Information regarding their experience during the discontinuation period was obtained from a questionnaire at the time of the re-visit.

The D, M, and F scores and the DMFT index were the outcome of this study. The covariates were the following 14 variables obtained from patient and dental data; sex, age of the patient at the initial visit, presence or absence of the gagging reflex, medical history of asthma and diabetes, discontinuation duration (months) until re-visit, whether they visited other conventional dental clinics during the discontinuation period, experience of nitrous oxide and oxygen inhalation or intravenous sedation, number of experiences of intravenous sedation, and the D, M, F scores and DMFT index before discontinuation.

Statistical analysis

All statistical analyses were performed with the JMP pro v.15 software package (SAS Institute Japan, Tokyo, Japan). Because the data for the D, M, F scores and the DMFT index did not show a normal distribution (using the Shapiro–Wilk test), the Wilcoxon signed-rank test was used for those comparisons before and after discontinuation. Differences between groups were regarded as significant if $p < 0.05$.

With respect to the items for which a significant difference was found in the comparison between the two groups, the amount of change before and after discontinuation was calculated in each patient.

After Fisher's Exact test to determine whether or not there was a significant association between two categorical variables, multivariable regression analysis was performed. Poisson regression analysis, for which the offset variable was the number of residual teeth before treatment discontinuation, was selected when all the scores after the discontinuation were higher than before (in cases of a positive value only). If the amount of change contained negative values, analysis of covariance was performed. For both analysis, stepwise selection method was used for variable selection. As the stepwise algorithms, we employed backward elimination and forward selection strategies regarding the 14 variables, using Likelihood ratio test ($p=0.05$) and Akaike's Information Criteria as information theory criteria.

Table 1 shows the distribution of the patient and dental data collected. Female patients accounted for 70.9% of the total study sample and were more than twice the number of male patients. Approximately one-fifth of the patients had a gag reflex. Half of the patients had experience of dental treatment with intravenous sedation, which was higher than that of nitrous oxide and oxygen inhalation. After both skilled dental anesthesiologists and attending dentists had diagnosed the urgency and need for intravenous sedation via an interview for all patients, intravenous sedation was performed. Most patients did not visit any other dental office during the treatment discontinuation period. Overall, 48.2% of patients discontinued treatment for 1 year or longer.

Results

All patients in this study either self-reported that they could not be treated normally or brought a referral letter stating the fact. Some patients had complained of a fear of needles. A total of 147 patients were enrolled initially, of whom 10 patients diagnosed with intellectual disabilities, 2 patients with dementia, and 25 patients lacking dental records were excluded. Consequently, 110 patients were included.

Figure 1 shows a comparison of the D, M, F scores and the DMFT index from before and after treatment discontinuation. The D score and DMFT index were higher significantly after discontinuation, whereas the F score was lower. There was no significant difference in the M score.

Table 2 shows the results of the Poisson regression analysis investigating the associated factors with the change in the D score. The change in the D score was associated by the D score remaining before discontinuation and the number of experiences of intravenous sedation. The rate ratios (RRs) were 1.04 and 1.08, and the 95% confidence interval (95% CI) were 1.01 to 1.07 and 1.03 to 1.12, respectively.

The change in the F score included negative values. Therefore, the analysis of covariance was performed instead of the Poisson regression analysis. Table 3 shows the results of the analysis of covariance for the F score. The duration of discontinuation (months), the DMFT index before treatment discontinuation, and the number of experiences with intravenous sedation was significantly associated the results. The effect of the discontinuation period was the greatest: the longer the discontinuation period, the smaller the number of filled teeth.

Table 4 indicates the Poisson regression analysis results of the DMFT index. The change in the DMFT index was significantly associated by the D and M scores before discontinuation, the DMFT index before discontinuation, and the experience with intravenous sedation. The RR of 2.92 for the M score before discontinuation was higher than that for other variables.

Discussion

In this study, we sought to identify the associated factors changes in the dental condition among dentally-fearful patients during periods of treatment discontinuation. We found that the D score and the DMFT index were higher, whereas the F score was lower after the treatment discontinuation. The factors associating the change in the D score were the pre-discontinuation D score and the number of experiences of intravenous sedation. Those associating the change in the F score were the duration of treatment discontinuation, the DMFT index before discontinuation, and the number of experiences of intravenous sedation. The change in the DMFT index during treatment discontinuation was also associated by the experience of intravenous sedation, as well as by the D and M scores and the DMFT index before discontinuation. Overall, discontinuation of dental treatment was proven to be associated with caries in dentally-fearful patients.

In general, the proportion of females who experience anxiety regarding dental treatment is high [14,15,16] and the degree of anxiety tends to decrease with increasing age [17]. Jeddy et al. reported that most patients with DADP were under 40 years of age [18]. In the present study, majority of the study participants were females, which was consistent with other reports. The participants, however, spanned all generations, because the patient distribution of university hospital should be quite different from that of general dental clinics. Regarding the caries experience in the discontinuation period, patient sex and age did not significantly associate the increase in caries. Instead, other patient and dental variables were proven to be associated.

Table 1 Description of the study sample (N = 110)

Independent variable	N	%
Patient Data		
Sex		
Male	32	29.09
Female	78	70.91
Age at initial visit (years)		
Age 1 (15–39 years)	39	35.46
Age 2 (40–54 years)	34	30.91
Age 3 (55–89 years)	37	33.64
Gagging Reflex		
Without gagging reflex	87	79.09
With gagging reflex	23	20.91
Asthma		
Without asthma	101	91.82
With asthma	9	8.18
Diabetes Mellitus (DM)		
Without DM	101	91.82
With DM	9	8.18
Discontinuation duration (month)		
Duration 1 (1–12)	57	51.82
Duration 2 (13–24)	30	27.27
Duration 3 (≥ 25)	23	20.91
Practitioner involvement		
No	108	98.18
Yes	2	1.82
Experience of IS[1]		
No	96	87.27
Yes	14	12.73
Experience of IVS[2]		
No	55	50.0
Yes	55	50.0
Number of IVS experienced		
IVS 1 (0)	55	50.00
IVS 2 (1–10)	48	43.64
IVS 3 (11–)	7	6.36
Dental data		
Number of residual teeth before discontinuation		
0–10	9	8.18
11–20	30	27.27
21–28	71	64.55
D, M, F Scores and DMFT index[3] before discontinuation		
D 1 (0)	46	41.82
D 2 (1–5)	51	46.36
D 3 (≥ 6)	13	11.82
M 1 (0)	31	28.18
M 2 (1–5)	35	31.82
M 3 (≥ 6)	44	40.00
F 1 (0–5)	22	20.00
F 2 (6–10)	34	30.91
F 3 (≥ 11)	54	49.09
DMFT 1 (0–10)	16	14.55
DMFT 2 (11–20)	51	46.36
DMFT 3 (≥ 21)	43	39.09
D, M, F Scores and DMFT index after discontinuation		
D 1 (0)	13	11.82
D 2 (1–5)	74	67.27
D 3 (≥ 6)	23	20.91
M 1 (0)	31	28.18
M 2 (1–5)	35	31.82
M 3 (≥ 6)	44	40.00
F 1 (0–5)	31	28.18
F 2 (6–10)	34	30.91
F 3 (≥ 11)	45	40.91
DMFT 1 (0–10)	12	10.91
DMFT 2 (11–20)	55	50.00
DMFT 3 (≥ 21)	43	39.09

[1] Nitrous Oxide/Oxygen Inhalation Sedation; [2] Intravenous Sedation; [3] D: decayed, M: missing, F: filled, DMFT index: decayed missing filled teeth index

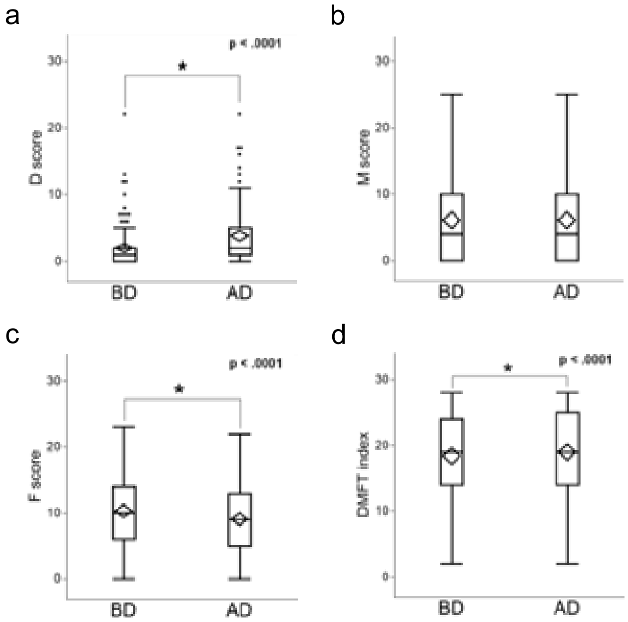

Figure 1 Comparison of D (decayed), M (missing), and F (filled) scores and the DMFT index before and after discontinuation of treatment owing to dental anxiety/dental phobia. a; D score, b; M score, c; F score, d; DMFT index. Abbreviations: BD; information on the last treatment before discontinuation, AD; information on the re-visit after discontinuation.

Table 2 Results of Poisson regression analysis for changes in D[1] score

Independent Variable	RR[2]	95% CI[3]	p-value
Discontinuation duration (month)	1.00	1.00 to 1.01	0.1184
D Scores before discontinuation	1.04	1.01 to 1.07	0.0189
Experience of IVS[4]	0.96	0.80 to 1.16	0.6810
Experience number of IVS	1.08	1.03 to 1.12	0.0029

[1] Decayed; [2] Rate Ratio; [3] Confidence Interval; [4] Intravenous Sedation
$p < 0.05$

Table 3 Results of analysis of covariance for changes in F[1] score

Independent Variable	Coefficient	95% CI[2]	p-value
Age at initial visit [15–54/55–89 years]	-0.27	-0.61 to 0.07	0.1208
Discontinuation duration (month)	-1.64	-2.51 to -0.78	0.0003
DMFT[3] index before discontinuation	-1.20	-1.80 to -0.59	0.0002
Experience number of IVS[4]	-1.08	-2.11 to -0.05	0.0408

[1] Filled; [2] Confidence Interval; [3] Decayed, missing, and filled teeth; [4] Intravenous Sedation
$p < 0.05$

Table 4 Results of Poisson regression analysis for changes in DMFT[1] index

Independent Variable	RR[2]	95% CI[3]	p-value
D Scores before discontinuation	1.17	1.10 to 1.25	< 0.0001
M Scores before discontinuation	2.92	2.74 to 3.12	< 0.0001
DMFT index before discontinuation	0.87	0.82 to 0.92	< 0.0001
Experience of IS[4]	0.68	0.43 to 1.01	0.0535
Experience of IVS[5]	1.49	1.13 to 2.00	0.0047

[1] Decayed, missing, and filled teeth; [2] Rate Ratio; [3] Confidence Interval; [4] Nitrous Oxide/Oxygen Inhalation Sedation; [5] Intravenous Sedation
$p < 0.05$

Discontinuation of treatment resulted in the higher D score or the DMFT index and the lower F score. The reduction in the F score indicates the development of secondary caries around a restoration. There was no change in the M score owing to treatment discontinuation. This was probably because the patient's anxiety was too strong to permit highly invasive treatment, such as tooth extraction. Therefore, most changes in the DMFT index in dentally-fearful patients consisted of the higher D score and the lower F score.

We found that patients with higher D and M scores before treatment discontinuation were at a high risk of an augmented DMFT index following discontinuation. The RR was particularly high for the M score variable (2.92), which may be due to the worse oral environment and hygiene of patients who had experienced many tooth extractions. In contrast, the higher the pre-discontinuation DMFT index, the lower the risk of caries. The intact tooth substance might be less exposed in the oral cavity in patients with a high pre-discontinuation DMFT index, owing to the many prosthetic treatments performed previously.

As a patient-related variable, the experience or frequency of intravenous sedation associated the caries during discontinuation of treatment. Once a dentally-fearful patient experienced the anxiolytic, sedative, and amnestic effects of intravenous sedation [19], he or she may more easily permit dental treatment under intravenous sedation and the consciousness of caries management may decrease. Propofol, which is a sedative-hypnotic prescription medication that is widely used in anesthesia, long-term sedation, and conscious sedation, has been reported to have alluring and addictive properties that lend itself to potential recreational abuse and dependence [20].

Although intravenous sedation is recommended for reducing body movements of patients with disabilities considering its reliable sedative effect [21], regular use in dentally-fearful patients should be avoided, owing to its psychological dependence. Although the level of DA has a stronger influence than patient demand on the clinician's decision-making [22], there is a lack of guidance on the assessment of anxiety among patients by dentists. Few dentists can accurately evaluate the DA levels for deciding whether to use intravenous sedation. DA scales, such as Corah's Dental Anxiety Scale [23], Kleinknecht's Dental Fear Survey [24], and the Index of Dental Anxiety and Fear [25], are reported to be useful for patient screening. Experience-based judgment and decision regarding drug behavior therapy, such as in this study, may lead to over-selection of patients.

Discontinuation of dental treatment must be avoided, as it is significantly related to caries, particularly in patients who had previously been treated using intravenous sedation. Patient education is necessary for the continuation of treatment, and dentists should explain the negative effects of treatment interruptions, understand the patient's psychology, and employ an empathetic approach to help arrest any downward spiral of the disease [26]. Patient psychosocial factors (such as treatment costs, awareness of necessity for treatment, communication) are associated with the extension of interruption [27]. A good relationship between the patient and the dentist can lead to effective communication, which can reduce the patient's anxiety and fear toward dental treatment and maintain the motivation to undergo dental treatment [28,29,30].

Even when performing dental treatment under intravenous anesthesia based on an accurate diagnosis, training patients to undergo dental treatment without pharmacological interventions is preferred. For example, cognitive behavioral therapy is effective against psychosomatic problems, such as DA [31]. Further, strategic approaches, such as individual systematic desensitization, group therapy, and modeling methods, which are derived from social learning theory, are reported to be quite effective in patients mildly or moderately impaired [32]. A combination of dental treatment and psychological intervention results in withdrawal from drug behavior therapy in dentally-fearful patients; thus, the risk of caries due to treatment discontinuation could be reduced.

In this study, the appropriateness of applying intravenous sedation was determined based on experience and not on objective indicators. In the 2021 International Classification of Diseases, phobia is classified under the clinical modification diagnosis code of F40.232 for fear and other medical care. For the diagnosis of DP, mental health professionals must use clinical skills and judgment. For example, the list of diagnostic criteria found in the Diagnostic and Statistical Manual of Mental Disorders, 5th edition [33], is necessary. However, in the present study, the participants were selected using only the chief complaint at the time of the first visit, and they had not been diagnosed with DP by mental health specialists. The degree or subject of fear was not clearly indicated, as this study is retrospective, which could contribute to a research bias.

In conclusion, we demonstrated that discontinuation of dental treatment causes an upsurge in incidence of caries in dentally-fearful patients. It is necessary to avoid such treatment discontinuation, particularly in patients previously treated using intravenous sedation, and to avoid the use of intravenous sedation to prevent psychological dependence and other detrimental effects.

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