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Title	The factors influencing the recovery of oral function and oral health related quality of life in patients with removable partial dentures.
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Degree Grantor	北海道大学
Degree Name	博士(歯学)
Dissertation Number	甲第13848号
Issue Date	2020-03-25
DOI	https://doi.org/10.14943/doctoral.k13848
Doc URL	https://hdl.handle.net/2115/94160
Type	doctoral thesis
File Information	Kai_Iwata.pdf



博 士 論 文

The factors influencing the recovery of oral function
and oral health related quality of life
in patients with removable partial dentures.

(部分床義歯装着による機能回復ならびに
口腔関連 QOL 向上に影響を与える因子について)

令和 2 年 3 月申請

北海道大学

大学院歯学研究科口腔医学専攻

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1. Introduction

The objectives of treatment to patients with partial edentulism are restoration of oral function including aesthetics, and maintenance and protection of the remaining tissue [1]. In order to achieve these objectives, removable partial dentures (RPDs) are generally used as prosthetic methods for partial edentulism. RPDs consist of retainers (direct or indirect), major and minor connectors, denture base, and artificial teeth. The basic concepts for RPD design are considered to include followings. The movement of RPDs need be suppressed during functioning. RPD design needs to be considered ensuring their strength and oral hygiene [2]. However, the location and types of their components vary depending on the individual factors such as the number, distribution and condition of remaining teeth, therefore RPD design is diverse. On RPD design, many experimental studies have been conducted [3-5], and their results supported the principles of RPD design. Kapur et al. [6], Zlatarić DK et al. [7] and do Amaral BA et al. [8] reported that RPD design affected the prognosis and periodontal health of abutment teeth. However, there are few clinical studies how RPD design affects the recovery of oral function such as masticatory performance [9]. Also, Ishida et al.[10] suggest that RPD as prosthetic rehabilitation for patients with partially edentulism improved the oral health related quality of life (OHRQoL) and OHRQoL of patients were influenced to neuroticism. However, the effect of RPD design on OHRQoL remains unclear.

The purpose of this study was to evaluate the RPD design in patients with partial edentulism and to estimate the factors of RPD design affecting the recovery of oral function and OHRQoL prospectively.

2. Materials and Methods

2.1. Subjects

We selected partially edentulous patients who had been treated with RPDs at the Clinic of Removable Prosthodontics, Hokkaido University Hospital, from July 2016 to December 2018. The selection criteria are patients over 20 years of age, who inserted final prostheses, who provided their written informed consent to participate in this study. The patients who had edentulous jaw, who inserted new RPDs in both jaw together or who treated maxillofacial prosthesis were excluded. The protocol of this study was approved by the Institutional Review Board of Hokkaido University Hospital (No. 016-0027).

Patients information were collected for age, sex, the number of remaining teeth and occlusal support, Eichner classification, Kennedy classification, the jaw inserted RPD and RPD design e.g. the number of abutment teeth, retainers, and artificial teeth, type of retainers and existence of coping. We obtained patients information, masticatory performance and OHRQoL before insertion of RPDs from all participants (baseline; BL). Additionally, masticatory performance and OHRQoL were measured three and six months after insertion of RPDs (3M and 6M, respectively) shown in Figure 1.

2.2. Masticatory Performance

As the parameter of oral function, masticatory performance was examined [11-13]. The subjects were asked to chew gummy-jelly (Glicorum, GC, Tokyo) on their habitual chewing side for 20 seconds. After chewing the subjects were asked to rinse their mouth with 10 ml of distilled water and to spit into a cup. The cup containing the gummy-jelly and the saliva was then filtered and the filtrate was collected. The glucose concentration in the filtrate was measured as glucose extraction using a glucose testing device (Gluco Sensor GS-II, GC, Tokyo). The measurement of the filtrate was conducted for two times, and the average values were taken for the analysis.

2.3. Oral Health-Related Quality of Life

OHRQoL was measured using Japanese version of the Oral Health Impact Profile (OHIP-J) [14,15]. This questionnaire measures the patient's perception of the impact of oral disorders on his or her wellbeing using 54 questions. Responses for each question were recorded using a 5-point scale with a maximum of 216 points. Lower OHIP-J scores represent higher OHRQoL.

2.4. Statistical Analysis

Masticatory performance and OHIP-J score at BL, 3M and 6M were compared using Wilcoxon sign rank test. The differences of masticatory performance and OHIP-J score between BL and 6M after the insertion of RPDs were defined as the treatment efficacy. Logistic regression analysis was performed to estimate the factors affected to treatment efficacy as masticatory performance and OHIP-J score. The variables were selected from age, sex, the number of remaining teeth and occlusal support, Eichner classification, Kennedy classification, the jaw inserted RPD, the number of abutment teeth, retainers, and artificial teeth, existence of coping and indirect retainers as independent variable selected by the stepwise method with a significance level of $P < 0.2$. In addition, the factors which were significant relation in other literature were selected [10,16]. Treatment efficacy, categorized into the improvement group and deterioration group, was dependent variables. Masticatory performance and OHIP-J score before treatment were categorized into 2 groups, where the 25th percentiles and 75th percentiles were used to discriminate between higher group and lower group, respectively. Treatment efficacy as masticatory performance were categorized into 2 groups, where the 25th percentile was used to discriminate between the masticatory performance improvement group from deterioration group. Treatment efficacy as OHIP-J score were categorized into 2 groups, where the 75th percentile was used to discriminate between the masticatory performance improvement group from deterioration group. OHRQoL improved when OHIP-J score decreased.

For all statistical analyses, P values less than 0.05 were considered statistically significant. All the collected data were analyzed using JMP 13.1(SAS Institute Inc., Cary, NC, USA).

3. Results

3.1. Subjects

Of the 194 patients initially selected for this study, 55 patients were excluded based on the exclusion criteria and 53 patients dropped out because of loss to follow-up (Figure 2). Reasons for dropping out three to six months after insertion of RPDs were not visiting, the inability to conduct surveys, and refusal to participate.

The subjects of the final analysis were 86 patients (34 men and 52 women), with a mean age of 69.4 ± 9.3 years. Patients information at baseline were shown in Table 1.

3.2. Masticatory performance (Table 2)

The mean, the media and 95 % confidence interval of masticatory performance were shown in Table 2. The mean of masticatory performance was 122.7, 147.8 and 137.9 mg/dl at BL, 3M and at 6M, respectively. The value of masticatory performance significantly increased from BL to 3M ($p < 0.0001$), and also increased from BL to 6M ($p = 0.0109$), while it significantly decreased from 3M to 6M ($p < 0.0001$).

3.3. Oral Health-Related Quality of Life (Table 2)

The mean, the media and 95 % confidence interval of OHIP-J score were shown in Table 2. OHIP-J scores were 49.2, 38.8 and 37.6 at BL, 3M, and 6M, respectively. It significantly decreased from BL to 3M ($p < 0.0001$) and decreased significantly from BL to 6M ($p < 0.0001$). There was no significant difference in the change from 3M to 6M ($p = 0.1574$). To decrease OHIP-J score meant to improve OHRQoL

3.4. Multiple logistic regression analysis (Table3 and 4)

As masticatory performance on the treatment efficacy, sex, the jaw inserted with RPD, the number of abutment teeth, the number of retainers, existence of indirect retainers and coping, the number of artificial teeth were selected as independent variables by the stepwise method.

Logistic regression analysis showed that male (odds ratio:7.8, $p=0.019$), lower masticatory performance before treatment (odds ratio: 24.5, $p=0.0015$), four or more abutment teeth (odds ratio: 11.7, $p=0.0195$), with coping (odds ratio: 123.1, $p=0.0006$) and 5 to 13 artificial teeth (odds ratio: 6.5, $p=0.0386$) were significantly associated with higher treatment efficacy as masticatory performance.

As OHRQoL on the treatment efficacy, the number of abutment teeth and retainers were selected as independent variables by stepwise method. Logistic regression analysis was performed by these factors adding OHIP-J score before treatment, which was a significant factor in other literature [10]. It was suggested that four or more abutment teeth (odds ratio:5.6, $p=0.0372$) and three or less retainers (odds: 7.4, $p=0.0249$) were significantly associated with improvement of OHIP-J score, indicating higher OHRQoL.

4. Discussion

There were a few clinical studies on the design of partial dentures. Kapur et al. compared the masticatory performance between cast circumferential clasps and I-bar cast clasps as direct retainers in the patients with Kennedy Class I by a randomized clinical trial [9]. However, there were various RPD designs based on the distribution of missing teeth. Also, other factors on RPD design such as the number of abutment teeth, retainers associated masticatory performance on the treatment efficacy. In this study, we evaluated the treatment efficacy from the viewpoint of masticatory performance and OHRQoL and showed that RPDs design was an effective factor in recovery of masticatory performance and OHRQoL in the patients with partial edentulism.

4.1. The recovery of Masticatory performance

The masticatory performance in patients with partial edentulism increased from insertion of new RPD to three months after prosthetic treatment, and then decreased from three months to six months after RPD insertion. However, there was a significant increase between baseline and six months after RPD insertion. There were few studies that examined the change of the masticatory performance before and 6 months after RPD treatment. De Carvalho Dias K et al [17]. evaluated the change of masticatory efficiency, and reported that there was no statistically significant difference in masticatory efficiency before and after denture insertion. The subjects of their study were the patients with maxillary complete dentures and mandibular RPDs in Kennedy Class I and masticatory performance was evaluated by colorimetric assay using fuchsin capsules. The result of their study was different from ours. The influence on treatment efficacy of the maxillary complete denture was more superior than those of the mandibular RPDs, which might be hidden, and different method of masticatory performance suggested different results. Fueki et al. [18] reported that prosthetic restoration for missing posterior teeth on mastication in patients with shortened dental arches significantly improved masticatory performance. However, there are few clinical studies how

long-time observation of masticatory performance after insertion of RPDs. In this study, the masticatory performance at six months decreased from that at three months after treatment. We do not have clear thoughts about the cause of this decrease. The reason seemed to be that, the occlusion and fitting of denture base might change in six months [19]. Further research will be necessary in the future.

The results of this study showed that the factors such as males, lower masticatory performance before treatment, four or more abutment teeth, existence of coping and more artificial teeth influenced masticatory performance on the treatment efficacy. Tumrasvin et al [20]. indicated that male, maximum bite force, and number of functional tooth units are factors affecting the recovery of masticatory performance. In this study, higher treatment efficacy as masticatory performance was seen in male. Also, the lower masticatory performance at BL was considered to have the higher recovery in oral function. The number of abutment teeth, retainers and existence of coping affect the movement of RPDs [3] Previous studies suggested that masticatory performance improved by placing dental implant to support the denture base in the patients with distal extension partial denture [21-23]. The dental implant under denture base suppressed denture movement. The coping under the denture base might have worked in the same way. Also, Nagayama et al [24]. showed that retainers and major connector designs influenced on the stabilization of remaining mobile teeth using RPDs.

If the number of artificial teeth was one to four, there were many occlusal supports in the natural dentition. In Kennedy Class II, the masticatory performance on natural dentition side was larger than that on prosthesis side [16]. It seemed that the masticatory performance on natural dentition side might be unchanged after new RPD insertion. Therefore, in the case of the greater the number of artificial teeth, the impact of the treatment efficacy on the RPDs was greater in the patients with partial edentulism.

4.2. The recovery of OHRQoL

OHRQoL of patients who had partial edentulism with RPDs increased from baseline to three months after new RPD insertion, and there was no significant difference between three months and six months after new RPD insertion. These results indicated that the prosthetic treatment in patients with partial edentulism improved the OHRQoL within a relatively short period.

It was reported in the review article that RPDs improved OHRQoL at a follow-up of less than 9 months by approximately 12% of the score range but showed no measurable improvement at a follow-up of more than 9 months [25]. This suggestion was similar to the result of our study. Also, another literatures supported these results [26]. Fueki et al [27]. indicated that OHRQoL of patients who had a partial edentulism with RPDs increased from baseline to three months after new RPD insertion, and there was no difference between three months and six months after new RPD insertion, and then decreased from six months to twelve months after new RPD insertion.

The masticatory performance decreased from three to six months after new RPD insertion, but there was no significant change in OHRQoL. It suggested that there was a weak relation between that the masticatory performance and OHRQoL in partial edentulous patients. In the previous cross-sectional studies, there was no significant relation among them. OHRQoL on the treatment efficacy was influenced by RPD design such as four or more abutment teeth, three or less retainers. Bassetti RG et al [28]. indicated that the type with rigidity of prosthetic treatment influenced on OHRQoL improvement. As the number of abutment teeth increased, the denture rigidity increased, and denture movement were suppressed. As a result, it seemed that discomfort of RPDs had decreased and OHRQoL had improved. In addition, because the number of retainers was less, the RPD design was simplified. Therefore, the comfortability of the patients was improved. However, the analysis results of this study have a low contribution ratio, and it seemed that the influence of RPD design on OHRQoL was limited. Ishida et al. indicated that OHRQoL of patients with higher levels of

neuroticism was low before prosthetic treatment but improved by oral rehabilitation with RPDs. That was, psychopsychological factors such as the patient's personality had a large influence on OHRQoL in the partial edentulous patients.

4.3. Limitation of this study

This study was a prospective observational study and did not be able to examine the treatment efficacy of specific RPD design. This study investigated RPD design in partial edentulous patients and examined the factors to relate the treatment efficacy. RPD design influenced on the recovery of masticatory performance, but there was a weak contribution ratio about impact of RPD design in OHRQoL as the subjective evaluation. It seems to be difficult to generalize the results of OHRQoL. The psychopsychological factors need to be collected and added to analysis about the recovery of subjective evaluation. It is necessary to increase the sample size due to collect and examine various partial edentulous distribution and denture design in order to clarify the accurate factors which influenced with oral function and OHRQoL on treatment efficacy.

5. Conclusion

In this study, it is shown that masticatory performance and oral health related quality of life of the patients with partial edentulism were improved by placement of stable RPD. Additionally, the recovery of oral function such as masticatory performance was influenced with RPD design such as the number of abutment teeth, retainers and artificial teeth and existence of coping. Also, OHRQoL was influenced with RPD design such as the number of abutment teeth, retainers.

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Table 1. Baseline characteristics of subjects

Variable	N=86
Age	Mean (SD): 69.4 (9.3) Median: 71
Sexiteishutu	
Male	34
Female	52
Treatment jaw	
Maxilla	21
Mandibula	65
Number of remaining teeth	Mean (SD): 17.4 (5.7) Median: 19
Number of occlusal support	Mean (SD): 5.4 (3.7) median: 5
Eichner Classification	
A-B2	34
B3-C	52
Kennedy Classification	
Class 1	61
Class 2	22
Class 3	1
Class 4	2

Table 2. vale of masticatory performance and OHIP-J score at survey points

		BL	3M	6M	3M-BL	6M-3M	6M-BL
MP	Mean	122.7	147.8	137.9	25.1	-9.9	15.1
	Median	121	147.2	140.2	19.5	-5	5.5
	95% CI	[113.5-132.0]	[139.4-156.1]	[128.5-147.2]	[16.0-34.1]	[-15.7- -4.1]	[6.3-23.9]
	P-value				<.00001*	<0.0001*	0.0109*
OHIP-J score	Mean	49.2	38.8	37.6	-10.4	-1.2	-11.5
	Median	51	36	36	-10	-1	-4
	95% CI	[41.9-54.5]	[32.7-44.9]	[31.5-43.8]	[-14.6- -6.1]	[-4.1-1.8]	[-16.6- -6.5]
	P-value				<.00001*	0.1574*	<.00001*

MP: masticatory Performance

OHIP-J: Japanese version of the Oral Health Impact Profile

BL: Base Line (before prosthetic treatment)

3M, 6M: three and six months after insertion of new dentures

*: Wilcoxon signed-rank sum test

Table 3. Multivariate Logistic regression analysis at treatment efficacy of masticatory performance

variable	Odds ratio	95%CI	P-value
Sex			
male	7.8	1.4-43.9	0.0190
female	1.0		
Jaw			
maxilla	1.0		
Mandibula	5.0	0.7-36.4	0.1119
Number of remaining teeth			
0-19	1.0		
20 $\leq$	4.4	0.8-23.1	0.0777
Masticatory performance before treatment			
High 75 %	1.0		
Low 25 %	24.5	3.4-177.7	0.0015
Number of abutment teeth			
≤ 3	1.0		
4 $\leq$	11.7	1.5-92.2	0.0195
Number of retainers			
≤ 3	1.0		
4 $\leq$	9.1	0.9-89.6	0.0591
Existence of Indirect retainers			
Without	6.7	0.7-62.1	0.0962
With	1.0		
Existence of coping			
Without	1.0		
with	123.1	8.0-1900.2	0.0006
Number of artificial teeth			
1-4	1.0		
5-13	6.5	1.1-38.1	0.0386

p<0.0001 R²=0.4215

Dependent variable: Chance in the masticatory performance

Improvement / deterioration

Table 4. Multivariate Logistic regression analysis at treatment efficacy of OHRQoL

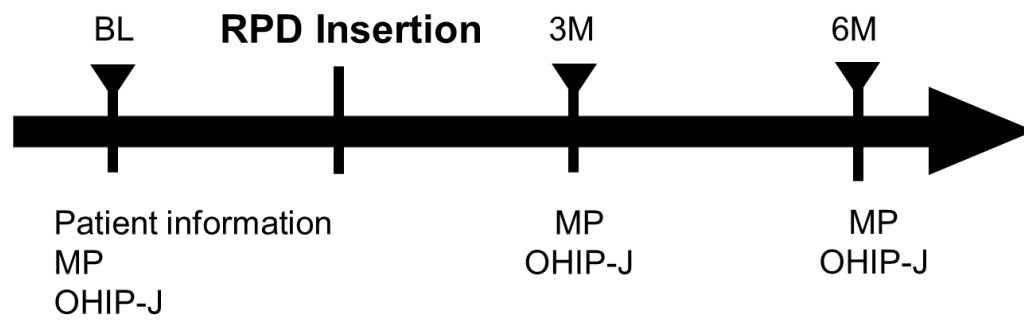
variable	Odds ratio	95%CI	P-value
OHIP-J score before treatment			
High 25 %	1.7	0.6-5.3	0.3478
low 75 %	1.0		
Number of abutment teeth			
≤3	1.0		
4≤	5.6	1.1-28.2	0.0372
Number of retainers			
≤3	7.4	1.3-42.7	0.0249
4≤	1.0		

P=0.0617 R²=0.0735

Dependent variable: Change in the Japanese version of the Oral Health Impact Profile (OHIP-J) score

Improvement / deterioration

Figure 1. Study protocol



BL, before insertion of RPDs; 3M, three months after insertion of new RPDs; 6M, six months after insertion of new RPDs; MP, masticatory performance; OHIP-J, Japanese version of the Oral health Impact Profile; RPD, removable partial denture.

Figure 2. Breakdown of participants

