

Effect of prosthetic restoration on masticatory function in patients with shortened dental arches: a multicentre study

K. FUEKI*, Y. IGARASHI*, Y. MAEDA[†], K. BABA[‡], K. KOYANO[§], K. SASAKI[¶], Y. AKAGAWA**, T. KUBOKI^{††}, S. KASUGAI^{‡‡} & N. R. GARRETT^{§§} *Removable Partial

Prosthodontics, Oral Health Sciences, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University, Tokyo,

[†]Department of Prosthodontics, Gerodontology and Oral Rehabilitation, Osaka University, Suita, Osaka, [‡]Department of Prosthodontics,

Showa University School of Dentistry, Tokyo, [§]Section of Implant and Rehabilitative Dentistry, Division of Oral Rehabilitation, Faculty of

Dental Science, Kyushu University, Fukuoka, [¶]Division of Advanced Prosthetic Dentistry, Graduate School of Dentistry, Tohoku University,

Sendai, **Department of Prosthodontics, Ohi University, Koriyama, ^{††}Department of Oral Rehabilitation and Regenerative Medicine, Grad-

uate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama University Graduate School of Medicine and Dentistry, Okayama,

^{‡‡}Oral Implantology and Regenerative Dental Medicine, Oral Health Sciences, Graduate School of Medical and Dental Sciences, Tokyo Medi-

cal and Dental university, Tokyo, Japan and ^{§§}Advanced Prosthodontics, Biomaterials and Hospital Dentistry, UCLA School of Dentistry,

California, USA

SUMMARY The aim of this multicentre study was to investigate the effect of prosthetic restoration for missing posterior teeth on mastication in patients with shortened dental arches (SDAs). Partially dentate patients who had an intact teeth in anterior region and missed distal molar(s) (2–12 missing occlusal units) classified as Kennedy Class I or Class II were recruited from seven university-based dental hospitals in Japan. Of the 125 subjects who underwent baseline (pre-treatment) and follow-up/post-treatment evaluation, 53 chose no replacement of missing teeth and 72 chose treatment with removable partial dentures ($n = 53$) or implant-supported fixed partial dentures ($n = 19$). Objective masticatory performance (MP) was evaluated using a gummy jelly test. Perception of chewing ability (CA) was rated using a food intake questionnaire. In the no-treatment group, mean MP and CA scores at baseline were similar to those at follow-up evaluation ($P > 0.05$). In the treatment group, mean MP after treatment was

significantly greater than the pre-treatment mean MP ($P < 0.05$). However, the mean perceived CA in the treatment groups was similar at pre- and post-treatment ($P > 0.05$). In a subgroup analysis of subjects in the treatment group, subjects with lower pre-treatment CA showed a significant CA increase after treatment ($P = 0.004$), but those with higher pre-treatment CA showed a significant decrease in CA ($P = 0.001$). These results suggest that prosthetic restoration for SDAs may benefit objective masticatory performance in patients needing replacement of missing posterior teeth, but the benefit in subjective chewing ability seems to be limited in subjects with perceived impairment in chewing ability before treatment.

KEYWORDS: implant-supported fixed partial denture, masticatory function, removable partial denture, shortened dental arch

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Introduction

Partial edentulism in which the most posterior teeth are missing is referred to as a shortened dental arch

(SDA). Käyser reported that SDA patients with at least four occlusal units (OUs: a pair of occluding premolars corresponds to one unit and a pair of occluding molars corresponds to two units) have sufficient

adaptive capacity to maintain oral function and proposed that missing posterior teeth be restored to the level of the premolar teeth and missing molars remain unrestored in elderly people (SDA concept) (1). Some clinical studies have shown that prosthetic treatment with removable partial dentures (RPDs) did not improve masticatory function in SDA patients (2–6). A recent systematic review concluded that SDA is an effective treatment option in terms of functioning, patient satisfaction and cost-effectiveness (7).

The SDA concept is known to Japanese dentists as an alternative for the treatment of partial edentulism (8). However, its clinical application seems to be limited, as the SDA concept has not been validated in Japan. Recently, a multicentre prospective study was conducted at seven university dental hospitals in Japan to investigate the effect of prosthodontic treatment with RPDs or implant-supported fixed partial dentures (IFPDs) on oral health-related quality of life (QHRQoL) and masticatory function in SDA patients (9). In a previous paper, we reported that OHRQoL was improved with prosthetic restoration for SDA (10). In the present paper, the effect of prosthetic restoration on masticatory function is presented. The null hypothesis to be tested in this study is that prosthetic restoration for SDA does not improve objective masticatory performance and patients' perceptions of chewing ability.

Materials and methods

This study employed a multicentre prospective design. Partially dentate patients who had an intact teeth in anterior region and missed distal molar(s) (2–12 missing occlusal units) classified as Kennedy Class I or Class II and who met the prescribed inclusion and exclusion criteria were consecutively enrolled into the study from seven university-based dental hospitals (9) (Table 1). The examples of SDA included in this study are shown in Table S1. The subjects chose no-treatment (wait and see; NT group) or treatment (TRT group) with RPD (clasp-retained resin base or metal base dentures) or IFPD for their edentulous spaces at the time of enrolment in study. QHRQoL and masticatory function were assessed on entry (pre-treatment) and re-assessed during regular check-up for the NT group or after treatment for the TRT group. Each subject received written and oral description of the experimental procedures, and informed consent was

Table 1. Criteria for subject enrolment into the study (9)

Criteria
Inclusion criteria
Kennedy Class I or Class II partially edentulous areas posterior to canines with no modification□spaces (2–12 missing occlusal units)
A pair of occluding premolars corresponds to one unit, and a pair of occluding molars corresponds to two units.
Kennedy Class I or Class II partially edentulous areas untreated for at least 1 month
Intact anterior dental arch restorable with fixed partial dentures or implant-supported fixed partial dentures
Exclusion criteria
Acute dental and periodontal diseases
Current use of removable partial dentures
Posterior teeth treated with fixed partial denture pontic or implant-supported fixed partial denture
Planned to be restored with cantilever fixed partial denture

obtained prior to enrolment into the study. All experimental procedures were approved by the Institutional Review Board of each university.

Objective masticatory performance

Subjects were asked to chew prepared samples of gummy jelly (20 × 20 × 10 mm, 5.5 g*) for 20 strokes, separately on the right and left side of their mouth (11). After chewing, the subjects were directed to expectorate the bolus, as thoroughly as possible, on a sheet of gauze. The collected pieces of the chewed gummy jelly were washed with running water for 30 s to remove saliva and stirred for 20 s in distilled water (35 °C, 15 mL). The concentration of dissolved glucose from the chewed gummy jelly was measured using a blood glucose metre†. The glucose concentration from three trials for each chewing side was averaged for each subject for statistical analyses. The dissolved glucose concentration has a linear relationship with the surface area of the gummy jelly, and this masticatory performance test is reliable in a clinical setting (11). In this study, the masticatory performance (MP) score was standardised and expressed as the percentage (%) of the mean glucose concentration obtained from five subjects with complete dentitions at each centre, indicating that a subject with

*UHA Mikakuto Co., Ltd, Osaka, Japan

†Glutest, Sanwa Kagaku Co., Nagoya, Japan

100-point MP score could chew a gummy jelly as well as a completely dentate subject could. Baseline evaluation was performed before treatment in TRT group. Follow-up/post-treatment evaluation was performed at a 3-month interval after baseline evaluation (NT group) or after prosthetic treatment (TRT group).

Perception of chewing ability

A food intake questionnaire validated in partially dentate subjects was employed to evaluate the patients' perception of their chewing ability (12). The questionnaire includes 20 common Japanese foods across a wide range of chewing difficulty. Subjects were asked to rate each of the items as being a food they can or cannot chew. A chewing ability (CA) score (%) was defined as the percentage of the total items they identified as being able to chew, with higher score indicating better chewing ability (minimum: 0% to maximum 100%). The food intake questionnaire was administered at baseline (pre-treatment), at the same follow-up/post-treatment 3-month interval as the MP, and again at 6 and 12 months.

Statistical analysis

There were missing CA data for subjects who did not complete follow-up/post-treatment evaluation at all three post-treatment intervals. Thus, the CA score at the last interval that each subject was followed up at was used for statistical analysis of CA. Within-subject comparisons between baseline (pre-treatment) and follow-up/post-treatment evaluation at 3 months for MP, and between baseline (pre-treatment) and follow-up/post-treatment evaluation at the last interval for CA, were performed using paired *t*-test. A regression analysis was performed to analyse association between the change in MP score and number of replaced OUs on the treatment side. A *P*-value less than 0.05 was considered statistically significant. SPSS 17.0[‡] was used for statistical analyses.

Results

Details of the characteristics of the subjects who underwent follow-up/post-treatment evaluation were

presented in the previous paper (10). Briefly, baseline evaluations were performed in 169 subjects, and 125 subjects [74.0%, mean age 63.0 years, standard deviation (SD) 10.6 years] received follow-up/post-treatment evaluation at least once. Of these 125 subjects, 53 (42.4%) chose no-treatment (NT group) and 72 (57.6%) received treatment (TRT group) with RPDs (42.4%: 53/125) or IFPDs (15.2%: 19/125). The mean age of subjects in the TRT (IFPD) subgroup (56.1 years) was less than the age of those in the NT group (64.5 years) and the TRT (RPD) subgroup (63.9 years). The mean missing OUs in the TRT (RPD) subgroup (6.9) were greater than that in the NT group (4.0) and the TRT (IFPD) subgroup (5.0). The NT group showed a lower percentage of chewing complaints (28%) than the TRT (RPD) (73%) or TRT (IFPD) (50%) subgroups. The mean (SD) OU increases with prosthetic treatment was 5.9 (2.4) [right side: 2.8 (2.6), left side: 2.5 (2.3)].

MP scores at baseline (pre-treatment) and follow-up/post-treatment evaluations are shown in Table 2. Effect size (ES), distributions of the change pattern (improved/worse/same) and mean change score with 95% confidence intervals (CI) are presented in tables according to a recommendation for reporting change score in clinical study (13). In the NT group, the mean MP score for both left and right sides at baseline was similar to those at follow-up evaluation ($P > 0.05$). In the TRT group, significant increases in mean MP scores were found for both treatment and no-treatment sides ($P < 0.05$), and the effect size for the treatment side (0.63) was greater than that for the no-treatment side (0.39). The restoration of one occlusal unit on the treatment side was associated with a 7.7-point increase in MP score ($P = 0.045$). A similar trend was found in the TRT (RPD) subgroup. In the TRT (IFPD) subgroup, the mean MP score for treatment side increased slightly, but it was not statistically significant (ES=0.24, $P = 0.40$). For no-treatment side in the TRT(IFPD) group, the mean number of missing OU was very small (0.2). The mean MP score was approximately 100% and did not change between intervals (ES=-0.28, $P = 0.40$).

CA scores at baseline (pre-treatment) and follow-up/post-treatment evaluations are presented in Table 3. In both the NT and TRT group, mean CA scores at the baseline (pre-treatment) evaluation were similar to those at the last follow-up/post-treatment evaluations ($P > 0.05$). The TRT (RPD) subgroup

[‡]SPSS Japan Inc., Tokyo, Japan

Table 2. Change in masticatory performance scores from baseline (pre-treatment) to follow-up/post-treatment evaluation

	Chewing side	Number of subject	Number (%) of SDA type I and II	Number of chewing side	Missing OU Mean (SD)	Number of replaced OU Mean (SD)	Baseline (pre-treatment) Mean (SD)
No-treatment	Right	48	44 (93.6)	48	1.8 (1.6)	–	75.6 (26.0)
	Left			48	2.3 (1.6)	–	74.9 (26.1)
Treatment	Treatment side	64	33 (51.6)	81	4.6 (1.0)	4.4 (1.0)	56.4 (30.7)
	No-treatment side			47	1.0 (1.5)	–	81.9 (30.7)
RPD	Treatment side	52	24 (46.2)	67	4.7 (1.0)	4.6 (1.0)	55.9 (28.7)
	No-treatment side			37	1.2 (1.7)	–	76.0 (30.4)
IFPD	Treatment side	12	9 (75.0)	14	4.2 (0.9)	3.8 (1.1)	58.9 (40.3)
	No-treatment side			10	0.2 (0.6)	–	104.1 (20.5)

Follow-up/Post-treatment (3M)	Δ (SD)	95% CI (lower/upper)	P	ES [§]	Improved n (%)	Worse n (%)	Same n (%)
Mean (SD)							
80.0 (32.0)	4.4 (40.3)	–7.2/16.1	0.453	–	24 (50.0)	23 (47.9)	1 (2.1)
77.0 (23.8)	2.0 (33.3)	–7.6/11.7	0.677	–	25 (52.1)	23 (47.9)	0 (0)
78.6 (27.5)	22.2 (35.4)	14.4/30.0	<0.001	0.63	58 (71.6)	23 (28.4)	0 (0)
93.3 (32.8)	11.4 (29.2)	2.8/20.0	0.010	0.39	26 (55.3)	21 (44.7)	0 (0)
81.2 (26.6)	25.4 (35.8)	16.6/34.1	<0.001	0.71	50 (74.6)	17 (25.4)	0 (0)
91.5 (34.7)	15.6 (30.9)	5.3/25.9	0.004	0.50	23 (62.2)	14 (37.8)	0 (0)
66.0 (29.3)	7.1 (29.6)	–10.0/24.3	0.402	0.24	8 (57.1)	6 (42.9)	0 (0)
100.0 (25.6)	–4.1 (14.7)	–14.6/6.3	0.400	–0.28	3 (30.0)	7 (70.0)	0 (0)

[§]ES = (mean score follow-up/post-treatment – mean score at baseline)/standard deviation (SD) of change scores. <0.2 is considered to be small, 0.4 is moderate and >0.8 is large.

showed a small, not statistically significant, decrease (ES = –0.17, $P = 0.29$). The mean CA scores in the TRT (IFPD) subgroup were high (>80%) at both pre- and post-treatment evaluations, and the difference between the pre-treatment and last evaluation interval was small and not statistically significant (ES=0.20, $P = 0.40$). The distribution of the change scores by the baseline (pre-treatment) score in each group is shown in Fig. 1. In the NT group, no relationship was found between the baseline and changed scores. In the TRT group, the subjects with CA pre-treatment score less than 80% tended to show improvement with treatment, while the subjects with pre-treatment CA scores greater than 75% tended to show a decrease after treatment. The subjects in the TRT group were divided into lower/higher CA sub-

groups using a cut-off score (80%), and the CA change scores were reanalysed in each subgroup. As results, the subgroup with lower pre-treatment CA showed a moderate improvement (ES=0.52, $P = 0.004$), while the higher pre-treatment CA group showed moderate deterioration (ES = –0.59, $P = 0.001$) (Table 4).

CA and MP scores and missing OUs at baseline of the subjects who participated in baseline evaluation but dropped out before follow-up/post-treatment evaluation (dropout subjects) are presented in Table 5. Overall, mean CA and MP scores and missing OUs at baseline for the dropout subjects were similar to those who participated in follow-up/post-treatment evaluations (follow-up subjects). However, the mean missing OUs on the left side of the dropout subjects in

Table 3. Change in chewing ability scores (%) from baseline (pre-treatment) to follow-up/post-treatment evaluation

			Follow-up/Post-treatment							
			Baseline (pre-treatment)							
			Missing OU		3M		6M		12M	
	Mean (SD)	<i>n</i>	Mean (SD)	<i>n</i>	Mean (SD)	<i>n</i>	Mean (SD)	<i>n</i>	Mean (SD)	
No-treatment	4.0 (2.2)	53	78.1 (21.0)	51	77.8 (21.9)	45	83.6 (19.1)	43	77.1 (23.8)	
Treatment	6.4 (2.4)	72	73.4 (22.0)	64	71.1 (21.3)	51	69.4 (20.5)	46	74.0 (22.4)	
RPD	6.9 (2.4)	53	69.8 (20.5)	52	67.2 (21.9)	40	66.3 (19.8)	33	68.0 (22.7)	
IFPD	5.0 (1.9)	19	84.0 (23.2)	12	86.9 (10.5)	11	82.0 (19.3)	13	90.4 (10.3)	
Last evaluation										
<i>n</i>	mean (SD)	Δ (SD)	95% CI (lower/upper)	<i>P</i>	ES ^{\$}	Improved <i>n</i> (%)	Worse <i>n</i> (%)	Same <i>n</i> (%)		
53	75.8 (24.1)	−2.4 (11.4)	−5.5/0.8	0.139	—	16 (30.3)	23 (43.4)	14 (26.3)		
72	72.0 (21.8)	−1.5 (21.3)	−6.5/3.5	0.545	−0.07	29 (40.3)	30 (41.7)	13 (18.0)		
53	66.5 (21.0)	−3.3 (22.6)	−9.5/2.9	0.293	−0.17	23 (43.4)	22 (41.5)	8 (15.1)		
19	87.4 (15.8)	3.4 (16.8)	−4.7/11.5	0.385	0.20	7 (36.8)	7 (36.8)	5 (26.3)		

^sES = (mean score follow-up/post-treatment – mean score at baseline)/standard deviation (SD) of change scores. <0.2 is considered to be small, 0.4 is moderate, and >0.8 is large.

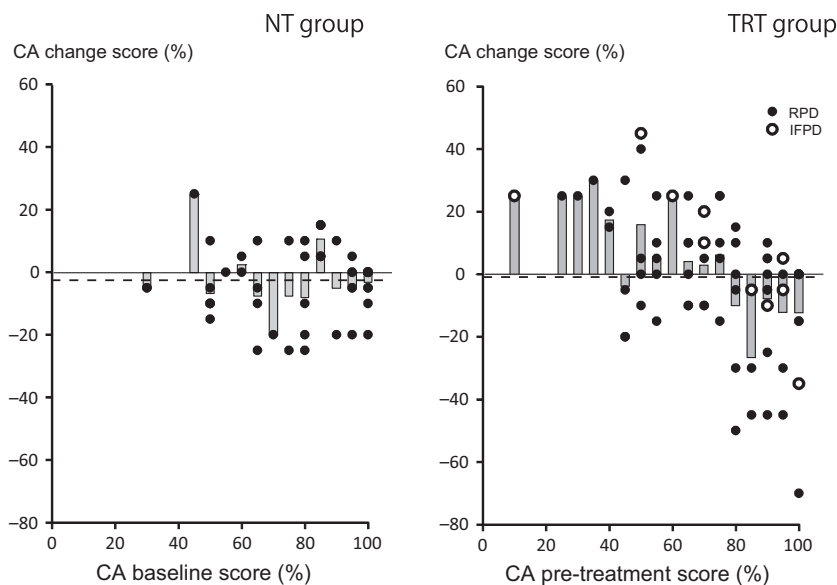


Fig. 1. Distribution of CA change score by baseline (pre-treatment) score in the NT (left) and the TRT group (right). Closed or open circles indicate individual data, and grey bars indicate mean CA change score corresponded to baseline (pre-treatment) score. Horizontal dot lines indicate the mean CA change score of the subjects in each group.

the TRT (RPD) subgroups was greater than that in the follow-up subjects (*t*-test, $P < 0.05$), and the mean MP score on the left side of dropout subjects in the TRT (IFPD) subgroup was less than that in the follow-up subjects (*t*-test, $P < 0.05$) (Table S2).

Discussion

The present study aimed to determine whether prosthetic restoration for subjects with a SDA could improve masticatory function. The results of the

within-subject comparison in the TRT group showed moderate and statistically significant improvement in mean MP score from pre- to post-treatment. Although a minimally important difference (MID) for the MP score employed in this study has not been proposed, considering that the MP score could have a 100-point range, 22-point increase on the treatment side appears to be clinically significant. However, MP did not reach the level of MP (100 points) seen in subjects with complete dentitions. On the other hand, the mean CA score (reflecting subjective perceptions of ability to

Table 4. Change in chewing ability scores (%) in lower and higher chewing ability subgroups (TRT group)

	<i>n</i>	Missing OU Mean (SD)	Baseline (pre-treatment) Mean (SD)	Post-treatment (Last evaluation) Mean (SD)		
Lower CA group (<80 points)	36	7.5 (2.5)*	55.1 (15.4)	64.0 (19.3)		
Higher CA group (≥80 points)	36	5.2 (1.7)*	91.9 (7.2)	80.0 (21.4)		

Δ (SD)	95% CI (lower/upper)	<i>P</i>	ES [†]	Improved <i>n</i> (%)	Worse <i>n</i> (%)	Same <i>n</i> (%)
8.9 (17.2)	3.1/14.7	0.004	0.52	20 (55.6)	6 (16.6)	10 (27.8)
−11.9 (20.1)	−18.7/5.2	0.001	−0.59	10 (27.8)	23 (63.9)	3 (8.3)

[†]ES = (mean score follow-up/post-treatment – mean score at baseline)/standard deviation (SD) of change scores. < 0.2 is considered to be small, 0.4 is moderate and > 0.8 is large. **P* < 0.05, T-test for comparison between the lower and higher CA groups.

Table 5. Chewing ability scores and masticatory performance scores at baseline of the subjects who did not participate (dropouts) in follow-up/post-treatment evaluation

	<i>n</i>	Missing OU Mean (SD)	CA score (%) Mean (SD)	Chewing side	<i>n</i>	Missing OU Mean (SD)	MP score Mean (SD)
No-treatment	17	4.8 (2.3)	82.4 (17.2)	Right	22	2.1 (1.7)	84.3 (39.7)
				Left	22	2.5 (1.8)	77.4 (34.2)
Treatment	27	7.0 (2.5)	67.0 (22.5)	Right	35	3.0 (2.3)	62.5 (29.8)
				Left	35	3.5 (2.1)	57.3 (23.3)
RPD	16	7.8 (2.6)	63.1 (21.9)	Right	17	2.8 (2.4)	60.1 (25.5)
				Left	17	4.7 (1.4)*	50.6 (20.3)
IFPD	11	5.9 (2.0)	72.7 (23.2)	Right	18	3.2 (2.3)	65.0 (34.2)
				Left	18	2.4 (2.0)	64.5 (24.8)*

**P* < 0.05, T-test for comparison with subjects who completed post-treatment evaluation.

chew various food items) at pre-treatment evaluation was similar to that at follow-up evaluation (*P* > 0.05). Thus, the null hypothesis related to MP was rejected.

In the TRT group, regression analysis showed that replacement of one OU on the treatment side was associated with a 7.7-point increase in MP score. If MID for MP score is assumed as 15–20 points, restoration of 2–3 OUs would be needed to provide a minimally important MP improvement, which is less than OUs necessary for a MID in OHRQoL (5 OUs) estimated in the previous paper (10). The effect of prosthetic restoration for SDA on objective masticatory performance may be greater than that on OHRQoL. Statistically significant increases in MP scores were found on not only the treatment side but also the non-treatment side, suggesting that the restoration of missing posterior teeth possibly improved objective masticatory performance on the non-treatment side as well. A study has shown that patients with missing

unilateral posterior teeth tended to chew on teeth remaining side (14). Thus, the subjects in the TRT group may have been able to chew more frequently on the treatment side after treatment. Alternation of chewing behaviour might have an exercise effect for the neuromuscular system responsible for chewing on the non-treatment side. More balanced occlusion with prosthetic restoration also may have a positive effect on mastication. However, this effect was less on the non-treatment side (ES=0.39) than on the treatment side (ES=0.69).

The TRT (RPD) subgroup showed moderate and statistically a significant improvement in the mean MP score on the treatment side. The mean change score was 25 points, which may be considered clinically significant. These findings agree with a study that investigated the effect of prosthetic treatment with RPDs on MP (15), a study comparing MP with RPDs with/without artificial molars (16) and a study comparing MP with/without RPDs (17). However, other studies

have not found improvement in MP with RPDs (6) or comparing RPDs having various lengths of posterior artificial teeth (18). The variation of methods for chewing tests employed in these studies and the different study designs may be responsible for this discrepancy.

In the TRT (IFPD) subgroup, the effect on MP score on the treatment side was small ($ES=0.24$) and not statistically significant ($P < 0.05$). A small study in 10 mandibular SDA subjects showed that the MP score improved with IFPD treatment, reaching a performance level close to that of subjects with complete dentition (19), and the effect size in this study ($ES=1.1$) that we estimated is substantially higher than that in our study. In the present study, 60% (18/30) of the subjects in the TRT (IFPD) subgroup did not participate in evaluation of MP at 3 months post-treatment. However, the mean MP score at baseline for the right side in the subjects that dropped out (60%) was comparable to that in follow-up subjects (64%), suggesting that the influence of dropout on MP seems to be limited. Thus, it is difficult to explain for the large difference in effect size between the studies. Further studies with a larger sample size and fewer dropouts are necessary to estimate more reliable effect size.

In this study, the treatment effect on MP with IFPDs was smaller than that with RPDs. As this study was not randomised controlled trial, subject characteristics may be different between the subgroups. Actually, percentage of SDA type I and II was greater in the IFPD subgroup (75%) compared to the RPD subgroup (46%), indicating that number of missing molar teeth in the IFPD subgroup was less than that in the RPD subgroup. In addition, the mean number of replaced OUs with IFPDs (3.8) was less than that with RPDs (4.6). These differences between the IFPD and RPD subgroups may be responsible for the relative small treatment effect with IFPDs.

In both the NT and TRT groups, the mean CA score at baseline (pre-treatment) evaluation was similar to that at post-treatment ($P < 0.05$), suggesting that the overall effect of prosthetic restoration for SDA on subjective chewing ability is limited, and thus the SDA concept proposed by Käyser cannot be rejected. The discrepancy between objective and subjective (patients reported) measures of masticatory function has been reported in a number of studies with variety of dental conditions such as partially dentate subjects

with RPDs (20) or IFPDs (21) and edentulous subjects with complete dentures (22) or mandibular implant-retained overdentures (23). Thus, clinical decision for prosthetic restoration for SDA with respect to masticatory function should be made after considering both objective and subjective outcomes.

The *post hoc* analysis found CA baseline score may be related to CA change score with prosthetic treatment. A similar relationship has been reported in edentulous subjects with complete dentures, wherein subjects with greater perceived impairment prior to treatment showed more improvement with treatment (24). Although the lower CA subgroup showed a moderate CA improvement (9%), the mean CA score was still low after treatment (64%). In contrast, the higher CA subgroup showed moderate deterioration (12%) following treatment, although the mean post-treatment score (80%) may be clinically acceptable. The cut-off score (80%) dividing the subjects in the TRT group into high and low CA was determined on the scatted plot (Fig. 1), because statistical approaches using regression analysis cannot estimate precise regression coefficient in this case (25). Furthermore, the cut-off score employed in this study should be validated in another SDA population prior to application in clinical decision-making.

In this study, 26% of 169 subjects who completed baseline evaluation did not participate in follow-up/post-treatment evaluation. The characteristics of the dropout subjects were similar to that in the follow-up subjects (10). In addition, the mean MP and CA at baseline in the dropout subjects of the NT and TRT group were comparable to those at the follow-up subjects. Overall, the dropout from the study seemed to have a minimal effect on the results. However, the mean MP score for the left side in the dropout subjects of the TRT (IFPD) subgroup (65 points) was significantly lower than evaluated group (92 points) ($P < 0.05$). The dropout in the TRT (IFPD) group may have had an influence on the results for the left side.

As addressed in the previous paper (10), this study has some limitations such as non-randomised group allocation, small sample size for IFPD, high dropout rate and limited follow-up interval. In addition, objective masticatory performance was evaluated with unilateral chewing that seems to be unnatural. Furthermore, this study was designed to investigate the treatment effect only on OHRQoL and masticatory function. Variety of outcomes such as longevity, tooth

loss, maintenance, prevention of caries and periodontal disease, nutritional status and cost-effectiveness should be taken into consideration in clinical decision-making. However, the findings obtained in this study will be helpful for consideration of prosthetic restoration for SDA subjects in Asian countries. Within these limitations, we conclude that prosthetic restoration of the SDA may provide benefit in terms of objective masticatory performance in patients needing replacement of missing posterior teeth, but the benefit in subjective chewing ability seems to be limited to subjects with perceived impairment in chewing ability before treatment.

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Correspondence: Kenji Fueki, Removable Partial Prosthodontics, Oral Health Sciences, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University, Tokyo, Japan, 1-5-45 Yushima, Bunkyo-ku, Tokyo 113-8549, Japan.
E-mail: kunfu.rpro@tmd.ac.jp

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Examples of shorted dental arches in this study.

Table S2. Masticatory performance scores at pre-treatment by chewing side in the treatment group.