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Fit of direct retainers in removable partial dentures after 8 years of use

H. M. A. M. KELTJENS, J. MULDER, A. F. KÄYSER & N. H. J. CREUGERS
Trikon, Institute for Dental Clinical Research, University of Nijmegen, School of Dentistry, Nijmegen, the Netherlands

SUMMARY In a cross-sectional study the fit of direct retainers was assessed after 8 years of use. A total of 101 metal frame removable partial dentures (RPD) were investigated, including 54 extension base prostheses without any tooth supported replacement and 47 tooth supported prostheses that replaced only premolars and molars. Of the frameworks studied, about 60% of the clasps showed a space between retainers and abutments. Logistic regression analyses demonstrated that the age of the RPD and the type of opposing dentition significantly influenced the fit of the clasps. The relative risks and a backward regression analysis revealed that the variable non-rigid extention base RPD had the greatest influence on clasp fit. It was concluded that in extension base RPDs a rigid design should be preferred.

Introduction

There are a variety of designs used for removable partial dentures, and most of them are not supported by scientific research. The design of metal frame removable partial dentures (RPDs), therefore, is still under discussion. Maintaining stability is one of the most important factors in their long-term success. To reach this goal retainers play an essential role. They provide support, retention and stability for the RPD and transmit stresses to the abutment teeth (Stewart, Rudd & Kuebner, 1992). These functions can only be exerted correctly when the fit of the retainers is perfect. Longitudinal data on the fit of RPD-retainers are scarce. Bending (permanent deformation) of clasp arms, which results in discrepancies between clasp arm and abutment, may lead to the transmission of unfavourable stresses to abutments and alveolar ridges.

This study investigated the extent that direct retainers are permanently deformed away from abutment teeth during use, and factors that could influence the long-term fit of these retainers. These factors may be taken into account when designing an RPD and might improve the long-term fit of the RPD.

Methods

Patients were selected from the clinic of the Dental School in Nijmegen and met the following criteria:

(1) the patient must be wearing a tooth-supported RPD which replaced only premolars and molars (Fig. 1) or an extension base RPD without any tooth supported replacement (Fig. 2);

(2) the RPD should be of a conventional design provided with extracoronal direct retainers and without onlay clasps or intracoronal or extracoronal attachments;

(3) the patient had no extensive treatment such as new restorations or repairs to abutments or RPDs since the moment of insertion;

(4) the RPD should have been worn daily without obvious complaints at the time of selection for this investigation.

The selected group consisted of 93 patients (32 men and 61 women) and 101 RPDs; 31 RPDs in the maxilla

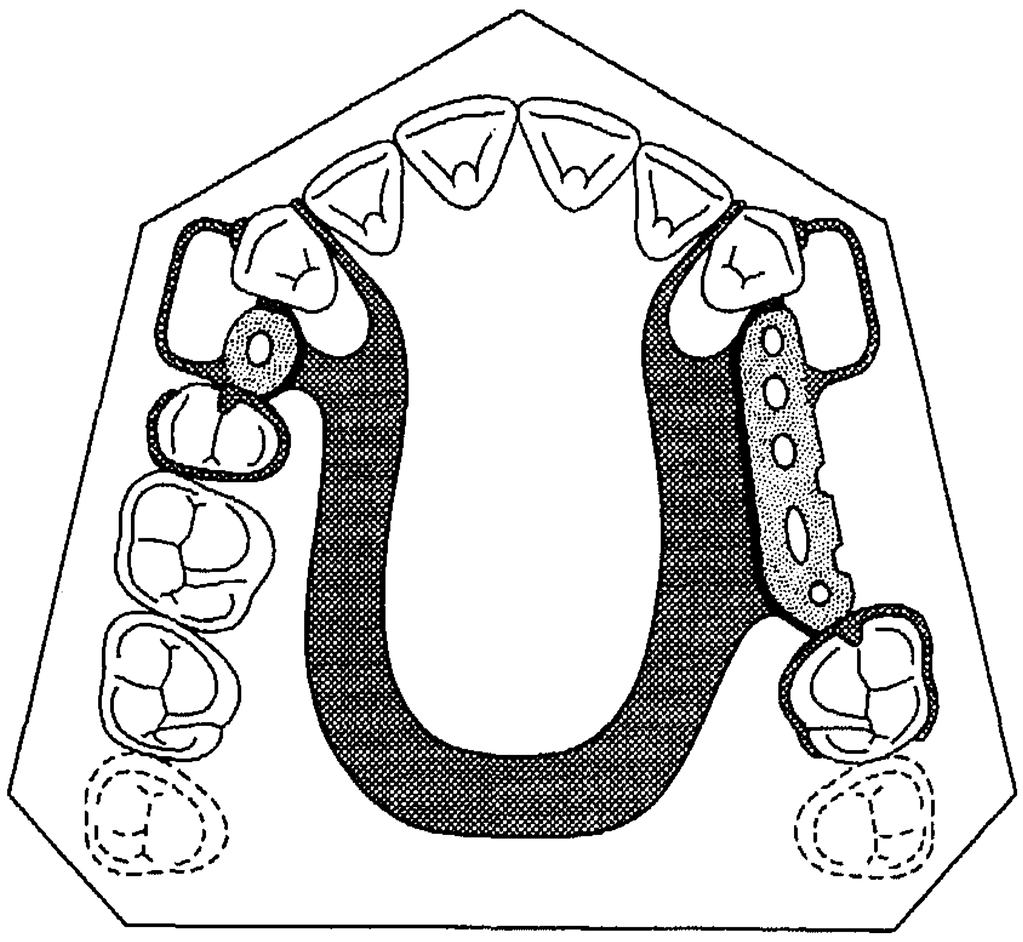

Fig. 1. Design of a tooth-supported RPD.

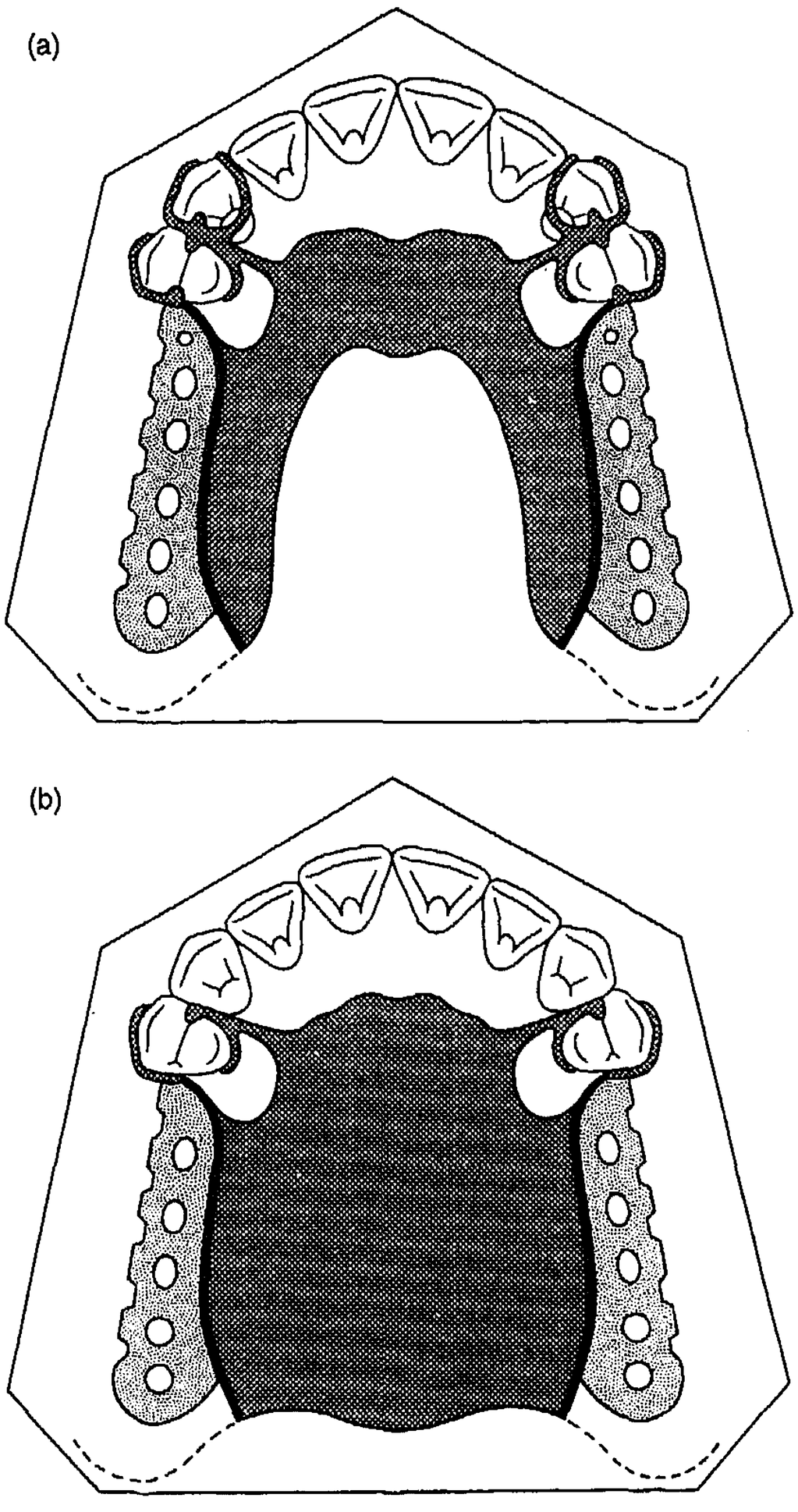

Fig. 2. Designs of extention base RPDs. (a) Rigid design and (b) non-rigid design.

Table 1. Distribution of the removable partial dentures according to jaw, type of mutilation and designs

	Tooth supported	Distal extension base		Total
		rigid	non-rigid	
Mandible	24	31	15	70
Maxilla	23	4	4	31
Total	47	35	19	101

Table 2. Antagonistic situation of the removable partial dentures

	Natural dentition	Acrylic plate RPD	Metal frame RPD	Over-denture	Complete denture
Mandible ($n = 70$)	21	4	11	1	33
Maxilla ($n = 31$)	18	0	12	0	1

and 70 RPDs in the mandible (Table 1). The mean age of the patients was 55 years (range 29–89 years). All patients were included in a recall programme. The sample consisted of 47 tooth-supported RPDs divided almost equally between both jaws, and 54 extension base RPDs with the majority located in the mandible. The extension base RPDs were either of a rigid design ($n = 35$), such as depicted in Fig. 2a, or of a non-rigid design ($n = 19$) (Fig. 2b). The mean time elapsed between the insertion and the beginning of this investigation was 8·4 years (S.D. 4·6).

A classification of the dentitions opposing the RPDs is given in Table 2. This table shows that RPDs in the maxilla were generally opposed by natural dentition, in some cases restored with a RPD. Nearly half of the RPDs in the mandible were opposed by a complete denture. Of the total, 15 patients wore RPDs in both jaws, of which eight patients who wore both RPDs were included in the study, while seven patients with only one RPD met the selection criteria.

The distribution of abutment teeth and clasps are given in Tables 3 & 4. In the mandible, most abutments were cuspids and premolars, which is in contrast with the abutments in the maxilla, which were mostly cuspids and molars. Only one incisor served as abutment.

Table 3. Distribution of the abutments according to tooth type

	Incisor	Cuspid	Premolar	Molar	Total
Mandible	1	92	102	49	244
Maxilla	0	46	25	46	11
Total	1	138	127	95	361

Table 4. Fit of the clasps divided into circumferential and vertical projection clasps (percentages)

	Space between clasp and abutment		
	no space	<0·5 mm	≥0·5 mm
Circumferential clasp (n = 288)	48	46	6
Vertical projection clasp (n = 71)	32	40	28

Total number of clasps 359.

Fourteen per cent of the abutment teeth were unrestored, 51% were restored with a direct filling material and 35% were restored with a cast restoration. The direct retainers were divided into circumferential (288) and vertical projection (71) clasps. Two clasps were excluded from the study because they could not be fitted into either group.

To determine the fit of the retainers any visible space between abutment and retainer was scored. If necessary a mirror was used. When a space was visible, the extent was assessed with a round orthodontic wire (thickness 0·5 mm). Differences were made between no space, spaces $< 0{\cdot}5$ mm or spaces $\geq 0{\cdot}5$ mm. All deviating parts of a clasp were tested and for every retainer the highest score was recorded.

To determine the influence of several factors onto the fit of clasps a logistic regression procedure in SAS was used (Hosmer & Lemeshow, 1989). The abutment and clasp were considered as units of investigation. The dependent variable was clasp fit. On behalf of the analyses this variable was divided into two levels: clasps with no space and the remaining group of clasps with space, which resulted in a binary dependent variable. Starting point of the analyses was that between the groups of clasps no differences in fit existed at the moment of insertion.

The logistic regression analysis was undertaken using all the following independent variables:

(1) 'type of clasp', divided into circumferential and vertical projection clasps;

(2) 'type of jaw', divided into maxilla and mandible;

(3) 'age of the RPD', 1–20 years;

(4) 'type of RPD', divided into tooth-supported RPD, rigid extension base RPD and non-rigid extension base RPD;

(5) 'restoration level of abutment', divided into unrestored abutments, abutments with direct filling materials and abutments with cast restorations;

(6) 'opposing dentition', divided into a group with a natural dentition (eventually restored with a fixed or removable partial denture) and another group consisting of complete dentures and complete overdentures.

The independent variable 'age of the RPD' was used to assign the basic curve. The influence of other independent variables onto this curve was assessed. The rigid and non-rigid extension base RPDs were compared with the tooth-supported RPDs, and the abutments provided with direct filling materials or cast restorations were compared with unrestored abutments.

Results

The results of the fit of retainers are summarized in Table 4. In 48% of the clasps, no space was visible between a circumferential clasp and the corresponding abutment tooth, and 46% had a space of less than 0·5 mm. The remaining 6% had a space of at least 0·5 mm. In the vertical projection clasps, 32% had no space, 40% had a space of less than 0·5 mm and 28% demonstrated a space of at least 0·5 mm.

Before the logistic regression analyses were performed, the possible interactions among the variables, which might influence the results, were analysed with a Chi-square test (Table 5). This table shows a substantial number of significant interactions. For the variable ' age of the RPD', which was used to constitute the basic curve, these interactions implied that vertical projection clasps as well as RPDs in the maxilla were older, whilst rigid extention base RPDs and RPDs opposed by a complete denture or overdenture were younger.

The logistic regression analyses estimated to what extent the variables influenced the fit of the clasps (Table 6). It was found that age of the RPD and the

Table 5. Interactions of the variables (Chi-square test)

	2†	3	4	5	6	7	Age of RPD
(1) Type of clasp	n.s.	***	***	n.s.	*	n.s.	*
(2) Type of jaw		***	*	***	n.s.	***	***
(3) Rigid extension base RPD			***	n.s.	n.s.	***	***
(4) Non-rigid extension base RPD				n.s.	***	***	n.s.
(5) Direct filling in abutment					***	*	n.s.
(6) Cast restoration on abutment						*	n.s.
(7) Opposing dentition							***

†Numbers correspond with vertical variables.
n.s. = not significant.

Table 6. Factors influencing the fit of the clasps (logistic regression analysis)

	Influence*	*P*-level
Type of clasp	–	
Type of jaw	–	
Age of RPD	†	0·03
Rigid extension base RPD	–	
Non-rigid extension base RPD	–	
Direct filling in abutment	–	
Cast restoration on abutment	–	
Opposing dentition	†	0·05

– = No influence.
† = Influence.

Table 7. Relative risks of the variables

	Relative risk	Confidence interval	
Type of clasp	0·765	0·629–0·931	Significant
Type of jaw	1·056	0·861–1·295	–
Rigid extension base RPD	0·971	0·797–1·184	–
Non-rigid extension base RPD	1·470	1·202–1·797	Significant
Direct filling in abutment	0·976	0·810–1·177	–
Cast restoration on abutment	0·929	0·759–1·135	–
Opposing dentition	1·293	1·076–1·554	Significant

type of opposing dentition significantly influenced the fit. The older the RPD, the worse the fit of the clasps. Furthermore, clasps used in RPDs opposed by a natural dentition had a worse fit compared to clasps used in RPDs opposed by complete dentures or overdentures.

As a second step of this analysis the relative risks were calculated (Table 7). The relative risks of the variables 'non-rigid extention base RPD', 'type of clasp' and 'opposing dentition' had a significant influence on clasp fit, of which 'non-rigid extention base RPD' had the most prominent influence.

The influence of the variable 'non-rigid extention base RPD' was also confirmed by a backward regression analysis. This analysis showed that the variables 'age of the RPD', 'non-rigid extention base RPD' and 'opposing dentition' were the most important factors that influenced the clasp fit.

Taking these results into consideration, variables such as type of jaw, direct filling in abutment, cast restoration on abutment and rigid extension base RPD seemed to have no influence upon clasp fit, while of the variable 'type of clasp' only the relative risk was significant. On the other hand, the influence of age of the RPD and opposing dentition was more definite. The variable 'non-rigid extension base RPD' had the greatest influence (see relative risks). Due to interactions (Table 5), this influence did not emerge in the logistic regression analysis.

Discussion

The RPDs selected for this study were those that were worn daily without complaints and the fit had not been influenced by retreatment procedures. The selection criteria were used because lack of use (not worn), new restorations, and repairing could bias the results. Therefore, the sample used for this study is not representative for RPDs in general. Moreover, all patients at the clinic have been included in a recall programme, in which problems with abutments or RPDs were recognized and treated in time.

The study revealed that a high number of clasps did not fit the abutment correctly, and some of the clasps showed a discrepancy of over 0·5 mm. However, it appeared to be of less importance clinically for the function of the RPDs because they were worn every day without obvious complaints from the patients. The applied treatment procedures at the clinic could be responsible for this effect. Before the RPDs were made, the abutments were reshaped by grinding to provide guiding planes and better positions for clasp arms (Stewart *et al.*, 1992). These guiding planes offer frictional resistance to displacement and supply some retention (Donahue, 1988; Ahmed & Waters, 1992), so most patients did not notice during function that the fit of the clasps deteriorated. Another explanation could be that patients adapted to their RPD and did not notice these changes. Cowan *et al.* (1991) pointed to such an effect in a study, based on telephone interviews, which demonstrated a high percentage of patients who wear their RPDs without complaint after 2 and 4 years. This investigation did not study the influence of the fit to the abutment itself or to the stability of the RPDs. However, another study indicated that the stability of RPDs is related to the fit of the framework (Fischer, 1983).

Ageing of the RPDs influenced the fit of the clasps, as older RPDs showed significantly more deviation. This was expected because, during functioning, the deformation of clasp arms will occur and increase in time. The results of this study are supported by an *in vitro* study by Snyder & Duncanson (1992) simulating 1 year's wear. In that study permanent deformation and wear of nearly all clasp forms was demonstrated. The deviation of about 60% of the clasps in our study seemed to be more favourable than the results of the *in vitro* study, especially when the mean wearing time of 8·4 years is taken into account.

The difference in the fit of the clasps found between rigid and non-rigid extension base RPDs is of interest for designing RPDs. It is possible that this difference is not only the result of deformation of the clasps alone. In non-rigid RPDs, stress on the abutment teeth is reduced. Consequently, the forces exerted on the RPD are mainly borne by the remaining bone and soft tissues. Due to resorption of the supporting bone, permanent tissueward displacement by rotation of the RPD may occur, resulting in deviation of the clasps. This could explain the high number of clasps with larger amounts of space in non-rigid RPDs. In rigid designs, a larger amount of the force is resisted by the abutment teeth, probably resulting in less rotation and deviation. This explanation is in agreement with an earlier study (Feingold, Grant & Johnson, 1988), in which resilient attachments showed an increase in the amount of denture base movement when compared with rigid attachments. Moreover, our study shows that increased forces exerted on the clasps in rigid designs did not lead to a higher level of clasp deformation.

Complete dentures or overdentures opposing RPDs may exert less chewing force on the RPDs than opposing natural dentitions. As a consequence, the smaller amount of force could lead to less deformation and a better fit of the clasps in the long term.

In conclusion this study demonstrated that the fit of RPD clasps is effected negatively by time. As far as the patients are concerned, the fit of the clasps did not influence the function of the RPDs. The deterioration of the fit of clasps in non-rigid extension base RPDs was greater than in rigid RPDs. Therefore, if the number and periodontal health of the abutment teeth permit a rigid design should be preferred.

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Correspondence: Dr H.M.A.M. Keltjens, University of Nijmegen, School of Dentistry, PO Box 9101, 6500 HB Nijmegen, the Netherlands.