

The Impact of Removable Partial Dentures on the Health of Oral Tissues: A Systematic Review

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Abstract

Objectives: The aim of the present study was to review the available literature data to identify relevant studies for inclusion and to verify whether there is evidence to support the hypothesis that the insertion of an RPD into the oral cavity has a deterioration effect on the oral health status.

Materials and methods: 570 articles were identified, from searching both electronic databases (e.g., PUBMED) and manual searching of relevant written journals using an agreed search protocol up to 31st December 2011. The extraction of data for inclusion was conducted by two independent reviewers. The main outcomes of intervention involved both methodology and assessment tools applied by investigators to assess the effect of a RPD in terms of plaque accumulation, caries incidence, and gingival tissue (inflammation).

Results: 401 articles were excluded following an initial screening; 169 articles were included for the further review. At a second round screening, 163 articles were also rejected and six (Randomised Clinical Trials [RCTs]) articles were eventually accepted for inclusion. Based on the results, there was some scientific evidence supporting the hypothesis that RPDs placement may increase plaque accumulation and gingival inflammation. The importance of an established prevention program for RPD wearers (including good plaque control and OHI) either prior to or during treatment was emphasised by all investigators in the included studies. Among the limitations, however when evaluating the data, was the lack of homogeneity between the included studies (e.g., study design and duration, calibration details, clinical parameters to be evaluated, reporting of dropout rates and treatment intervention).

Conclusion: The conclusion from this present review would indicate that there were insufficient RCTs to adequately address the original research question, although a number of suggestions may be recommended. There was no doubt from the evidence presented in the published literature that in the absence of good oral hygiene measures a RPD may promote accumulation of the plaque which may in turn lead to gingival inflammation. Furthermore, there also appears to be a higher risk of dental caries (particularly root caries) in RPD wearers in the absence of good oral hygiene measures. The importance of an integrated prosthodontics maintenance programme with regular recall visits including both oral and denture hygiene care of a RPD cannot be under-estimated and should be adopted as a gold standard in general dental practice.

Keywords: Partial denture; Oral cavity; Oral hygiene

Introduction

According to Tanaka et al. [1] the placement of a removable partial denture [RPDs] in the oral cavity would appear to affect both the quality and quantity of the bacteria by increasing the accumulation of plaque on the remaining teeth. For example, the insertion of RPDs into the oral cavity may restrict the cleaning mechanism of the tongue and lips, which in turn, may increase plaque accumulation [2]. Local factors that compromise oral hygiene and encourage plaque retention could also potentially increase the risk of development of caries and periodontal disease especially in the abutment teeth used to support the prosthesis. The question as to whether or not RPDs *per se* can cause damage to both the hard and soft tissues in the oral cavity is somewhat controversial. For example, it has been previously suggested that a RPD has a high biological cost on both soft and hard tissues which may (in time) lead to an increase in gingival inflammation, periodontal pocket depth, tooth mobility and dental caries [3-6]. However, other investigators have reported that RPDs may only cause minimal or no damage to the remaining teeth and periodontal tissue [7-13]. Furthermore, it has been reported that both gingival inflammation and periodontitis can be adequately treated by the clinician if the patient's plaque control is well regulated [14]. The aim of the present study was to review the published literature to identify appropriate studies for inclusion

and to verify whether there was any justification to support the hypothesis that the insertion of an RPD into the oral cavity has a deterioration effect on the health of the soft and hard tissues.

Materials and Methods

The search methodology used for the present study was based on the PRISMA statement [15].

Selection criteria

Types of study: The review included any type of studies (e.g., clinical trials, randomized controlled trials (RCT), quasi RCT, *in vivo* and long term studies) as well as studies describing PICO questions and/or a PRISMA statement in which patients wearing RPDs were assessed for both their caries and periodontal status during the duration of the study.

Types of participants: Inclusion criteria for potentially eligible studies were partially edentulous patients who were over the age of 18 years and classified as either new RPD wearer or patients with an existing RPD.

Types of interventions:

1. Oral hygiene motivation prior to and during treatment with RPDs, in terms of any mechanical methods such as oral hygiene

instruction including brushing and/or adjunctive aids such as mouth washes were considered for inclusion.

2. Modification in the existing partial denture design (replacement denture).
3. Report of follow up period e.g. a minimum of 6 months after the insertion of the RPD.
4. Scaling procedures prior to and after the insertion of the RPD.

Types of language: Only completed published papers in English were considered for inclusion in this review.

Types of outcome measures: 1. The health status of denture bearing areas for example: soft tissue, periodontal tissues (for example pocket depth, plaque index, attachment loss, gingival recession, gingival index) as well as the hard tissues-teeth (caries).

Search strategy

The search strategy involved electronic database search in Medline/PUBMED combined with hand searching up to 31st December 2011. Hand searching also included examining any relevant published or incomplete journals. The search key words in PUBMED were (“removable partial dentures” AND “attachment loss” OR “periodontal health” OR “gingival health”), (removable partial dentures AND oral hygiene OR scaling procedures), (removable partial dentures AND caries), randomized controlled trial OR controlled clinical trial OR cohort OR longitudinal OR “follow up” OR prospective OR case-control).

Method of the review

A review of the abstracts and titles was conducted by A.Ezawi [AE] who then obtained copies of all the relevant studies where available for further consideration. Two reviewers (AE and DG) sought to determine the eligibility of the papers and data extraction. Any differences as to inclusion or exclusion of articles were resolved following discussion between AE and DG.

Quality assessment of the included studies

The methodological quality of the included studies was assessed based on the criteria for the concealment of treatment allocation as described in the Cochrane Handbook for Systematic Review of Intervention [15]. Excluded studies were those studies where the random (or quasi-random) allocation of treatment was clearly not used in the study or random allocation was not stated, and was not implied/or possible to interpret. Studies that failed to clearly detail any open outcome assessment used, or blind outcome assessments that were not reported and subsequently considered unlikely by the reviewer(s) were also excluded.

Results

Overall description of the included and excluded studies

After the first screening of the identified papers for the current review, 570 potentially relevant articles were identified by searching either the electronic database (PUBMED) or by hand searching articles from the published literature. Unpublished articles were found by searching both the electronic databases or by hand searching. 169 articles were considered as relevant for full-text reading and 401 articles were excluded at the initial screening stage (Figure 1). Following an assessment of the selected 169 articles, 163 articles were excluded [1-12,14,16-165]. A review on denture base materials was identified following the completion of the study [166]. 6 articles were subsequently included in the present review [13,167-171]. The flow diagram of the selection procedure is demonstrated below (Figure 1).

From the 6 included articles, one article investigated denture connector designs (Lingual plate and lingual bar) [167], one article investigated

the effect of different denture clasps designs (gingivally and occlusally approaching clasps) [13], 3 articles compared two denture groups; e.g., Fixed Partial Denture [FPD] or RPD [168-170], one article compared two groups of patients who were either called back for regular check-ups with patients who were not on a regular check-up programme [171].

Excluded studies

General overview of the excluded studies: There were a total of 401 articles excluded at the initial screening stage with 169 articles considered as relevant for further full-text reading (Figure 1). The reason for exclusion of 163 articles were as follows: 1) 30 review articles [4,14,16-46], 2) 9 *in vitro* articles [47-54]; 3) 4 case reports [55-58], 4) 2 pilot studies [59,60], 5) 5 incomplete data (no details of patient’s age) [5,61-64], 6) 2 survey articles [65,66], 7) Age criteria not meeting the inclusion criteria [67], 8) 2 articles could not be obtained [68-69 (duplicate of 29)], 9) 1 Randomised control trial Short-term study [70], 11) Remainder of the excluded articles were of a non-randomized controlled trial (RCT) design (short and long term studies) including investigation into microbiological impact on gingival health, denture design etc. [71-165]. A review on denture base materials was identified following the completion of the study [166].

Analysis of the included studies

Study design: The six studies (long term) included in the current review were of a RCT design (Table 1) [13,167-171].

Study population: Most of the studies were conducted in the University hospitals. The recruited study subjects in these studies were partially dentate, elderly and adult who received periodontal treatment and all necessary restorative treatment prior to commencing the study. Regarding the gender distribution, most of the included studies enrolled almost equal numbers of female and male participants (Table 1). [167-171]. One study included only male subjects [13]. The total number of participants was 366 from the 6 included studies as described in Table 1.

Study duration: The duration of the included studies ranged from 2 years to 5 years (Table 1).

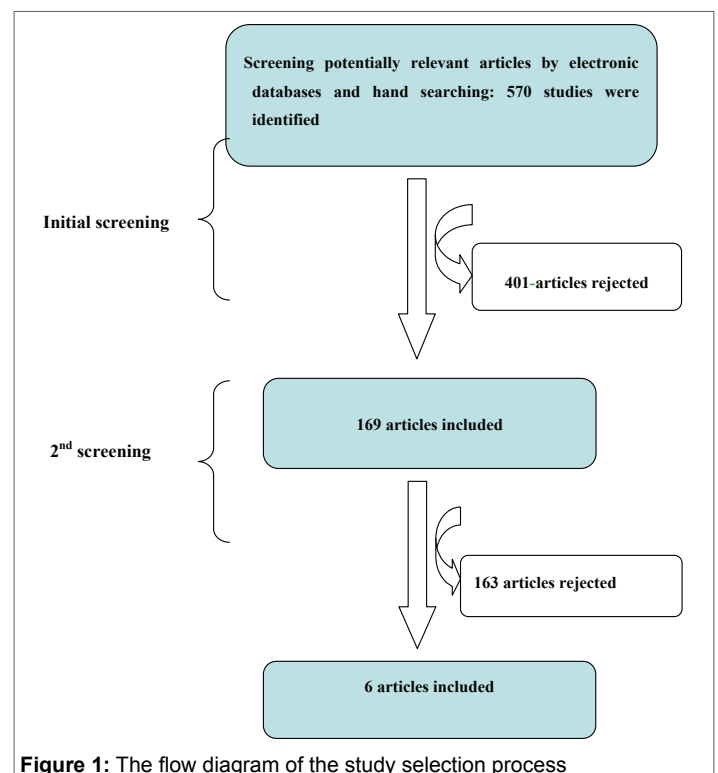


Figure 1: The flow diagram of the study selection process

No	Study	Duration	Participants	Intervention	Outcome investigated
1	Kapur et al. [13]	5 years	99 completing out of 134 (M: 134)	I-bar clasp vs. circumferential clasp	Plaque index, calculus index, gingival inflammation, pocket depth, gingival recession, bone height level, tooth mobility. Success rate
2	Akaltan & Kaynak [167]	2 ½ years	36 completing out of 36 (Not recorded)	Lingual palate major connector vs. lingual bar major connector	Gingival index, plaque index, tooth mobility, pocket depth, gingival recession, attachment loss
3	Jepson et al. [168]	2 years	50 completing out of 60 (M: 23, F: 35)	Cantilever RBB vs. RPDs	New and recurrent caries incidence, defective restoration, endodontic complication and tooth fracture
4	Budtz-Jorgensen & Isidor [169]	2 years	53 FPD (M: 13, F: 14) RPD (M: 12, F: 14)	FPDs vs. RPDs	Gingival index, plaque index, pocket depth, radiographic bone level, caries. Prosthetic parameters, functional, masticatory system by palpation.
5	Budtz-Jorgensen & Isidor [170]	5 years	42 completing out of 53 (M: 25, F: 28)	FPDs vs. RPDs	Gingival index, plaque index, pocket depth, radiographic bone level, caries. Prosthetic parameters, functional, masticatory system by palpation. Study appears to be a continuation of Budtz-Jorgensen & Isidor [169].
6	Vanzeveren et al. [171]	2 years	30 completing out of 30 (M: 19, F: 11)	Plaque control, reinforcement instruction, denture hygiene control, and professional prophylaxis vs. not recalled	Gingival index, plaque index, tooth mobility, pocket depth, attachment level, bacteriological examination

Table 1: Characteristics of the included studies

Study	Statistical test
Kapur et al. [13]	Log rank test, two-trial t-test
Akaltan & Kaynak [167]	ANOVA, student's t-test, Mann-Whitney H-test, paired t-test, Wilcoxon signed ranks test
Jepson et al. [168]	Uni-variate and multi-variate regression analysis
Budtz-Jorgensen & Isidor [169]	Chi-square test
Budtz-Jorgensen & Isidor [170]	--
Vanzeveren et al. [171]	Wilcoxon test, Mann-Whitney test, MANOVA

Table 2: Statistical tests used in the included studies

Statistics power calculation

There were a wide variety of statistical tests used in the included studies (Table 2) [13,167-171].

In most of the six included studies, the degree of concealment was unclear (e.g., random allocation stated/indicated but the actual allocation concealment method was neither described, or that an apparently adequate concealment scheme was reported but there was a degree of uncertainty as to whether the allocation was adequate concealed). Only in the Jepson et al. [168] study were the selected participants randomly assigned to one of the treatment groups by gender, stratified by age using computer generated random numbers.

Consideration of withdrawals and dropouts

Withdrawals and dropouts were only reported in three out of the six included studies (Table 1). The reasons for 'drop out' in the included studies were not recorded in three of the included studies (16, 18, 20) with no explanation provided in one study [13]. The remaining two studies [168, 171] reported that the 10 participants in each of the two studies dropped out for either personal reasons, ill health/debilitating diseases or death.

Data analysis

No further analyses were performed. The heterogeneity among the included studies ruled out the conduct of a meta-analysis.

Previous history of dental and gingival conditions at baseline

Baseline data were recorded after the participants were provided with periodontal treatment, scaling and polishing, restorative treatment and after completion of the prosthetic therapy. Some studies, for example, Jepson et al. [168] reported that the plaque score should be not more than 20% in order to be included in the study; whereas Kapur et al. [13] excluded medically compromised patients.

Types of treatment intervention

In all the six included studies [13,167-171] oral hygiene instruction, periodontal therapy and scaling and polishing and all necessary restorative treatment were conducted before commencing the study.

Clinical methodology used to assess the outcomes

There was a number of different assessment methods used for the clinical outcome measurements in the six included studies. However, the most commonly reported method used by investigators to assess the effect of the RPDs on both hard and soft tissues were: gingival index (GI) and plaque index (PI) and pocket depth (PD) (Table 1) Regarding the subjective assessment in the six included studies there were no reports of any subjective assessment made during the duration of the studies (Table 1).

Measurement of Compliance

There were no reported measurements of patient compliance in any of the included studies.

Blindness of the studies

No blinding of the examiners or interventions was described in any of the included studies.

Overall conclusions from the included studies

The overall conclusions that were reported by Investigators in the included studies are described in Table 3 [13,167-171].

Discussion

One of the problems in evaluating the effect of RPDs in the oral cavity was that there was considerable variation in the studies (e.g., duration, methodology used to assess the outcome(s) as well as the variation in the denture design, the status of the opposing arch and information relating

No	Study	RPD effects
1	Kapur et al. [13]	No evidence was provided on the unfavourable clinical outcomes (e.g., plaque (PII), calculus, gingival health (GI, PD, GR, BL, TM scores). The results from the study would suggest that a well-constructed RPD (of either design), supported by the abutment teeth with healthy periodontal tissues, and a six-month regular follow up may be a satisfactory treatment modality
2	Akaltan & Kaynak [167]	The results from the study indicated that both RPDs designs demonstrated a considerable reduction in all the periodontal parameters during the study period apart from the increase in gingival recession scores
3	Jepson et al. [168]	There was a significantly greater incidence of both new and recurrent caries lesions in patients provided with RPDs compared with patients with cantilever RBBs
4	Budtz-Jorgensen & Isidor [169]	The risk of dental caries and its consequences was higher in the RPD wearers than in the FPDs group
5	Budtz-Jorgensen & Isidor [170]	The risk of dental caries and its consequences e.g. tooth fracture, extraction and root canal treatment was higher in the RPD group than in the FPDs group and this may be as a result of the increased plaque accumulation in RPD wearers
6	Vanzeveren et al. [171]	According to the investigators the significant increase in the plaque scores during the study period was as a result of the patient's neglect and not as a result of the insertion of the partial denture

Table 3: Conclusions that were reported by investigators in the included studies

to the oral hygiene instructions. A number of investigators have suggested that the insertion of RPD into the oral cavity promoted changes in both the quantity and quality of the plaque and as a consequence increased the gingival inflammation or caries status as observed on the supporting teeth [3-4,168,68,92,133]. For example, Addy & Bates [6] suggested that the insertion of a RPD increased the risk of increased plaque levels and gingival inflammation. However, it was not clear from this particular study whether the subjects were new or existing RPD wearers or how they lost their teeth in the first place. A number of investigators [5,117] have suggested that improvements in the design of a RPD in conjunction with good oral hygiene procedures may limit any potential impact of a RPD on both the hard and soft tissues. According to Karpur et al. [13] a well-constructed removable partial denture of either design, supported by favourable abutments and accompanied by a regular recall program offers a satisfactory treatment modality. Furthermore, the incorporation of a well-designed RPD together with the implementation of a prosthetic maintenance programme, with regular check-ups and interventions may therefore be the ideal solution for the preservation and wellbeing of RPD wearers [8,12,92]. It is also important to acknowledge that the patient's personal hygiene procedures and motivation together with a supervised oral hygiene program may also play an important role for preventing any possible deterioration effects on the health of the oral tissues [1,169]. However, as Erpenstein [34] suggested that the interrelation between the periodontal status of a patient and a particular prosthetic appliance is of paramount importance when prosthetic treatment planning is to be designed. It is therefore essential that there was co-operation between both the Prosthodontic/Restorative and Periodontic specialties regarding the resolution of any periodontal therapy prior to initiating prosthetic treatment with the patient. From the published literature however, there appears to be very limited data on the instructions given to patients regarding the care of a RPD, relatively few investigators recorded this information [9,117] and as such it may be difficult to interpret the importance of any of these recommendations from the evidence in the published literature. As mentioned earlier in this review there may be a major impact on the quality of life of RPD wearers and while this aspect was not a major consideration when designing this present review there is no doubt that this topic deserves further investigation in future reviews on the impact of RPDs in the oral cavity. It was evident from the published literature that the caries risk, especially root surface caries was reported to be higher in RPD wearers, particularly if a regular follow-up appointment was not considered [3,124]. Fluoride therapy was also recommended by a number of Investigators as a preventive measure in RPD treatment; with a further recommendation that any coverage by the RPD and its components on the exposed root surface should be avoided [60,100,126]. Although not specifically covered the present systematic

review it should be recognised that there have been major advancements in the development of acrylic denture base materials e.g., poly methyl methacrylate resin (PMMA) over the last decade or so. For example, to improve the poor impact strength and low fatigue resistance of PMMA fiber reinforced resins have been introduced to improve the physical and mechanical properties of the material [166]. According to Vivek & Soni [166] the introduction of thermoplastic resins provided a number of advantages over the conventional powder-liquid systems, for example, in esthetics, stability, and comfort as well as improved mechanical properties such as wear characteristics and solvent resistance. The non-porous nature of these materials may also have a role in reducing the number of bacteria which may in turn reduce the amount of plaque accumulation.

One of the concerns when reading the methodology in the study design section of the various published studies was the lack of detail on how the examiners were trained and calibrated (e.g., Kappa values). It was evident from the review of the published literature that a number of the so-called classic studies failed to provide this information on any of the clinical outcomes that they were under investigation (e.g., 3,7,8,10 and 12). There were also limited data on study blinding, allocation, randomisation, drop outs etc., from a number of the excluded studies and some of these aspects were also missing from the included studies. Jepson et al. [168] did however mention that there was calibration of the examiners for caries diagnosis but no Kappa values were stated in their paper and this may raise concerns regarding the reproducibility of the outcomes being assessed. In retrospect there were also concerns that by conducting a very stringent review solely based on RCTs, the present study would find only a few studies that were robust for inclusion in the review. For example, a number of the so-called classic studies on the impact of RPDs and the importance of oral hygiene measures [12] were excluded on the basis of no randomisation etc. The final number of studies that were included was six in number and whether sufficient information and subsequent conclusions on the impact of RPDs on both the caries and periodontal status of denture wearers can be proposed on the basis of a relatively small number of studies may be questionable. The lack of homogeneity in the number of the included studies may also prevent any valid (evidence based) recommendations being proposed. There is undoubtedly a need for well conducted longitudinal RCTs to be conducted as proposed by Gomes and co-workers [35,45].

Conclusion

The conclusion from this present review would indicate that there were insufficient RCTs to adequately address the original research question, although a number of suggestions may be recommended. There was no doubt from the evidence presented in the published literature that in the absence of good oral hygiene measures a RPD may promote

the accumulation of the plaque which may in turn lead to gingival inflammation. Furthermore, there also appears to be a higher risk of dental caries (particularly root caries) in RPD wearers in the absence of good oral hygiene measures. The importance of an integrated prosthodontics maintenance programme with regular recall visits to include both oral and denture hygiene care of a RPD cannot be under-estimated and should be adopted as a gold standard in general dental practice.

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