

# Adverse Effects of Removable Partial Dentures on Periodontal Status and Oral Health of Partially Edentulous Patients

*Rania Rodan BDS\*, Osama Al-Jabrah BDS\*, Mahasen Ajarmah BDS\**

## ABSTRACT

**Objective:** To compare differences in caries and periodontal scores between removable partial denture wearers and non wearers; abutment with non-abutment teeth in the wearers and wearers with “satisfactory” to those with “unsatisfactory” dentures.

**Methods:** Ninety-six partially dentate patients were included in this study. Teeth were examined for caries and periodontal diseases. Removable partial dentures were evaluated for material, stability, retention and occlusion. Comparisons were made between wearers versus non-wearers regarding abutment versus non-abutment teeth and wearers with satisfactory dentures versus with problematic (or unsatisfactory) dentures. Significant differences in mean values were determined using a paired t-test, General Linear Model and Analysis of Variance. Level of significance was set at 0.05.

**Results:** There were 38 (39.6%) partially edentulous with no removable partial denture experience and 58 (60.4%) denture wearers (32 (33.3%) with unsatisfactory, 26 (27.1%) with satisfactory dentures). Removable partial denture wearers had significantly more coronal caries ( $p<0.05$ ) and root surface caries ( $p<0.001$ ) compared to non-wearers. However, Subjects who had problem complaints of their dentures had significantly more attachment loss and pocket depth compared to those who wore satisfactory dentures ( $p<0.05$ ). In partial denture wearers, abutment teeth had significantly more levels of caries and periodontal diseases when compared to non-abutment teeth. Abutment teeth of subjects wearing satisfactory dentures had significantly greater scores of caries ( $p<0.0001$ ) compared to those of non-wearers; and lesser scores of gingival recession ( $p<0.05$ ) and attachment loss ( $p<0.01$ ) compared to those of wearers with unsatisfactory dentures. In addition, abutment teeth of wearers with problem dentures had significantly higher scores of caries and periodontal diseases compared to non-wearers.

**Conclusion:** Wearing removable partial dentures increased the likelihood of coronal and root surface caries and to a lesser extent adversely affected the periodontal status. Abutment teeth appeared to suffer the most deleterious effects.

**Key words:** Abutment tooth, Oral health, Periodontal disease, Removable partial denture.

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## Introduction

Dental caries and periodontal disease are the most common causes of tooth loss.<sup>(1,2)</sup> Tooth loss can result in diminished function, unbalanced diet, malnutrition,<sup>(3)</sup> as well as loss of self-esteem.<sup>(4)</sup> Once teeth are lost, the restoration of function and

aesthetics, without causing additional complications and further tooth loss, is a challenge for dentistry.<sup>(5-10)</sup>

The consequences of failure to restore the loss of natural teeth may include drifting and tilting of the remaining natural teeth, which in turn may result in problems in masticating foods, deterioration of

\*From the Department of Dentistry, Prince Hashim Bin Al-Hussien Hospital, (PHHH), Zarka-Jordan

Correspondence should be addressed to Dr. R. Rodan, (PHHH)

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periodontal structures,<sup>(11,12)</sup> over eruption of opposing teeth,<sup>(13)</sup> reduction in masticatory efficiency,<sup>(2)</sup> pain in the temporomandibular joint,<sup>(14)</sup> defects of speech,<sup>(15)</sup> loss of appearance,<sup>(16-18)</sup> impaired oral hygiene,<sup>(19)</sup> and attrition of the remaining natural teeth.<sup>(1)</sup>

Removable Partial Dentures (RPDs) are one of the most widely accepted means of tooth replacement.<sup>(12,20-23)</sup> These prostheses are generally attached to the remaining natural teeth by clasps that hold the denture in place.<sup>(18,23)</sup>

One of the principal functions of a RPD is the preservation of the remaining dentition.<sup>(8,24)</sup> Therefore, the biological acceptability of denture design should be of primary concern and the mechanical elements of the appliance should not jeopardise the health of oral tissues.<sup>(19,25)</sup>

The introduction of RPDs in the mouth has the potential of altering the oral environment and increase of plaque formation particularly on tooth surfaces in contact with the partial denture causing further damage, especially to abutment teeth, to which the clasps are attached.<sup>(5-7,9,11,15,23,26-28)</sup> In addition, RPDs increase the likelihood of new and/or recurrent caries on abutment teeth. Also they may adversely affect the patient's periodontal condition. Abutment teeth appear to suffer the most deleterious effects since being clasped would subject them to additional forces that may cause tooth mobility.<sup>(3,10,19,21,22,29,30)</sup>

Removable partial denture wearers exhibit high risk for tooth loss. People who have periodontal disease and high caries susceptibility are obviously at greater risk for further tooth loss since partial dentures are likely to aggravate these conditions.<sup>(7,9,12,27,31,32)</sup>

As RPD wearing may lead to increase plaque formation on those areas of teeth and soft tissues which are covered by the denture<sup>(33)</sup>, excellent oral hygiene measures along with care in denture design to maintain a healthy oral environment are highly recommended.<sup>(11,15,16,30,34)</sup>

The objectives of this study were to compare differences in caries and periodontal scores between removable partial denture wearers and non wearers; abutment with non-abutment teeth in the wearers and wearers with "satisfactory" to those with "unsatisfactory" dentures.

## Methods

This study was conducted between September 2008 to March 2009 in the Prosthetic and Periodontal clinics, Division of Dentistry, Prince Hashim Bin Al-Hussein Hospital, Zarka, Jordan.

Exclusion criteria were; Completely edentulous

patients, fully dentate subjects, partially edentulous subjects, with missing one or more posterior teeth, where the prosthetic treatment was not indicated (i.e: shortened dental arch concept),<sup>(1,20)</sup> or with congenitally missing teeth with no enough space for the prosthetic replacement (i.e: congenitally missing teeth with the possibility of orthodontically space closure),<sup>(35)</sup> and all partially edentulous subjects who were indicated for fixed prosthesis (crown and bridge work) or whenever RPD treatment was not indicated.

Including criteria were; Partially dentate non-RPD wearers who were candidates for RPD treatment with no history of recent extractions within 3 months,<sup>(36)</sup> and partially edentulous, RPD wearers with a denture experience of a period not less than 6 months.<sup>(27)</sup>

A total of 131 partially edentulous subjects met criteria for inclusion in this study. However, only 96 subjects accepted to participate in this study. This group of patients were asked to complete a questionnaire and were clinically examined.

Dental and periodontal status were examined for partially edentulous subjects of both groups (wearers and non-wearers). Periodontal examinations were essentially the same as that performed by Newman *et al.*<sup>(37)</sup> Coronal and root surface caries, gingival recession, pocket depth, attachment loss and tooth mobility were noted by one periodontist examiner.

The mean number of carious lesions was calculated for all subjects, for abutments and non-abutments teeth. For non denture wearers, abutment teeth were appointed as those located next to the edentulous spaces. Mean values were calculated for both abutment teeth and all other teeth and the means were compared to determine differences in these two-teeth groups per person. Gingival recessions and pocket depths were measured using The University of Michigan "0" periodontal probe with Williams markings 1, 2, 3,..., 10). Measurements were performed for all surfaces (in mm), and the means were calculated. Comparisons were performed between wearers and non-wearers, abutments and non-abutments. Loss of attachments was calculated as sums of gingival recessions and pocket depths; means were calculated and compared between the groups as above. Tooth mobility was performed by holding the tooth firmly between one metallic instrument handle and the index finger buccolingually. Grade of mobility was estimated using Miller's technique,<sup>(38,39)</sup> where mobility is scored 0-3 (Score 0: no detectable movement; Score 1: barely distinguishable tooth movement; Score 2: movement up to 1mm in any direction; and Score 3: movement of the crown more than 1mm in any

direction and/or when teeth can be deoressed or rotated in their sockets) and the means were calculated and compared between the groups as above.

Prostheses were examined by one prosthodontist. All RPD wearers were examined for denture-related mucosal lesions and each denture was evaluated for material as good or deteriorated, stability as stable or unstable, retention as retentive or non-retentive and occlusion as good or poor. If any one or more of these denture characteristics was found to be inadequate, the denture was considered "unsatisfactory".

Data were analysed by using Statistical Package for Social Sciences, Version 11 (SPSS, v11) software. A paired t-test was used to determine if the mean values were significantly different for the two tooth groups. McNemar's test of significance was performed to further determine the degree of significance.

RPD wearers were evaluated as a group and a General Linear Model procedure was used to test for differences between abutment teeth in RPDs wearers and non-wearers in caries and periodontal disease.

Analysis of variance test (ANOVA) was used to test the relation between the status of the existing partial denture and caries and periodontal disease. Level of significance was set at  $P < 0.05$ .

## Results

A total of 2625 patients, 1180 male, 1445 female, were treated in prosthetic clinic, over a 6 months period, from September 2008 to March 2009. One hundred-thirty one partially edentulous subjects matched the specific study criteria. Ninety-six of whom (53 females, 43 males) accepted to participate in this study, completed the questionnaire and underwent the clinical prosthetic and periodontal examination.

There were 38 (39.6%) partially edentulous with no RPD experience and 58 (60.4%) RPD wearers (32 (33.3%) with unsatisfactory, 26(27.1%) with satisfactory dentures). The mean age of the participants was  $52.01 \pm 10.13$  years, 55.2% were females. The mean age of existing prostheses was  $2.94 \pm 2.43$ , with a range between 6 months and 12 years. Table I shows age, gender and existing teeth distribution of partially edentulous subjects according to RPD wearing.

Table II compares between denture wearers and non-wearers in regard to caries and other periodontal scores. Partial denture wearers had more coronal and root surface caries compared to non-denture wearers.

The differences were significant ( $p < 0.05$  and  $p < 0.001$ , respectively). However, periodontal variables showed no significant differences between the two groups.

Table III shows that subjects who had problem(s) with their RPDs had significantly more attachment loss and pocket depth compared with those who wore satisfactory RPDs ( $p < 0.05$ ).

Table IV shows that in non-wearers, there are no differences between abutment and non-abutment teeth in all recorded oral variables. However, wearing RPDs had seriously affected the oral health status. Abutment teeth had significantly higher levels of caries and periodontal diseases when compared to non abutment teeth. There was a significant difference in caries scores, with abutment teeth having higher mean score for root surface caries ( $p < 0.001$ ).

Table V shows that those whose dentures had problems had higher scores of gingival recession ( $p < 0.05$ ) and loss of attachment ( $p < 0.01$ ). Subjects wearing satisfactory RPDs had significantly greater coronal and root surface caries scores than did the non-wearers ( $p < 0.0001$ ). In addition, non-wearers tended to have less levels of caries or periodontal disease than RPD wearers.

## Discussion

Comparing oral health status of subjects who did not wear RPDs with RPD wearers, it was found that non-wearers had significantly less caries and periodontal disease than RPD wearers. In addition, they obviously had lower scores of coronal and root surface caries ( $p < 0.001$ ). These findings have been reported previously.<sup>(15,20,23,40)</sup>

When remaining natural teeth of non-RPD wearers were compared with abutment teeth of subjects wearing satisfactory RPDs. These findings, again, emphasized the adverse effects of RPDs in causing caries development especially on abutment teeth. On the other hand, satisfactory RPDs would not cause periodontal breakdown of teeth-supporting tissues, i.e. RPDs cause additional carious lesions but not periodontal damage. The results of the present study are consistent with others reported in previous studies.<sup>(7,9,11, 26-28)</sup>

Differences in the pattern of periodontal disease between RPD wearers and non-wearers were rather small and the two groups showed similarities in periodontal scores, however, teeth of RPD wearers had significantly more coronal and root surface caries than the non-wearers. This is also similar to what was reported with other studies that RPDs

**Table I.** Age, gender, and existing natural teeth distribution of the participants according to removable partial denture wearing

	Denture wearers	Non-denture wearers	Total
<b>Age</b>			
Mean $\pm$ SD	52.09 $\pm$ 10.39	52.11 $\pm$ 9.85	52.09 $\pm$ 10.13
range	29-74	34-71	29-74
<b>Gender</b>			
Male/Female (Total)	25/33 (58)	18/20 (38)	43/53 (96)
<b>Teeth present</b>			
Mean $\pm$ SD	17.33 $\pm$ 3.11	16.76 $\pm$ 2.61	17.10 $\pm$ 2.92
Range (Total)	10-24 (1005)	12-22 (637)	10-24 (1642)
<b>Abutment teeth Mean</b>			
$\pm$ SD	4.59 $\pm$ 0.75	4.45 $\pm$ 0.95	4.53 $\pm$ 0.83
Range (total)	4-6 (266)	2-6 (169)	2-6 (435)
<b>Non abutment teeth</b>			
Mean $\pm$ SD	12.74 $\pm$ 3.51	12.32 $\pm$ 3.21	12.57 $\pm$ 3.39
Range (Total)	4-20 (739)	6-18 (463)	4-20 (1202)

SD: standard deviation

**Table II.** The mean difference of caries and periodontal scores between partial denture wearers and non-wearers

	Coronal Surface caries	Root surface caries	Gingival recession	Pocket depth	Loss of attachment	Mobility
RPD wearers (1005)	0.023	0.025	1.30	1.90	3.20	0.96
Non-denture wearers (632)	0.0078	0.0072	1.00	1.51	2.74	0.60
P value	0.0308	0.000743	0.421	0.136	0.0760	0.252
Significance	*	**	NS	NS	NS	NS

RPD: Removable partial denture, NS: Not significant \* $p < 0.05$ , \*\* $p < 0.001$  (McNemar's Test)

**Table III.** The mean difference of caries and periodontal scores between subjects wearing satisfactory and unsatisfactory RPDs

RPD wearers	Coronal caries	Root surface caries	Gingival recession	Pocket depth	Loss of attachment	Mobility
"Unsatisfactory" (553)	0.023	0.026	1.55	1.96	3.58	1.06
Satisfactory (452)	0.022	0.023	0.98	1.73	2.71	0.86
P value	0.953	0.844	0.0481	0.646	0.0293	0.685
Significance	NS	NS	*	NS	*	NS

RPD: Removable partial denture, NS: not significant \* $P < 0.05$  (McNemar's Test)

increase the likelihood of incidence of new caries and recurrent caries.<sup>(3,10,19,21)</sup>

When teeth of RPDs wearers with problems were compared with those of satisfactory RPD wearers, significant differences existed between the two groups. Denture wearers with problem partials had significantly higher scores of gingival recession and attachment loss than wearers with satisfactory RPDs. This may indicate that it was not the denture that was related to a difference in two periodontal conditions, namely, gingival recession and attachment loss. On the other hand, there were no significant differences between the two groups regarding coronal and root surface caries, pocket depths and teeth mobility. Therefore, it appears that RPDs affect caries and periodontal status, but not gingival recession and pocket depth when they are judged as "satisfactory". Denture faults are common causes of gingival inflammation and periodontal destruction,<sup>(9)</sup> poor denture stability may result in impingement of underlying tissues or injury to residual alveolar ridges and trauma to the periodontal support of abutment teeth.<sup>(10)</sup> Stanford considered the use of

implants in combination with RPDs in a compromised dentition to provide greater support and enhance retention of prostheses, so that the adverse effects RPDs on oral health can be reduced.<sup>(41)</sup> In addition, dental literature have focused on the importance of designing RPDs and their role in minimizing the unwanted effects on oral health.<sup>(30)</sup> Denture designs should be as simple as possible to achieve the task without adversely affecting the patient's oral health.<sup>(8,31,32)</sup>

Previous studies on patients who received RPDs and were provided with oral hygiene instruction and seen at regular intervals for recall appointment for both scaling and polishing of teeth and adjusting the RPDs reported that the RPD *per se* did not cause additional disease.<sup>(42,43)</sup> It would appear that these earlier studies were attempting to understand the relationships discovered in this study that appear to affect both caries and periodontal disease. On the other hand, even if the RPD is satisfactory, the patient must understand that there is a greater risk of caries. Therefore professional recall and good oral self care are important to reduce such a risk. The

**Table IV.** The mean difference of caries and periodontal scores between abutment and non abutment teeth in RPD wearers and non wearers

Partially edentulous	Coronal caries	Root surface caries	Gingival recession	Pocket depth	Loss of attachment	Mobility
(a) Non-wearers						
Non abutment (463)	0.0077 (0.01)	0.0069 (0.016)	1.015 (0.86)	1.53 (0.79)	2.55 (1.36)	0.59 (0.63)
Abutment (169)	0.0081 (0.018)	0.0082 (0.020)	0.99 (0.71)	1.45 (0.76)	2.45 (1.91)	0.64 (0.67)
P value	5.18	3.02	1.44	0.781	0.643	0.886
Significance	NS	NS	NS	NS	NS	NS
(b) Wearers						
Non abutment (739)	0.0092 (0.019)	0.0080 (0.021)	1.028 (0.89)	1.54 (0.75)	2.57 (1.33)	0.67 (0.59)
Abutment (266)	0.060 (0.042)	0.071 (0.043)	2.050 (0.95)	2.89 (0.71)	4.94 (1.30)	1.78 (0.63)
P value	0.00813	0.000775	0.0455	0.0392	0.0428	0.0336
Significance	**	***	*	*	*	*

NS: Not Significant \*  $P < 0.05$  \*\*  $P < 0.01$  \*\*\*  $P < 0.001$  (McNemar's test)

**Table V.** ANOVA table for caries and periodontal scores of abutment teeth in subjects wearing "satisfactory", "unsatisfactory" RPDs and in non-wearers

Denture status	Coronal caries	Root surface caries	Gingival recession	Pocket depth	Loss of attachment	Mobility
Mean scores for General Linear Model						
"Unsatisfactory" RPD wearer	0.033	0.039	1.78	2.31	4.15	1.30
"Satisfactory" RPD wearer	0.036	0.040	1.24	2.04	3.27	1.14
Non-wearer	0.0079	0.0076	1.00	1.49	2.50	0.62
P Values						
"Unsatisfactory" RPD / "Satisfactory" RPD	NS	NS	0.05	NS	0.01	NS
"Unsatisfactory" RPD / Non-wearer	0.0001	0.0001	0.01	0.05	0.001	0.01
"Satisfactory" RPD / Non-wearer	0.0001	0.0001	NS	NS	NS	NS

(Periodontal scores are given in mm). RPD: Removable Partial Denture; NS: Not Significant

importance of oral and denture hygiene has been emphasized by several investigators.<sup>(3,9,44,45)</sup>

In non-wearers, teeth located just next to edentulous spaces (considered equivalent to abutments) were found to have similar scores of caries and periodontal diseases compared to other teeth. For RPD wearers in this study, abutment teeth were more likely to have caries and periodontal conditions than other teeth in the same individual. The wire clasps around abutment teeth promote the accumulation of plaque,<sup>(7,9,15,19,27,29,32,45)</sup> which could lead to the development of caries.<sup>(3,20)</sup>

Clasps can also transmit detrimental forces to abutment teeth and this could promote the development of periodontal disease.<sup>(19,32)</sup> However, for partially edentulous non-denture wearer subjects, the results showed that all remaining, non-abutment, natural teeth had no differences in caries and periodontal scores from the teeth considered equivalent to abutments. These findings are supported by many investigators.<sup>(8,9,21,31,32)</sup> In addition, clasps may result in excessive trauma to supporting tissues<sup>(5,7,8,17,28,40)</sup> and cause abutment

teeth mobility,<sup>(8,9,21,31,32)</sup> due to the added lateral forces.<sup>(19,32)</sup> In addition to increasing caries development particularly of root surface<sup>(3,20)</sup> and on abutment teeth.<sup>(2,11,45)</sup>

In spite of the adverse effects of RPDs on oral health, their advantages and benefits have been reported in dental literature.<sup>(10,15,18,20-22,24,40,44)</sup> Acrylic RPD used in this study, generally, had wire clasp direct retainers, acrylic resin base and major connector components with artificial teeth. This type of prosthesis lacks vertical support with poor load distribution, a lack of major connector strength and rigidity. In addition, excessive tissue coverage which contributes to significant potential adverse tissue effects.<sup>(33)</sup> It has been reported that this type of prosthesis should only be used for short-term replacement only, 3 months or less.<sup>(1)</sup> On the other hand, an earlier study showed that wearing of dentures for 3 months resulted in healthy tissue and that the denture-wearing appeared to stimulate keratinisation.<sup>(36)</sup> However, later studies have reported that severe changes were noted at 6 months of RPD wearing.<sup>(27,46)</sup>

Although conventional RPDs are constructed with cast metal frameworks, there are occasions when it is appropriate to provide dentures made entirely in acrylic resin. The main advantages of acrylic dentures are their relatively low cost and the ease with which they can be modified. They are therefore most commonly indicated where the life of the denture is expected to be short or where alterations such as additions or relines might be needed. Both of these reasons may make the expense of a metal denture difficult to justify.<sup>(23)</sup>

The results of the present study showed a wide age range of the included participants, most of whom were in the sixth decade of life and there were minimal differences in the mean age between RPD wearers and non-wearers. However, in terms of gender differences, it was found that 55.2% of the participants were females, this could be partly explained by the fact that more females attended dental clinics and seek treatment compared to males, this predilection of women over men is more likely due to higher incidence of tooth loss,<sup>(26)</sup> denture-induced hyperplasia<sup>(6)</sup> and stomatitis<sup>(5)</sup> among women.

Tooth loss increases with age and older patients had more missing teeth.<sup>(2)</sup> The consequences of partial tooth loss and failure to replace missing teeth with artificial substitutes have been extensively reported in the literature,<sup>(1,2,11-19)</sup> however, There appears to be a clear connection between oral and dental health status of partially dentate individual and wearing RPDs.

Numerous studies report that wearing RPD prostheses can increase the risk of caries and periodontal disease. This is the “biological cost” of wearing a removable prosthesis.<sup>(1,22,23)</sup>

The findings of the present study could be from the use of poorly wire-clasp supported, acrylic based RPDs which retain more plaque and exert destructive forces on the abutment teeth. In addition to the fact that more than 55% of RPD wearers had one or more denture faults in retention, stability, occlusion and/or material.

Further studies on a larger sample and including other factors; such as oral and denture hygiene measures, gender differences, general health status may be needed to verify the results of this study.

## Conclusion

Wearing of RPDs increased coronal and root surface caries. Subjects who wore RPDs with one or more problems; such as non-retention, unstability, poor occlusion and/or deteriorated material or those

causing mucosal lesions, increased gingival recession and caused loss of attachment compared to those wearing satisfactory RPDs. Abutment teeth appeared to suffer the most deleterious effects, with significantly higher scores of caries and periodontal diseases than other teeth in the same person. Partially edentulous, non-RPD wearers had the least caries and periodontal scores compared to RPD wearers.

## References

1. **Bowley J.** Minimal intervention prosthodontics: Current knowledge and societal implications. *Med Principles Pract* 2002; 11: 22–31.
2. **Petersen PE, Yamamoto T.** Improving the oral health of older people: the approach of the WHO Global Oral Health Programme. *Community Dent Oral Epidemiol* 2005; 33: 81–92.
3. **Wöstman B, Budtz-Jørgensen E, Jepson N, Mushimoto E, Palmqvist S, ASofa A, et al.** Indications for removable partial dentures: A literature review. *Int J Prosthodont* 2005; 18: 139–145.
4. **Jones JA, Orner MB, Spiro A, Kressin NR.** Tooth loss and dentures: patients’ perspectives. *Int Dent J* 2003; 53: 327–334.
5. **Davenport JC.** The oral distribution of candida in denture stomatitis. *Br Dent J* 1970; 129: 151–156.
6. **Ralph JP, Stenhouse D.** denture-induced hyperplasia of the oral soft tissues *Br Dent J* 1972; 132: 68–70.
7. **Lechner SK.** A longitudinal survey of removable partial dentures. III. Tissue reactions to various denture components. *Aust Dent J* 1985; 30: 291–295.
8. **Feingold GM, Grant AA, Johnson W.** The effect of partial denture design on abutment tooth and saddle movement. *J Oral Rehabil* 1986; 13: 549–557.
9. **Vacaru R, Podariu AC, Jumanca D, Galuscan A, Muntean R.** Periodontal-restorative interrelationships. *Oral Health Dent Med Bas Sci* 2003; 3: 12–15.
10. **Jin X, Sato M, Nishiyama A, Ohyama T.** Influence of loading positions of mandibular unilateral distal extension removable partial dentures on movements of abutment tooth and denture base. *J Med Dent Sci* 2004; 51: 155–163.
11. **Bates JF.** *Removable partial dentures construction.* 2<sup>nd</sup> ed. Bristol: John Wright and Sons Ltd. 1978.
12. **Chan MF, Adams D, Brudvik JS.** The swing-lock removable partial dentures in clinical practice. *Dent Update* 1998; 25: 80–84.
13. **Al-Jabrah OA, Al-Shumailan YR.** Prevalence of temporomandibular disorder signs in patients with complete versus partial dentures. *Clin Oral Investig* 2006; 10: 167–173.
14. **Tallents RH, MacherDJ, Kyrkanides S, Katzberg RW, Moss ME.** Prevalence of missing posterior

- teeth and intraarticular temporomandibular disorders. *J Prosthet Dent* 2002; 87: 45-50.
15. **Davenport JC, Basker RM, Heath JR, Ralph JB, Glantz P-O.** A clinical guide to removable partial dentures. The removable partial denture equation. *Br Dent J* 2000; 189: 414-424.
  16. **Wright SM.** Prosthetic practice in the National Health Services: Partial dentures. *Dent Update* 1992; 19: 424-429.
  17. **Donovan T, Derbabian K, Kaneko L, Wright R.** Aesthetic considerations in removable prosthetics. *J Esthet Restor Dent* 2001; 13: 241-253.
  18. **Dosumu OO, Dosumu EB, Arowojolu MO, Babalola SS.** Rehabilitative management offered Nigerian localized and generalized aggressive periodontitis patients. *J Contemp Dent Pract* 2005; 3: 40-52.
  19. **Bazigran MK, Bates JF.** Effect of clasp design on gingival health. *J Oral Rehabil* 1987; 14: 271-281.
  20. **Davenport JC, Basker RM, Heath JR, Ralph JP, Glantz P-O.** A clinical guide to removable partial dentures. Need and demand for treatment. *Br Dent J* 2000; 189: 364-368.
  21. **Mizuuchi W, Yatabe M, Sato M, Nishiyama A, Ohyama T.** The effects of loading locations and direct retainers on the movements of the abutment tooth and denture base of removable partial dentures. *J Med Dent Sci* 2002; 49: 11-18.
  22. **Mazurat NM, Mazurat RD.** Discuss before fabricating: Communicating the realities of partial denture therapy. Part II: Clinical outcomes. *J Can Dent Assoc* 2003; 69: 96-100.
  23. **Davenport JC, Basker RM, Heath JR, Ralph JB, Glantz P-O, Hammond P.** A clinical guide to removable partial dentures. Connectors. *Br Dent J* 2001; 190: 184-191.
  24. **Porto VC, Kazniakowski RAB, Baggio FB, Conti PCR.** Alternative esthetic and cost-effective therapy using a removable partial overdenture for the treatment of a patient with class III malocclusion. *Braz J Oral Sci* 2006; 5: 985-990.
  25. **Hobkirk JA, Strahan JD.** The influence on the gingival tissues of prostheses incorporating gingival relief areas. *J Dent* 1979; 7: 15-21.
  26. **Dorey JL, Blasberg B, MacEntee MI, Conklin RJ.** Oral mucosal disorders in denture wearers. *J Prosthet Dent* 1985; 53: 210-213.
  27. **Cook RJ.** Response of the oral mucosa to denture wearing. *J Dent* 1991; 19: 135-147.
  28. **Sesma N, Lagana DC, Morimoto S, Gil C.** Effect of denture surface glazing on denture plaque formation. *Braz Dent J* 2005; 16: 129-134.
  29. **Kern M, Wagner B.** Periodontal findings in patients 10 years after insertion of removable partial dentures. *J Oral Rehabil.* 2001; 28: 991-997.
  30. **Zlatarić DK, Celebić A, Valentić-Peruzović M.** The effect of removable partial dentures on periodontal health of abutment and non-abutment teeth. *J Periodontol.* 2002; 73: 137-144.
  31. **Bates JF.** Retention of partial dentures. *Br Dent J* 1980; 149: 171-174.
  32. **Petridis H, Hempton TJ.** Periodontal considerations in removable partial denture treatment: A review of the literature. *Int J Prosthodont* 2001; 14: 164-172.
  33. **Bissada NF, Ibrahim SI, Barsoum WM.** Gingival response to various types of removable partial dentures. *J Periodontol.* 1974; 45: 651-659.
  34. **Watson IB.** The effect of complete dentures on oral mucosa. *J Dent* 1978; 6: 171-178.
  35. **Sabri R.** Management of missing maxillary lateral incisors. *J Am Dent Assoc* 1999; 130: 80-84
  36. **Kapur K, Shklar G.** The effect of complete dentures on alveolar mucosa. *J Prosthet Dent* 1963; 13: 1030-1037.
  37. **Newman, Takei, Carranza.** *Carranza's textbook of clinical periodontology.* 9<sup>th</sup> ed. W. B. Saunders Co. 2002.
  38. **Grant DA, Stern IB, Listgarten MA.** *Periodontics.* 6<sup>th</sup> ed. C. V. Mosby Company: St. Louis. 1988.
  39. **Miller SC.** *Textbook of periodontia.* The Blakeston Co: Philadelphia. 1950.
  40. **Davenport JC, Basker RM, Heath JR, Ralph JP, Glantz P-O, Hammond P.** A clinical guide to removable partial dentures. Initial prosthetic treatment. *Br Dent J* 2001; 190: 235-244.
  41. **Stanford CM.** Dental implants: A role in geriatric dentistry for the general practice? *J Am Dent Assoc* 2007; 138; 34-40.
  42. **Akaltan F, Kaynak D.** An evaluation of the effects of two distal extension removable partial denture designs on tooth stabilization and periodontal health. *J Oral Rehabil* 2005; 32: 823-829.
  43. **Reshad M, Jivraj S.** The influence of posterior occlusion when restoring anterior teeth. *J Can Dent Assoc* 2008; 36: 567-574.
  44. **Akar GC, Ergül S.** The oral hygiene and denture status among residential home residents. *Clin Oral Invest* 2008; 12: 61-65.
  45. **Moimaz SAS, Saliba NA, Saliba O, Zina LG, Bolonhez MRC.** Association between dental prosthesis and periodontal disease in a rural Brazilian community. *Braz J Oral Sci* 2006; 5: 1226-1231.
  46. **van Mens PR, Pinkse-Veen MJ, James J.** Histological differences in the epithelium of denture-bearing and non-denture-bearing human palatal mucosa. *Archs Oral Bio* 1975; 20: 23-27.