Patient Satisfaction and Radiographyical Evaluation of Acetal Resin Retentive Clasp Arm versus Conventional Clasp on Abutment Teeth in Upper Unilateral Removable Partial Dentures

Faten A. Abu Taleb[1], Ibrahim R. Eltorky[1], Mohamed M. El-Sheikh[1], Shereen Abdel Moula[2]

[1] Department of Prosthodontics, Faculty of Dentistry, Tanta University, Egypt
[2]Department of Oral medicine, Periodontology, Oral Diagnosis & Radiology Department, Faculty of Dentistry, Tanta University, Egypt
drafaten@hotmail.com

Abstract: Restoration of esthetics is an important function of removable partial denture (RPD) and it determines the success of the treatment. The goal of achieving optimal esthetics, while maintaining retentive integrity, stability, and protecting the health of the tooth is the most difficult task. The aim of this study to evaluate and compare through patient satisfaction and radiographyically between cobalt chromium clasp and acetal resin retentive arm clasp on the abutment teeth. Fourteen female patients aged thirty to forty five years old had unilateral upper free end saddle & the second premolar is the Last standing tooth with almost intact opposing natural teeth were divided randomly into two groups, seven patients in each. The first group received chrome cobalt removable partial dentures with fully metal R P I clasp on the second premolar of the free end side with double Aker clasp on the first & second molar & cingulum rest at canine on the sound side connected together by palatal plate major connector. While the second group , the R P I retentive arm was made from acetal resin. Aappraisal of questionnaire ranks showing the patient's appreciation towards both treatment modalities and radiographic evaluation of bone density around abutments were evaluated at insertion, six and twelve months. All patients responded to most of the statements of satisfaction questionnaire with high satisfaction for the treatment. Patients of group II strongly agreed the treatment more than Group I patients .The bone density around abutment teeth was decreased at follow up period of both groups ,but the first group was highly significant than the second group , In comparing the mean difference of the two groups ,there was significant difference during follow up period.**[**Faten A. Abu Taleb[1], Ibrahim R. Eltorky[1], Mohamed M. El-Sheikh[1], Shereen Abdel Moula[2] **Patient Satisfaction and Radiographyical Evaluation of Acetal Resin Retentive Clasp Arm versus Conventional Clasp on Abutment Teeth in Upper Unilateral Removable Partial Dentures.** *J Am Sci* 2013;9(5):425-432]. (ISSN: 1545-1003). http://www.americanscience.org. 55

Key wards: Cobalt chromium – acetal resins - direct retainer- Retentive arm -bone density.

1. Introduction

Patient demands a removable partial denture (RPD) for health, anatomic, psychological, or financial reasons. Fabricating an esthetically pleasing RPD while avoiding the unsightly display associated with conventional clasp assemblies often presents a challenge to the dentist[1]. The traditional use of the metal clasp like cobalt chromium (Co-Cr), gold, stainless steel, and titanium hampers esthetics, since its obvious display conflicts with patient's prosthetic confidentiality. Methods to overcome this esthetic dilemma include the painting of clasps with tooth-colored resin, [2] use of lingually positioned clasps, [3,4] engagement of mesial rather than distal undercuts, [5] and use of gingival approaching clasps. Unless clasps can be avoided by using precision attachments, [6] some of the RPD framework will be invariably visible.

Synthetics, as well as metal alloys, are used, among other materials, in dentistry for denture fabrication. The most common denture materials are derived from methyl polymethacryl, which is classified as an acrylic substance [7]. Polyoxymethylene (POM) also known as acetal resin has been used as an alternative tooth-colored denture base and denture clasps material since 1986 and was promoted primarily for superior esthetic. Acetal resins (acetyl resin) are formed by polymerization of formaldehyde. Because of its compatibility, it was consider as RPD framework for patient with allergic reaction to co-chromium alloy [8].

Fitton tested some physical characteristics of POM (acetal resin) for dental use like the modulus of elasticity in compression, extension, and flexure, stress relaxation, force displacement behavior of clasp forms, impact strength, and glass transition temperature. Results showed that resin clasp may be resilient enough to engage the undercuts for the retention of RPD. But the low flexural modulus requires the resin to be used in greater cross-sectional area than the metal alloys in order to gain useful retention. This greater bulk has implication for plaque accumulation and maintenance of periodontal health. [9]

Clasps are used as direct retainers for the RPD. The flexible clasp tip engages the undercut of the abutment to provide retention. [10,11,12] The components of any clasp assembly must satisfy six biomechanical requirements: retention, stability, support, reciprocation, encirclement and passivity. [10,11] In addition, the clasp assembly must ideally not affect aesthetics adversely. Careful selection of

clasp position on the individual tooth, clasp type, clasps material, clasp location in the dentition and the number of clasps is important.

A clasp arm design producing less stress is important for predictable long-term use of an RPD. Three factors which are clasp material, clasp form, and the amount of undercut affect the design of a clasp arm.[14] Clasp form involves the elements of length, curvature, cross sectional dimension, and taper. Among these, the first 2 elements are determined by the abutment tooth contour, and the latter 2 elements are under the control of the dentist or technician. Furthermore, clasp form is associated with stress distribution, which affects fatigue and permanent deformation.[15] Poor fit may cause the decrease of retention and failure of RPD function.[16] However, the mechanical properties of a clasp material are generally determined by the alloy used.[17]

Retentive clasp arms must be capable of flexing and returning to their original form and should retain an RPD satisfactorily. The tooth should not be unduly stressed or permanently distorted during service and should provide esthetic results.[18]

It is reported that acetal resin have a sufficiently high resilience and modulus of elasticity to allow its use in the manufacture of retentive clasps, connectors, and support elements for RPDs. Retention clasps can be excellent with retainer that lock the remaining dentition, however they may subject abutment teeth to excessive stresses & premature tooth loss .Some clinicians aimed to reduce the weight of the prosthesis to minimize the damage to the abutment teeth, splinting some or all the abutment teeth to dissipate the forces .[8,9]

Arda and Arikan, simulated a 36-month clinical use of RPD clasps made of acetal resin and assessed their retentive force and deformation by comparison with similar clasps cast of Co-Cr. The result showed no deformation for the acetal resin clasp after 36 months of simulated clinical use unlike the Co-Cr clasp which presented an increase in the distance between the tips. However, the acetal resin clasps require less force for insertion and removal than Co-Cr clasps even after the simulated period. [19]

Retentive features as circumferential clasps and I-bars can be quite unaesthetic. Precision attachments may be used, but they require technique sensitivity. Aras and Chitre[20] presented various direct retainers that allow esthetically functional alternative for direct retainer assembly. One of these retainers was the thermoplastic "thermo flex" clasp, as they concluded that it brings many benefits of metal-free restorations without the pitfalls associated with acrylic. They flex around the largest tooth and use its superior elastic memory of engage deeper undercuts for a rigid functional load.

2. Materials and methods

Fourteen partially edentulous individuals (30-45 years) were selected from the Out- patient Clinic, Prosthetic Department, Faculty of Dentistry, Tanta University. They had maxillary unilateral distal free end edentulous area (Kennedy class II) with the second premolar as the last standing tooth. The upper jaw was almost with complete dentition.

They were having Angle's class I ridge relationship, sufficient inter-maxillary space, and a good oral hygiene. All should have no previous prosthetic management and should be free from any systemic diseases that might affect bone. All individuals were examined clinically and radio-graphically. Periapical radiographs were made for all abutment teeth and for the edentulous alveolar ridge. Occlusal analysis was also done to detect any premature contact or over-eruption, which was corrected by selective grinding. The patients were randomly divided into two equal groups, seven in each.

Group 1:

Patients had received upper removable partial denture with fully metal R P I clasp on the abutment tooth at the free end side and double Aker clasp on the first and second molar with cingulum rest on the canine of the healthy side joined to the saddle by palatal plate.

Group 2:

Patients had received removable partial denture with acetal resin retentive arm R P I clasp on the abutment tooth at the free end side and double Aker clasp on the first and second molar with cingulum rest on the canine of the healthy side joined to the saddle by palatal plate.

Construction of the removable partial denture

Study casts prepared from alginate impressions were surveyed, proximal surfaces of the abutment teeth were prepared parallel to the path of insertion to act as guiding planes. Following mouth preparation, final impressions were made using rubber base impression material in a custom tray (Figure1) .Master casts were surveyed, modified and duplicated. For the first group, wax pattern & casting was completed in the conventional manner. For the second group, the master casts were duplicated twice. One of the duplicate casts was made of stone used for constructing the wax pattern of the acetal resin retentive arm direct retainers. The other duplicate cast was made of investment used to construct the other parts of the direct retainer in chromo-cobalt in conventional manner. Wax pattern of acetal resin direct retainer were made in a special muffle. After the wax pattern was eliminated ,the acetal resin material was softened at 260 degree

centigrade & injected into the mold with a special injection gun .Pressure was maintained till the material cools . Clasp retentive arm was deflected, finished & polished, then seated on the master cast & mechanically attached to the metal framework by self-cure acrylic resin. (Figure2).The metal framework was tried for both groups. Maxillo mandibular relation was recorded, setting up of teeth & denture was tried in the patient's mouth. Lastly at insertion, stress the oral & hygienic measures for each patient (Figure 3).

The patient satisfaction (Heo *et al.*, 2008)[21].

The patients were asked to give their perception on the received partial denture and mention to aspects of satisfaction using a questionnaire. After informed consent was obtained, each patient was asked to fill out a satisfaction questionnaire regarding aspects of, comfort, esthetics, prosthesis loosening and general satisfaction. Responses to statements were given on the Likert response scale [22]. 5 = Strongly agree;4 = Agree;3 = Neither agree nor disagree;2 = Disagree;1 = Strongly disagree for each of these parameters. When the score for a variable was high, patients were more satisfied. The questionnaire was completed unaided by the subject.

Bone density measurements

A sensor which connected to the computer and the image was displayed immediately on the computer monitor after exposure, Orix X-ray machine (Orix – AET, ARDET, s.r.i., Milano, Italy), Rinn XCP periapical film holder (Rinn Corporation, XCP instrument, USA), and an individually constructed radiographic acrylic template were used for making standardized digital images for the maxillary partial denture abutments following the long cone paralleling technique. [23] The template was designed to receive the Rinn XCP film holder in a position palatal to the abutments and parallel to their long axes. The radiographic template with the bite block carrying the sensor chip was inserted in the patient's mouth. The bite block was assembled to the plastic aiming ring at the end of the cone by means of the indicator arm. The software of the Digora system was used for evaluation of the changes in the bone density of maxillary partial denture abutments. This was done by making a line on the distal surfaces of each maxillary partial denture abutment. The line extended from the crest of the alveolar ridge to the apex of the tooth and passed adjacent to the space of the lamina dura parallel to the surface of the root& 1mm away distally for each abutment. The value indicating bone density along the line was recorded

Statistical analysis was carried out using the statistical analysis system program (SAS). Paired t-test was used at $p \leq 0.05$ to assess the changes in bone density within each group at partial denture insertion, 6 and 12 months from insertion. Student t-test was used to compare between the two groups.

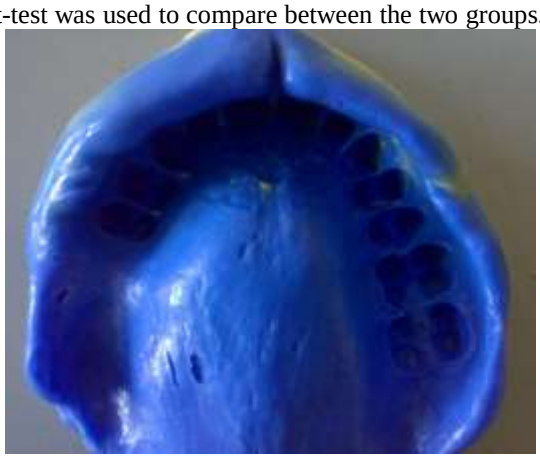


Figure1: Rubber base impression material in a custom tray

Figure 2: Finished partial denture

Figure3: Finished denture in patient mouth

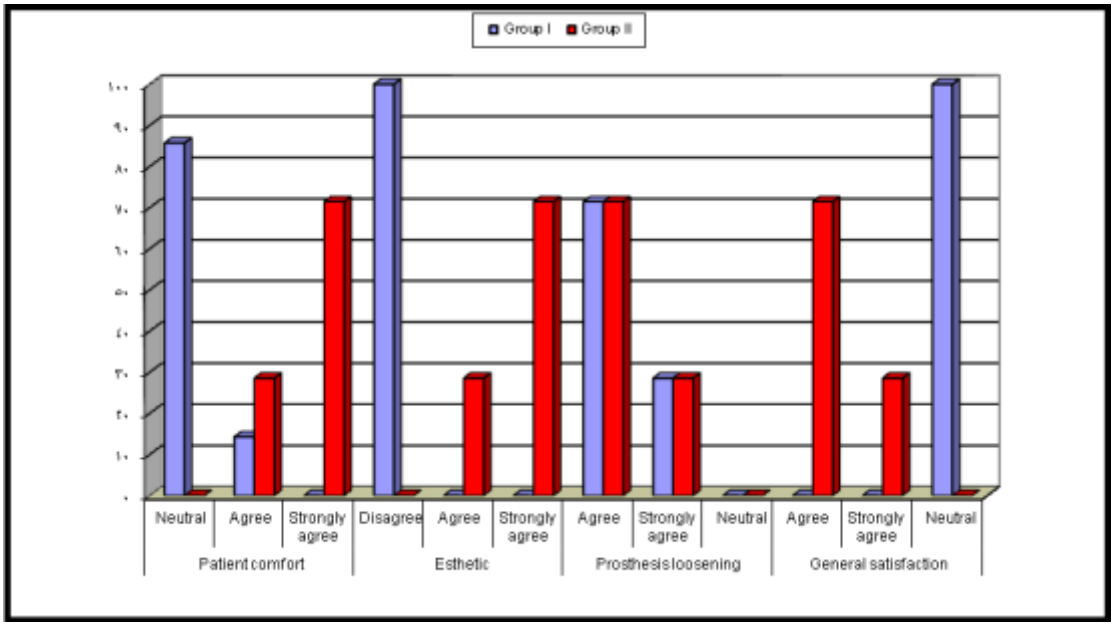
3. Results

The patient satisfaction as regards patient comfort, esthetic, prosthesis loosening and general satisfaction was evaluated. The percentage of the patients agree the treatment was high in group II than in group I (Table 1 and Graph 1).There was significant difference between two the groups, as $p \leq 0.005$ in all patient questionnaire except prosthesis loosening there was insignificant difference.

Table: 1 Showing the patient satisfaction of groups 1 and 2

Patient satisfaction		Group I		Group II		Chi-square test	
		No.	%	No.	%	X^2	*P*-value
Patient comfort	Neutral	6	85.71	0	0.00	11.333	0.003*
	Agree	1	14.29	2	28.57		
	Strongly agree	0	0.00	5	71.43		
Esthetic	Disagree	7	100.00	0	0.00	14.000	0.001*
	Agree	0	0.00	2	28.57		
	Strongly agree	0	0.00	5	71.43		
Prosthesis loosening	Agree	5	71.43	5	71.43	0.000	1.000
	Strongly agree	2	28.57	2	28.57		
	Neutral	0	0.00	0	0.00		
General satisfaction	Agree	0	0.00	5	71.43	14.000	0.001*
	Strongly agree	0	0.00	2	28.57		
	Neutral	7	100.00	0	0.00		

$P \leq 0.005$:* significant



Graph 1: Showing the patient satisfaction of group1 and 2

Radigraphyically

For group 1 ,there was highly significant bone reduction and in group 2 there was significant bone reduction but fewer than group 1. As the mean and standar deviation of group 1 was 180.73±4.37 at baseline ,142.66 ±6.15 at 6 months and 110.34 at 12 months.While in group 2 the mean and standar deviation was 132.49±6.13, 121.01±6.60 and 113.5.08±5.71 at baseline, 6months and 12 months rspectively. (Figures 4 and 5,Table 2, Graph 2).

Fig. 4: Densitometric measurement of the alveolar bone with the Digora software of the first group.

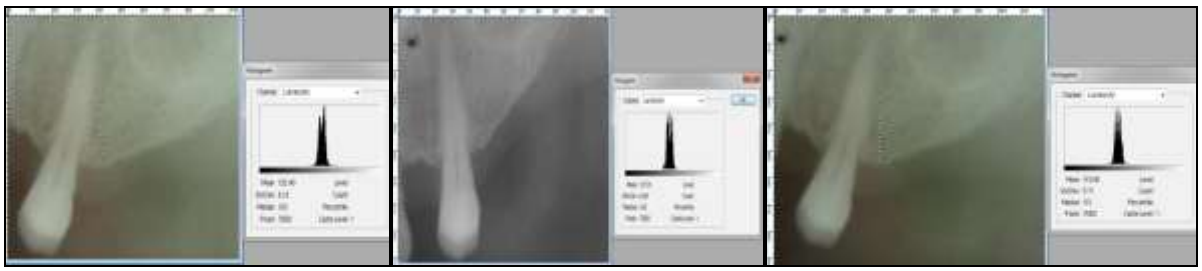
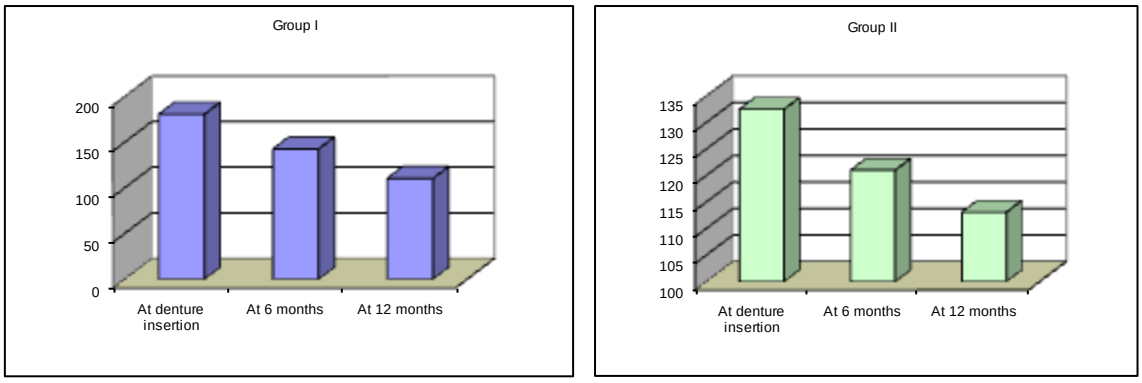


Fig. 5: Densitometric measurement of the alveolar bone with the Digora software of the second group

Table 2: showing the reduction in bone denesity in group 1 and group2 at follow upperiod.

Bone density	Group I Mean±SD	Group II Mean±SD	t-test	*p*-value
At denture insertion	180.73±4.37	132.49±6.13	16.954	0.000
At 6 months	142.66±6.15	121.01±6.60	6.350	0.000
At 12 months	110.34±5.05	113.08±5.71	0.951	0.360
P –value (at insertion & 6 months)	0.000	0.005		
P –value (at insertion & 12 months)	0.000	0.000		
P –value (6 months & 12 months)	0.000	0.023		

$P < 0.05$: Significant $P < 0.01$: Highly significant

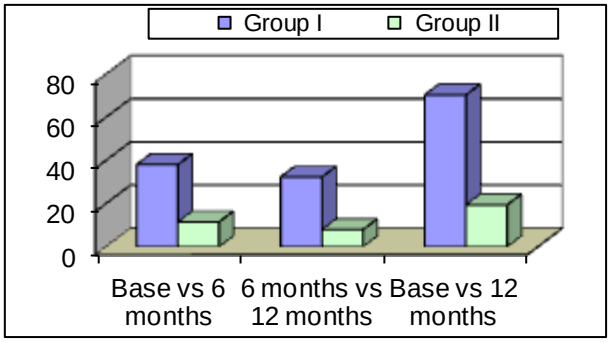


Graph 2 showing the reduction in bone denesity in group 1 and group2 at follow upperiod.

In comparing the mean difference between the two groups, there was significant difference at the follow up period.

Table 3. Showing the mean difference between groups 1 and 2 at follow up period.

	Group I Mean±SD	Group II Mean±SD	t-test	*p*-value
Base vs 6 months	38.07±2.852	11.48±3.41	15.825	0.000
6 months vs 12 months	32.32±3.1	7.93±3.166	14.563	0.000
Base vs 12 months	70.39±2.524	19.41±3.166	33.312	0.000



Graph 3: Showing the mean difference between group 1 and group2 at follow up period.

4.Discussion

In this study fourteen female patients with maxillary class II (Kennedy classification) with missing first and second molar were selected and their age ranging from 30-45 years. Female patients were selected in this study so that the measurements for amount of bone loss would not be contributed to any sexual variation. Related factor[24,25]**.** Also, selection of patients with the same age eliminate its effect on biting force and bone metabolism[26,27]**.** The opposing arch in all selected patients was either dentulous or partially edentulous restored with fixed prosthesis to standardize the effect of opposing occlusion and their effect on force transmission[28,29]**.**

The possible use of polyacetal resin as a denture base material was considered by Smith over 40 year's ago[30] and was promoted primarily on the basis of superior esthetics, which allowed the clasp to better match the color of the abutment tooth. [8] Acetal as a homo-polymer has good short-term mechanical properties, but as a co-polymer has better long-term stability. Acetal resin is very strong, resists wear and fracturing, and is quite flexible. These characteristics make it an ideal material for pre-formed clasps for partial dentures, single pressed unilateral partial dentures, partial denture frameworks, provisional bridges, occlusal splints, and even implant abutments. Acetal resins resist occlusal wear.[31]

Retentive clasp arms must be capable of flexing and returning to their original form and should retain an RPD satisfactorily. The tooth should not be unduly stressed or permanently distorted during service and should provide esthetic results.[18] acetal resin have a sufficiently high resilience and modulus of elasticity to allow its use in the manufacture of retentive clasps, [8,9] The ideal RPD design principle is to transfer forces that are applied to removable partial dentures to the supporting teeth and tissue in an a traumatic fashion.[32,33].

The results of this study regarding the patient questionnaires indicate that acetal resin clasps were accepted by all patients due to its reduced volume, esthetic and flexible clasps. Such a removable denture is a comfortable solution for partial edentulous patient, achieving the principles of static and dynamic maintenance and stability[8,18,35]

A major concern with the use of a distal-extension removable partial denture (RPD) is the control of excessive torquing forces that may act on the abutments distally towards the edentulous area and by time lead to distal wall resorption and tooth movement[34] .So abutment distal wall evaluation is of concern to study the clasp effect on abutment teeth.

In the present study, the bone density of both groups was significantly decreased and this attributed to the effect of partial denture on the abutment .The reduction of bone density of the second group was fewer than the first group due to load distribution over teeth and acetal resin clasp flexibility which transmit less stress to the abutment compared to metal clasp and at the same time there was good bracing from the other rigid metallic components of the clasp. The force required to remove acetal clasp was significantly lower than that with chrom- cobalt clasp [19], [36]

Conclusion

It is always a challenge to obtain optimal esthetics while maintaining retention, stability, and healthy tooth structure with cast partial dentures. Acetal resins are highly versatile engineering polymers that bridge the gap between metals and ordinary plastics. Because they offer the strength of metal and the flexibility and comfort of plastic, they make an ideal material for the fabrication of dental prostheses, particularly clasps. They are monomer free and offer an innovative and safe treatment alternative for patients who are allergic to conventional resins. For patients who do not wish to have metal in their mouth, for cases where no preparation of teeth is desired, or in periodontally compromised cases where minimum stresses onto the abutments are desired, acetal resin partial and removable

bridges offer a vastly expanded range of applications.

References

1. Moreno de Delgado M, Garcia LT, Rudd KD. Camouflaging partial denture clasps. J Prosthet Dent. 1986; 55:656-560.
2. Ozcan M. The use of chair side silica coating for different dental applications: a clinical report. J Prosthet Dent .2002; 87:469-472.
3. Highton R, Caputo A, Matyas J. Force transmission and retentive capabilities utilizing labial and palatal I-bar partial dentures. J Oral Rehabil .1987; 14:489-499.
4. Pardo-Mindan S, Ruiz-Villandiego JC. A flexible lingual clasp as an aesthetic alternative: A clinical report. J ProsthetDent.1993; 69:245-246.
5. Chow TW, Clark RK, Clarke DA *et al.* A rotational path of insertion for Kennedy- Class IV removable partial dentures. Br Dent J.1988; 164:180-183.
6. Prieskel HW. Precision Attachments in Dentistry In: PreiskelH.W.editor. Precision Attachments in Dentistry, 3rd ed. London: Henry Kimpton Ltd; 1979.
7. Aleksandruk G., Frączak B., SzymaniakL *et al.* Adhesion of *Candida albicans*to solid acrylic surfaces and soft denture-lining. Protet. Stomatol 2003; 53: 44–49.
8. Turner JW, Radford DR, Sherriff M. Flexural properties and surface finishing of acetal resin denture clasps. J Prosthet 1999; 8:188-195.
9. Fitton JS, Davies EH, Howlett JA, etal. The physical properties of a polyacetal denture resin. Clin Mater .1994; 17:125-129.
10. Beaumont, AJ. An Overview of Esthetics with RPDs. Quintessence Int .2002; 33:747-755.
11. McGivney, GP. Carr, B. McCracken's. Removable Partial Prosthodontics 10thed. St Louis: MosbyYear-Book; 106, 2000.
12. Owen, CP. Fundamentals of Removable Partial Dentures 2nded. Cape Town: UCT Press.28, 2000;
13. Budtz-Jørgensen, E. Bochet, G. Grundman, *et al.* Aesthetic Considerations for the Treatment of Partially Edentulous Patients with Removable Dentures. Pract Periodont Aesthet Dent. 2000; 12: 765-772.
14. Bates JF. The mechanical properties of the cobalt-chromium alloys and their relation to partial denture design. Br Dent J.1965; 119:389-396.
15. Earnshaw R. Fatigue tests on a dental cobalt-chromium alloy. Br Dent J.1961; 110:341-346.
16. Sato Y, Ae Y, Yuasa Y, *et al.* Effect of friction coefficient on Akers clasp retention. J Prosthet Dent.1997; 78:22-29.
17. Sato Y, Yuasa Y, Akagawa Y, *et al.* An investigation of preferable taper and thickness ratios for cast circumferential clasp arms using finite element analysis. Int J Prosthodont .1995; 8:392-397.
18. Kotake M, Wakabayashi N, Ai M *et al.* Fatigue resistance of titanium-nickel alloy cast clasps. Int J Prosthet.1997; 10:547- 552.
19. Arda T, Arikan A. An *in vitro* comparison of retentive force and deformation of acetal resin and cobalt chromium clasps. J Prosthet Dent .2005;94:267-274.
20. Aras M A .Chitre V Direct retainer: Esthetic solution in the smile zone. J Indian Prosthet Soc .2005; 5:4-9.
21. Heo YY, Heo JS, Chang WM, Park J. The patients' satisfaction following implant treatment. J Korean Acad Prosthodont.2008; 46:569-572.
22. Likert R, Wolfle D. standards for appraising psychological Research. Am Psycho1 J. 1949; 4:320-325.
23. Plotnick IJ, Beresin VE, Simkins AB. A technique for standardized serial dental radiographs. J Periodontol 1971; 42:297-309
24. August M, Chung K, Chang Y, Glowacki J." Influence of estrogen status on endosseousimplants integration". J Oral MaxillofacSurg.2001;59:1280-1285.
25. Drozdzowska B, Pluskiewicz W. Longitudinal changes in mandibular bone mineral density compared with hip bone mineral density and quantitative ultrasound at calcaneus and hand phalanges. British J ofRadiology.2002; 75: 743-748.
26. Miyaura K, Matuska Y, Morita M, etal.A Comparison of biting force in different age and sex groups. A study of biting efficiency with mobile and non-mobile teeth. J Oral Rehabil. 1999; 26: 223-228.
27. Atwood D. Some clinical factors related to rate of resorption of residual ridges. J Prosth Dent.2001;6: 1- 19.
28. Fahmy A, Abuelroos EM, Nada MM. "Effect of using attachment on implant supported distal extension lower partial overdentures." Cairo Dent J. 2008; 24:11-18.
29. Carr AB, Brown DT. McCracken's removable partial prosthodontics.12th ed. St Louis: CV Mosby. 2011:24.
30. Smith DC. Recent developments and prospects in dental polymers. J Prosthet Dent. 1962; 12:1066-1078.
31. Phoenix RD, Mansueto MA, Ackerman NA, *et al.* Evaluation of mechanical and thermal properties of commonly used denture base resins. J Prosthodont 2004;13:17-27.
32. Carr AB, McGivney CP, Brown DT. McCraken's Removable Partial Prosthodontics. 11th edn. Missouri: Mosby, 2005;35:, 67–68.
33. Phoenix RD, Cagna DR, Defreest CHF. Stewart's Clinical Removable Partial Prosthodontics. 3rd edn. Chicago: Quintessence, 2003:103–127.
34. A Shifman& Z Ben-Ur: the mandibular first premolar as an abutment for distal-extension removable partial dentures: a modified clasp assembly design.*British Dental Journal* .2000, 188: 246 - 248.
35. Bortun C, Lakatos S, Sandu L, Negrutiv M *et al.* Metal free removable partial dentures made of thermoplastic material, T M J; 2006, 56:80-87.
36. Jean C W , George H L , Russell A W ,R obert L S , Mark S 35.In vitro deformation of acetal resin and metal alloy removable partial denture direct retainer . J Prosthetic Dent .2003, 90: 586-596.