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Clinical and Radiographic Comparison between Acetal Resin and Cobalt-Chromium Partial Dentures in Kennedy's Class I Situations

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Abstract
Aim*: This study was conducted to compare the effect of different denture framework materials (Cobalt Chromium (Co-Cr) & acetal on bone resorption, gingival index, pocket depth and patien satisfaction in Kennedy's class I removable partial dentures.*
Subjects and methods: *Fourten partially edentulous patients with mandibular Class- I were selected. The patients were classified randomly into two group (seven patients in each group). Group 1: Patient received Class- I cobalt chromuim RPD. Group 2: Patient received Class- I acetal (flexible)RPD. Evaluation of bone resorption, gingival index, pocket depth and patient satisfaction was carried out radiographically and clinically at the time of insertion, six and twelve months later for each patient.*
Results*: Analysis of the results revealed significant difference between the two types of denture frameworks (P< 0.05) , the Co-Cr denture framework showed higher gingival index, pocket depth and bon resorption that increased by time. While for patient satisfaction acetal framework was higher.*
Conclusion: Within limitation of this study acetal partial denture framework had better biological effect on soft tissues and bone resoption than Co-Cr partial denture framework. Also, acetal resin more satisfactory for the patient.

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I. Introduction

Number of partially dentate adults is increasing, and many patients will require replacement of missing teeth. Loss of teeth, which may be due to trauma, dental diseases not only alters the psychological thought of the patients but also disturbs the esthetics, phonetics, and functional occlusion Replacement of missing teeth is highly essential in order to restore the defect and regain function as best as possible. Although current treatment options also include fixed partial dentures and implants, removable partial dentures (RPDs) can have advantages and are widely used in clinical practice. [(1-3)]

Although cobalt-chromium is widely considered the best material for a denture framework, the main problem of conventional metallic removable partial denture is that the rigid clasps damage the natural dentition as it engages the undercuts in addition to are not aesthetically pleasing and releasing of the toxic metallic ions that can lead to various adverse tissue reactions hypersensitivity reaction. Acetal resin can be used as an alternative denture base and clasp material instead of metal alloys and conventional denture base acrylic resins. Thermoplastic acetal has some additional properties as; superior aesthetics, high resistance to abrasion, excellent tensile and shock strength. high proportional limit with little viscous flow (enabling it to behave elastically over a large enough range to be used as a material for clasp fabrication[(4-6)]

Anumber of authoers evaluated the effects of acetal resin clasps on the abutment teeth supporting structures as compared to cobalt-chromium clasps. It was concluded that acetal resin clasps were superior to cobalt-chromium clasps as produced fewer reductions in bone height and in bone density around the abutment teeth inspite of produced increase in the crevicular fluid.[(7)]

Radiographically evaluation of the effect of distal extension removable partial denture either constructed from acetal and vitallium materials on bone height change of abutment teeth.It was concluded that thermoplastic mandibular distal extension removable partial denture material was superior to vitallium material regards to preservation of abutment alveolar bone.[(8)]

Insertion of a partial denture constitutes a risk factor for periodontal health and supporting alveolar bone of the remaining teeth. Hence, many design philosophies for distal extension cases can be developed to preserve the supporting structure from resorption [(9)]

Bone resorption, gingival index and pocket depth and patient satisfaction in Kennedy's class I removable partial dentures were evaluated in this study to compare between the effects of the cobalt-chromium and acetal..

II. Patients And Methods:

This study was a randomized clinical study. Forten partially edentulous (mandibular Kennedy class I) patients were selected for partial denture construction , from those attending the outpatient's clinic of Removable Prosthodontic Department, Faculty of Dental Medicine, Al –Azhar University, Cairo, Boys. Patients were ranging from 41-50 years old, free from any systemic disease or neuromuscular disorder that might affect their bite force, free from any temporo-mandibular joint disorder and with normal occlusal relationship, had their maxilla in complete set of teeth or restored by fixed, and the remaining natural teeth had apparently good periodontal condition. All patients had sufficient bone volume at the mandibular molar regions, covered with normal thickness of muco-periostium and showing no signs of inflammation or ulceration.. All selected patients were informed about the nature of this research and their informed consents were obtained. The selected patients with history of drug therapy interferes with bone resorption or deposition, immuno-compromised patients, patients with current chemotherapy or radiotherapy, hemophiliac disorders, physical and mental disabilities which interfere with the maintenance of dentures, severe skeletal jaw discrepancies, severe clenching habits, patients who have already current or previous smokers were excluded.

After thorough mouth examination of both hard and soft tissues panoramic x-ray (Dentsply, Sirona, Germany) was carried out for each patient for full mouth examination. Surgical preparation such as extraction of teeth with poor prognosis, removal of the residual roots, impacted teeth and mal posed teeth which were not orthodontically correctable, periodontal preparation such as scaling and root planning, elimination of gross occlusal interferences by selective grinding procedure were carried out.

After selection of suitable stock tray size and establishment of any required modifications, accurate primary alginate (Cavex, Holland) impressions for both arches were made. The impressions were poured with die stone (Chera, Germany) to get the study casts, after surveying the study cast, the framework was drawn on the diagnostic cast. RPA clasp which consist of mesial minor conector and mesial occlusal rests on the main abutment teeth, distal guide plane and occlusaly approaching cast circumferential retentive arm were placed on the premolar tooth adjacent to the free end saddle. Lingual plate major connector was used for both denture types.

Special tray was constructed using the previously made mandibular study cast. After mouth preparation border molding was done using green stick compound (Harvard Dental GmbH, Berlin, Germany) and an accurate impression was made using rubber base impression material (Thixoflex® M – C. Silicone impression material – Zhermack® - Italy) for construction of master cast. Then the master cast was placed on the surveying table at the same selected tilt used for the study cast. The design of the partial denture was drawn on the master cast Block out and relief of the master cast was carried out.. The master cast was duplicated to produce the refractory cast for making wax pattern. Then transferring the design from the master cast to the refractory cast was done. Using lost wax technique, Cobalt Chromium (BEGO, Germany) framework was fabricated using casting machine (BEGO, Germany) while acetal (BIOCETAL– Thermoplastic Acetal – Poland) framework was fabricated using thermopress injection molding process.

Thermopress injection molding process of the acetal framework were carried out as following. The flask that was used for this injection process composed of two separate parts and three holes ,One part of the flask was filled with extra hard stone. The main hole of the flask was filled with wax through which the acetal resin injection process was carried out . The framework was placed inside the unset stone while the wax sprue extended to the main flask hole. The stone and invested cast were painted with separating medium (Acrylic sep, Bredent, Senden, Germany).The counter part of the flask was placed over its corresponding part of the flask, then it was filled with mix of stone through the second flask's hole. After complete set of the stone, the flask was opened and the wax elimination process was carried out, then the flask was closed. The acetal resin granules were placed inside the Aluminum cartridge (tube) of the thermopress 400 that was sealed by its capThe cartridge was lubricated by cartridge lubricating material (Thermopaste 400, Bredent, Senden, Germany) and introduced into one of the two heating cylinders of the furnace. The cartridge membrane is pointed to the flask chamber. The flask was placed over the flask heating disc of the furnace in the manner that permitted the flask's hole facing the cartridge injection hole through which the acetal resin was injected. The flask was mounted inside the furnace using the hand press of the furnace then the furnace was closed. The control panel of the thermopress (Thermopress 400, Bredent, Senden, Germany) was set so that the pre-injection temperature was reached 220 C0 within 15 minutes. The injection with heating process was performed at a temperature of

220 C0 for 1 minute, and the pressure inside the furnace was 7.5 bar. After the injection process had finished the furnace was opened, the hand press of the furnace was released, and the flask was removed.

The selected pressure impression was made after the framework construction for purpose of correcting the master cast (Altered cast technique). Acrylic resin custum tray was made over the edentulous ridge framework. Greenstick compound was used for border molding the impression tray.The tray was relived at the crest of the ridge. Impression was made with zinc oxide paste if the ridge was free from undercute. The ridge area of the cast that would be replaced by the corrected impression was outlined and removed with handsaw. Retentive groves on cut surface of cast was made. Framwork with the impression was sealed to the sectioned cast The sectioned cast with impression was inverted,beaded boxed and poured into dental stone.The resultant cast was used to complet the partial denture.

Face bow (Bioart, New York, USA) recored was carried out and transferred to semi adjustable articulator (Bioart, New York, USA) and mounting of the maxillary cast was done Interocclusal wax record was made in maximum intercuspation using record block. The lower cast was mounted on articulator. Setting of the artificial teeth, try in, processing, finishing,polishing and occlusal adjustments were performed to accommodate processing discrepancies then delivered to the patients. .The patients were allowed to wear the dentures then comparison parameters were evaluated at insertion, after six months and one year for each patient.

A) Clinical observation:

Pocket depth:

The gingival tissue around both implants and abutments were isolated and gently dried by a piece of gauze, and then each surface was individually scored. The pocket depths were recorded using graduated periodontal probe to the nearest millimeter on 4 surfaces of the terminal abutment; mesial, mid-buccal, distial and mid lingual. The periodontal probe was held parallel to the long axis of the tooth and pocket depth was measured from the gingival margin to the bottom of the pocket using gentle pressure. The mean of the four measurements for each patient was calculated and recorded.

Gingival index:

This index permits both immediate evaluation of the patient's gingival condition and his motivation, based upon the actual bleeding tendency of the gingival papillae. A periodontal probe was inserted into the gingival sulcus at the base of the papilla on the mesial aspect, and then moved coronally to the papilla tip. This was repeated on the distal aspect of the papilla. The intensity of any bleeding was scored and recorded as:

Score of 0 : Absence of inflammation/Normal gingiva.
Score of 1 : Mild inflammation, slight change in color, slight edema, no bleeding on probing.
Score of 2 : Moderate inflammation, moderate glazing, redness, edema and hypertrophy, bleeding on probing
Score of 3 : Severe inflammation, marked redness and hypertrophy,ulcerations and tendency to spontaneous bleeding.

Overall patient satisfactiond

Patients were asked to firstly grade their dentures in general, and then they were asked to provide separate grades on the retention, aesthetics, ability to speak and masticate with their dentures. Patients satisfaction was graded by using an analogue scale ranging from 0 to 3 score.[10]

score of 0: Not satisfied.
score of 1: Satisfied, level is adequate.
score of 2: Satisfied, level is good.
score of 3: Satisfied, level is very good.

B) Radiographic observation:

Charged-coupled device system consisted of an electronic chip used as a sensor for the radiation with a cable connected the sensor (RVG device, AET, ARDET, Milano, Italy) to the computer and the image was displayed immediately on the computer monitor after exposur. Digital periapical x-ray film of the premolar abutment teeth was performed for each patient at time of insertion, six months and after one year for both denture types according standardization the periapical radiograph using parallel cone technique.. At each site the evaluation was made by measuring the distance in mm from the crest of the alveolar bone to the cement-enamel junction using reference lines and points. The changes in the bone height in the subsequent measurements were calculated. The mean changes of the mesial and distal bone heights of the abutments were considered as the bone changes of that patient.

III. Statistical analysis:

Data was collected, tabulated, and statistically analyzed by SPSS© 20 for windows. The data distribution of normality was done by using Kolmogorov-Smirnov test. The test showed parametric distribution of data for bone loss. Meanwhile, the test showed non-parametric distribution of data in patient satisfaction, pocket depth, and gingival index. Comparison of the two groups (Cobalt chromium and Acetal) for the parametric data was done by independent t-test, and one-way ANOVA with post hoc turkey test was used for comparison between the different times. For the non-parametric data, comparison between the two groups was done by Wilcoxon signed rank test, and Friedman test with post-hoc Dunn was used for comparison between different time. The level of significance was set at 0.05 alpha level ($p<0.05$)

IV. Results:

The mean, standard deviation and p value of group t-test of bone loss, gingival index and pocket depth of the abutment teeth and patient satisfaction are shown in table (1).

Analysis of the results revealed that radiographic and clinical evaluation showed that a statistically significant difference between two groups, bone loss was greater in cobalt chroumium group around abutment. Also Pocket depth & gingival index was greater in group I than group II ($P< 0.05$).

Overall patient satisfaction showed significant difference between the two groups at insertion and after 6 and 12 month intervals. Acetal group was greater than cobalt chromium group.

The results of the effect of time on periodontal health in both groups are showed in table (2). Statically analysis of the results revealed that alveolar bone height and gingival index in both groups showed significant difference after 6 & 12 month intervals. While Pocket depth and Patient satisfaction in both groups showed significant difference after 12 month intervals.

Table(1): Comparison between acetal an Co-Cr dentures

	Acetal group			Cobalt chromium group		
	Time	Mean	SD	Mean	SD	P
Gingival index	At insertion	0	0	0	0	0
	At 6 m	1.42	0.786	2.42	0.786	0.024*
	At 12m	1.285	0.755	2.57	0.532	0.014*
Pocket depth	At insertion	1.1429	0.626	1.571	0.449	0.102
	At 6m	2.214	0.393	3.214	0.393	0.017*
	At 12m	2.785	0.4879	4.142	0.69	0.026*
Patient satisfaction	At insertion	2.1429	0.6900	0.428	0.5345	0.034*
	At 6 m	1.7143	0.487	1.285	0.487	0.024*
	At 12 m	2.714	0.487	1.4286	0.534	0.014*
Bon loss around abutment	At insertion	0.317	0.079	0.395	0.095	0.117
	At 6m	0.475	0.009	0.630	0.001	0.00*
	At 12 m	0.7422	0.146	0.939	0.044	0.004*

Table(1): Effect of time on periodontal health in both groups:

		Acetal group		**Cobalt chromium group**	
		Fr	P	F	P
Gingival index	Insertion vs 6months	-1.50	0.015*	-1.214	0.023*
	Insertion vs 12 Months				
	6 Months vs 12 months	-1.50	0.015*	-1.357	0.033*
		-1.50	1	0.143	0.0789
Pocket depth	Insertion vs 6months	2.004	0.135	2.004	0.135
	Insertion vs 12 Months				
	6 Months vs 12 months	3.608	0.001*	3.608	0.001*
		1.604	0.326	1.604	0.326
Patient satisfaction	Insertion vs 6months	2.004	0.135	-1.214	0.23
	Insertion vs 12 Months				
	6 Months vs 12 months	3.207	0.004*	-1.357	0.033*

		1.203	0.687	0.143	0.789
Alveolar bone height		T	P	T	P
	Insertion vs 6months	.05121	.015*	.03316	0.00*
	Insertion vs 12 Months	.05301	.000*	.03432	0.00*
	6 Months vs 12 months	.05301	.000*	.03432	0.00*

V. Discussion

Materials for clasps and frameworks of (RPDs) need to have enough flexibility for the clasps and rigidity for other framework components. Therefore, Co-Cr is the most popular alloy for the frameworks of RPDs. The biggest disadvantage of Co-Cr clasps is their poor esthetic appearance. Tooth colored clasps made of thermoplastic resins have been developed to overcome the aesthetic problems.[11]

Acetal resin has a sufficiently high resilience and modulus of elasticity to allow its use in the manufacture of retentive clasps. Acetal resin is also strong, resists fracturing, and is flexible so, does not wear during occlusal forces and consequently will maintain vertical dimension over long periods of time..[12]

Regarding gingival index and pocket depth for both group it was found that group I (cobalt chromium) recored higher mean value than group II (acetal) after 6 and 12 month respectively. The differences was statistically significant. This due to RPD may contribute to the formation of biofilm and consequently, an increase in the incidence of caries and periodontal disease. These results agree with a study found that the periodontal conditions of the teeth adjacent to the dentures were poorer than around those not directly involved in its construction due to food stagnation and difficult oral hygiene caused by the removable partial denture components. In addition, removable partial denture might sink into the soft tissues causing bone resorption. They found also that acetal resin clasps produced fewer reductions in bone height than cobalt-chromium clasps.[13,14]

Regarding bone loss for both two groups, it was found that group I (cobalt chromium) recored higher mean value than group II (acetal) after 6 and 12 month, the differences were statistically significant. This could be due to the fact that the rigid cobalt- chromium clasp transferred more stresses to the abutment teeth than flexible acetal resin clasp did. These results agree with a study has been carried out to evaluate the effects of acetal resin clasps on the abutment teeth supporting structures as compared to cobalt-chromium clasps. It was concluded that acetal resin clasps were superior to cobalt-chromium clasps as produced fewer reductions in bone height and in bone density around the abutment teeth inspite of produced increase in the crevicular fluid.[7]

Regarding the overall patient satisfaction for both groups, it was found that group I (cobalt chromium) recored lower mean value than group II (acetal) at insertion and after 6 and 12 month.This could be due to the fact that to achiev optimal superior esthetics usually takes place by utilising acetal clasps since their colour matches with that of teeth, and it was documented for their high ability to eliminate expending of metal clasps which improve esthetics. These results agree with a study was carried out to compare patient prefernace and satisfaction of thermoplastic resin partial denture and metallic partial denture . It was concluded that thermoplastic RPD hold an advantages over m etallic RPD in the term of oral appearance and over greater satisfaction.[15,16]

Regarding the effect of time on periodontal health in both groups, it was found that alveolar bone height and gingival index in both groups showed significant difference after 6 & 12 month intervals. While Pocket depth and Patient satisfaction in both groups showed significant difference after 12 month intervals. This could be due to food stagnation and difficult oral hygiene caused by the removable partial denture components, In addition removable partial denture may sink into the soft tissues causing gingival inflammation.These results agree with a study assessed the patients' dental, periodontal and mucosal statuse. It was revealed that high prevalence of plaque, gingivitis, and gingival recession especially in dentogingival surfaces . Thus, there was a special need for regular oral hygiene reinforcement, scaling and prophylaxisamong removable partial denture wearers.[17]

VI. Conclusion

Within limitation of this study acetal partial denture framework had better biological effect on soft tissues and bone resoption (lower GI, pocket depth) than Co-Cr partial denture framework. Also acetal resin was more satisfactory for the patients

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