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Comparative Study Clarifying the Most Suitable Material to Be Used as Partial Denture Clasps

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Keywords: Removable Partial Denture (RPD); Clasps; Direct Retainer; Mechanical properties; Roughness; Retention, Deformation; Cobalt Chromium (CoCr); Thermoplastic Acetal; Versacryl; Thermopress

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Abstract

BACKGROUND: Removable partial denture's clasp is of particular importance as it affects the denture longevity during the function. The key of successful clasp selection is to select a direct retainer that will control tipping and torquing forces on the abutment teeth, provide retention against reasonable dislodging forces and are compatible with both tooth and tissue contour and the aesthetic desire of the patient. In this consideration, different materials employed for the clasp construction were compared mechanically.

AIM: This study aims to compare the most usable esthetic clasps mechanically to clarify the most suitable material to be used as partial denture clasps.

METHODS: Evaluation of surface roughness, retention and deformation has been investigated utilising different in-vitro methods. All these techniques provide valuable information regarding the mechanical properties of the materials tested. However, none of the in-vitro techniques can expose the tested materials to conditions similar to that of the oral environment (in-vivo) such as pH value and temperature variations.

RESULTS: Most commonly, RPD clasps are fabricated from the same alloy of the metal framework, as cobalt-chromium (CoCr) alloy although it is unaesthetic. Other methods consumed to avoid such esthetic mystery have included coating retainers with tooth-coloured resin or introduction of esthetic materials as Thermoplastic Acetal, Versacryl, and Thermopress.

CONCLUSION: It has been concluded that the non-metal Acetal resin retainer reveals superior mechanical properties.

Introduction

The esthetic dental restorations play a great role in neoteric communities not only for females but also for males, due to the assertiveness of physical look. Dental implant succeeded in expanding such scope, yet it is not highly recommended for the tremendous scale of patients, especially those who are suffering from some medical, psychological and financial problems [1].

Esthetic removable partial dentures (RDPs) are considered as the best and most compatible remedy preference for these subjects in replacing their lost teeth with superior esthetics. One of the major problems of RPDs was the display of the clasp assemblies. Etching the retainer's arm and overlaying it with a tooth-coloured resin coat is one of many recent ways employed to solve this issue. Moreover, as the physical appearance of these ethic retainers is of vital essentiality, yet their mechanical properties play a great role in their success and intraoral utilisation [2].

Employing of acrylic resins or resin composite to veneers in metals of RDP faces a difficulty which lies in the diversities between both their potentiality to inflect and coefficients of thermal expansion. Non-noble metals possess durability and resist remarkable flection. However, utmost disfigurement takes place to resins concerning both their physical and thermal status, as the matrix becomes fragile beyond its elastic borders. The resin composite matrix also tends to be brittle beyond its elastic limit. As a sequel, the capacities of both metals and resins for plastic disfigurement are in a broad conflict. Latest concerns extend to the impact of the intraoral masticatory vigour together with both the adjustability and extra magnitude of the veneered retainers formed by the compiling of the covering matter. Exaggerated declining in the retainer's length and thickness should be averted to secure the stiffness and shorten the fracture of the retainer as well as provide maximum esthetics [3].

One of the different recent modalities utilised to enhance the semblance of metal retainer structures and sour them for outstanding and supreme esthetics is to fabricate the clasps in a tooth-coloured substance as the Thermoplastic resins [4] [5] [6]. However, in literature, few data are obtainable on the long-dated execution of such retainers concerning retention.

Polyoxymethylene (POM) which is well known as Acetal resin, an injection-moulded resin also acts as a standby to the classical PMMA. Fabrication of POM takes place by the polymerisation of formaldehyde. The homopolymer polyoxymethylene is a series of alternating methyl sets united by an oxygen whit. Besides that, it behaves elastically on a wide scale which allows it to be utilised as the suitable material for retainer construction. This is due to its superior proportional limit with the minimal viscous flow [4].

Lately, POM is considered as a highly desirable material for medical employment due to its superior degree of crystallinity as well as it is selected as one of the strongest and stiffest thermoplastic materials. Also, being chemically very stable, resistant to abundant solvents, disinfectants and humidity, together with its lofty tissue compatibility [7].

POM has been consumed globally in dentistry as an offset for both PMMA and metals in tremendous of prosthetic employments since two decades ago. The most commonly functioning appliances were the esthetic clasps of RPD [6][8][9], cast posts and cores [10] as well as brackets [11].

Valaplast is an esthetic retentive retainer utilised in RPDs concerned for cosmetic improvement of teeth since it belongs to the Nylon family. Its retention is noticed on a wide range for being thin, light in weight, resistant to fracture and with a high modulus of elasticity [11].

The thermoplastic resin injection materials are remarkable for their superior merits such as; subsided modulus of elasticity, easily manipulated and esthetically acceptable results. The advantage of such low elastic modulus provokes and facilitates the engagement of more undercut improving the denture retention through these retainers [12].

So, this study aims to compare the most usable esthetic clasps mechanically to clarify the most suitable material to be used as partial denture clasps.

Material and Methods

Ideal model of maxillary partially edentulous case (Kennedy Class III) employed for educational purposes has been selected as a master model replicating the anatomical features of the teeth.

The ideal model was duplicated to make a stone cast with the maxillary premolar and the molar duplicated into wax to be surveyed before casting it into metal. This was carried out to provide mesially (8 mm) and lingual guide planes (6 mm) and create a 0.25 mm undercut area on the distobuccal surface. An occlusal rest seat 2 mm deep was prepared on the mesial occlusal surface for the molar tooth while providing distal (8 mm) and lingual guide planes (6 mm) and to create a 0.25 mm undercut area on the mesiobuccal surface, an occlusal rest seat 2 mm deep was prepared on the distoocclusal surface (Figure 1).

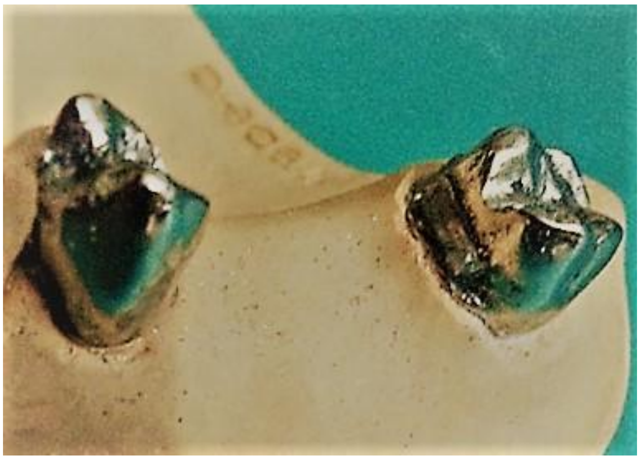

Figure 1: Model of surveyed metal teeth

The specimens included, five premolar clasps with 0.25 mm undercut and five molar ones with 0.50 mm undercut.

The materials of these five retainers for each abutment tooth are Chrome Cobalt (CoCr) metal clasp, Versacryl, Valplast, Acetal resin and Thermopress clasp. Each type of these retainers was fabricated as recommended by the manufacturer attaching to them a wax plate (4 x 7 x 3 mm) which was attached to the minor connector parallel to the path of insertion. The plate was utilised later for maintaining the clasp in the testing machine (Figure 2).

The procedure of testing clasps retention was conducted utilising a specially designed insertion-removal apparatus (*Festo AG & Co, KG and Istanbul, Turkey*). The apparatus allowed the placement (insertion) of the retainer to its predetermined terminal position and its subsequent removal from the metal model.

Figure 2: The Specimens; A-Thermopress clasps; B-Metal clasps; C-Acetal clasps; D-Versacryl clasps

The retentive force of the retainer (g) was measured during removal (Figure 3). The clasp attached to the testing apparatus was placed on the corresponding abutment metal model fixed on a stainless-steel container. The container was filled with distilled water. Continuous cycles (4380) are starting from baseline till the 3-years of clinical utilisation of placement and removal of the retainer, simulating 3-years of clinical utilisation, were performed along the path of insertion and removal determined by preliminary surveying procedures of the abutment metal model and at each time interval, the maximum load is measured.

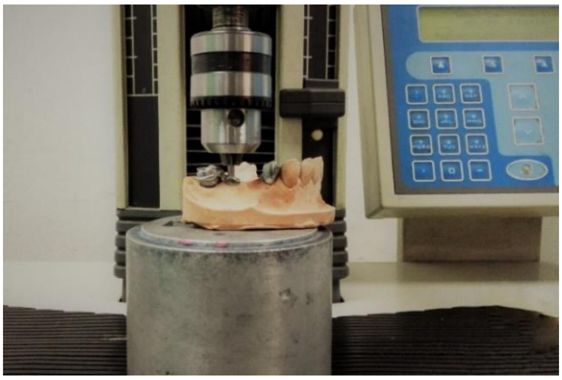

Figure 3: The testing machine with one of the specimens

A tensile load (in Newton) was applied at a crosshead speed of 10 mm per minute to the clasp until it was dislodged. The sensor (*Spider SW; Mettler-Toledo, Inc, Columbus, Ohio.*) connected to the load cell detected the magnitude of the tensile load applied at the moment the retainer was removed from the metal model. The maximum loads required to remove the clasp at 7 different periods of 0, 730, 1460, 2190, 2920, 3650 and 4380 continuous cycles were recorded by the computer (*Inspiron 8600; Dell Inc, Round Rock, Tex.*) connected to the sensor.

Acetal resin clasps and then CoCr ones were tested to avoid any possible surface attrition of the models. After fatigue due to retention testing methods, deformation test was performed; the distance between the tips of the retentive and reciprocal arms of each retainer which were placed in the acrylic resin blocks in the same position as previously described was measured to calculate the amount of deformation happened. The inner surface of each clasp was inspected and was measured with the electron microscope to record the amount of roughness happened (*Toolmaker TM-505; Mitutoyo Ltd.*) and then recorded (Figure 4).

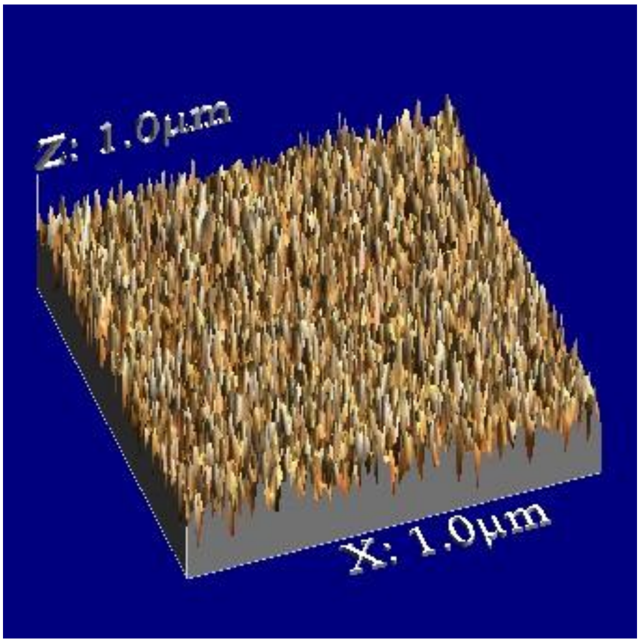

Figure 4: Picture under the electron microscope form the metal specimen

The mean values and SDs of the retentive force magnitudes were recorded for the 7 periods for dislodgement of each clasp (there was no difference between the results from premolar and molar specimens for each group material so, the records from the molar specimen were analyzed as the molar clasps had more surface area to be tested). Comparison of the data was conducted with 3-way analysis of variance (ANOVA) and a least significant difference (LSD) multiple range test (a = 0.05).

Statistical Analysis

Data were presented as the mean and standard deviation (SD). Data were explored for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests. Roughness (Ra) revealed a parametric distribution, so One-Way ANOVA utilised to study the difference between tested Materials on mean

Roughness (Ra) followed by Tukey's posthoc test for pairwise comparison when ANOVA is Significant. Dependent t-test used to compare between Baseline data and each follow-up period data for every material.

Retention and deformation displayed a nonparametric distribution, so Kruskal Wallis used to study the difference between tested Materials on mean Retention and deformation followed by Mann Whitney U-test posthoc test for pairwise comparison when ANOVA is Significant. Wilcoxon Signed Rank test used to compare between Baseline data and each follow-up period data for every material.

The significance level was set at P ≤ 0.05. Statistical analysis was performed with IBM® SPSS® (*SPSS Inc., IBM Corporation, NY, USA*) Statistics Version 22 for Windows.

Results

Difference Between Different Tested Materials on Mean Roughness (Ra)

Mean, and standard deviation (SD) for the Roughness (Ra) for different tested Materials were presented in Table 1 and Figure 5.

Metal (0.2549 ± 0.0043) and Acetal (0.2549 ± 0.0043) showed the lowest mean roughness compared to thermo (0.2624 ± 0.0006), Versa (0.2618 ± 0.0014) and Val (0.2626 ± 0.0008) at p ≤ 0.001 at baseline.

Metal (0.2508 ± 0.0027) and thermo (0.2499 ± 0.0019) showed the lowest mean roughness compared to Acetal (0.2633 ± 0.0004), Versa (0.2616±0.0004) and Val (0.2617 ± 0.0004) at p ≤ 0.001 at 1 month.

Metal (0.2493 ± 0.0026) showed the lowest mean roughness followed by Val (0.2609 ± 0.0010) followed by thermo (0.2615 ± 0.0009) and Versa (0.2616 ± 0.0007) followed by Acetal (0.2629 ± 0.0004) and at p ≤ 0.001 at 3 months.

Table 1: Mean and standard deviation (SD) of Roughness (Ra) for different tested materials

	Material										p-value
	Acetal		Thermo		Versa		Val		Metal		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Baseline	.2549a	.0043	.2624b	.0006	.2618b	.0014	.2626b	.0008	.2549a	.0043	≤ 0.001*
1 Month	.2633b	.0004	.2499a	.0019	.2616b	.0003	.2617b	.0004	.2508a	.0027	≤ 0.001*
3 Months	.2629a	.0004	.2615ab	.0009	.2616ab	.0007	.2609b	.0010	.2493c	.0026	≤ 0.001*
6 Months	.2891a	.0302	.2622b	.0016	.2607b	.0011	.2553b	.0047	.2510b	.0031	0.001*
9 Months	.2584ab	.0011	.2602a	.0010	.2593ab	.0010	.2551bc	.0072	.2527c	.0042	0.012*
12 Months	.2579b	.0012	.2592ab	.0017	.2610a	.0010	.2595ab	.0012	.2549c	.0029	≤ 0.001*

Means with the same letter within each row are not significantly different at p=0.05; *= Significant; NS=Non-significant.

Acetal (0.2891 ± 0.0302) showed the highest mean roughness compared to Metal (0.2510 ± 0.0031), thermo (0.2622 ± 0.0016), Versa (0.2607 ± 0.0016) and Val (0.2553 ± 0.0047) at p = 0.001 at 6 months.

Metal (0.2527 ± 0.0042) showed the lowest mean roughness followed by Val (0.2551 ± 0.0072) followed by Versa (0.2610 ± 0.0010) and Acetal (0.2584 ± 0.0011) followed by thermo (0.2602 ± 0.0010) and at p = 0.012 at 9 months.

Metal (0.2549 ± 0.0029) showed the lowest mean roughness followed by Acetal (0.2579 ± 0.0012) followed by Val (0.2595 ± 0.0029) followed by thermo (0.2592 ± 0.0017) and Versa (0.2610 ± 0.0010) and at p ≤ 0.001 at 12 months.

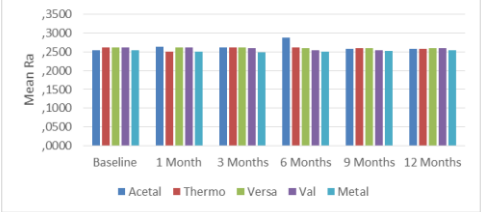

Figure 5: Histogram showing the mean Roughness (Ra) for different tested Materials

Mean Difference and Standard Deviation (SD) Between Baseline and Different Follow-Up Periods for Each Material:

Mean Difference and standard deviation (SD) between baseline and different follow-up periods for each material were presented in Table 2 and Figure 6.

A significant increase on mean Surface roughness after 1 and 3 months; after 6, 9 and 12 months, an insignificant increase on mean roughness for Acetal.

A significant decrease on mean Surface roughness after 1, 3 and 12 months; after 6 and 9 months, an insignificant decrease on mean roughness for Thermo.

Table 2: Mean Difference and standard deviation (SD) between baseline and different follow-up periods for each material

		Paired Differences		t	p-value
		Mean	SD		
Acetal	Baseline - 1 Month	-.0083833	.0044459	-4.619	0.006*
	Baseline - 3 Months	-.0080167	.0045490	-4.317	0.008*
	Baseline - 6 Months	-.0342000	.0333606	-2.511	0.054 NS
	Baseline - 9 Months	-.0035333	.0040128	-2.157	0.084 NS
	Baseline - 12 Months	-.0027400	.0040371	-1.518	0.204 NS
Thermo	Baseline - 1 Month	.0122750	.0027705	8.861	0.003*
	Baseline - 3 Months	.0007000	.0003651	3.834	0.031*
	Baseline - 6 Months	.0009000	.0008042	2.238	0.111 NS
	Baseline - 9 Months	.0021250	.0018264	2.327	0.102 NS
	Baseline - 12 Months	.0023750	.0002062	23.041	≤0.001*
Versa	Baseline - 1 Month	.0002250	.0017727	.254	0.816 NS
	Baseline - 3 Months	.0015000	.0002000	12.990	0.006*
	Baseline - 6 Months	.0015750	.0021329	1.477	0.236 NS
	Baseline - 9 Months	.0021500	.0016823	2.556	0.083 NS
	Baseline - 12 Months	.0003750	.0022780	.329	0.764 NS
Val	Baseline - 1 Month	.0009200	.0010085	2.040	0.111 NS
	Baseline - 3 Months	.0017167	.0009663	4.352	0.007*
	Baseline - 6 Months	.0072667	.0049318	3.609	0.015*
	Baseline - 9 Months	.0074667	.0073650	2.483	0.056 NS
	Baseline - 12 Months	.0030667	.0009730	7.720	0.001*
Metal	Baseline - 1 Month	.0040833	.0051375	1.947	0.109 NS
	Baseline - 3 Months	.0055333	.0042571	3.184	0.024*
	Baseline - 6 Months	.0038833	.0062608	1.519	0.189 NS
	Baseline - 9 Months	.0021667	.0075965	.699	0.516 NS
	Baseline - 12 Months	-.0000667	.0064217	-.025	0.981 NS

** = Significant; NS = Non-significant.*

A significant decrease on mean Surface

roughness only after 3 months; after 1, 6, 9 and 12 months an insignificant decrease on mean roughness for Versa.

A significant decrease on mean Surface roughness after 3, 6 and 12 months; after 1 and 9 months, an insignificant decrease on mean roughness for Val.

A significant decrease on mean Surface roughness only after 3 months; after 1, 6, 9 and 12 months an insignificant decrease on mean roughness for Metal.

Difference between Different Tested Materials on Mean Retention

Mean and standard deviation (SD) for the Retention for different test. Materials were presented in Table 3 and Figure 6.

Metal (8.02014 ± 2.7228) showed the highest mean Retention followed by to thermo (2.9698 ± 1.2505), Acetal (39527 ± 1.7613) and Val (2.8696 ± 1.3727) and the lowest for Versa (1.7159 ± 0.3434) at P = 0.009 at baseline.

Metal (9.1109 ± 6.4264) and Acetal (3.9527 ± 1.7613) showed the highest mean Retention followed by to thermo (2.2149 ± 0.6867) and Val (2.3340 ± 1.5755) and the lowest for Versa (1.3805 ± 0.4561) at P = 0.003 at 1 month.

Table 3: Mean and standard deviation (SD) of Retention for different tested materials

	Material										p-value
	Acetal		Thermo		Versa		Val		Metal		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Baseline	3.9527^{ab}	1.761	2.9698^{ab}	1.250	1.7159^{b}	0.343	2.8696^{ab}	1.372	8.2014^{a}	2.722	0.009*
1 Month	8.2350^{a}	1.940	2.2149^{ab}	.686	1.3805^{b}	0.456	2.3340^{ab}	1.575	9.1109^{a}	6.426	0.003*
3 Months	3.3129^{ab}	0.712	3.0995^{ab}	1.553	1.8504^{b}	0.875	2.4068^{ab}	0.274	9.8193^{a}	4.889	0.012*
6 Months	2.3163^{b}	0.364	8.4239^{b}	1.805	2.1581^{b}	1.024	1.4516^{b}	0.409	14.5209^{a}	2.546	0.001*
9 Months	2.6660^{b}	0.439	8.6016^{b}	5.094	3.2561^{b}	1.257	4.6698^{b}	2.343	10.1663^{a}	4.264	0.039*
12 Months	2.2418^{b}	1.968	4.1404^{b}	1.540	1.3633^{b}	1.177	2.0611^{b}	0.660	13.0802^{a}	8.668	0.037*

Means with the same letter within each row are not significantly different at P = 0.05; = Significant; NS = Non-significant.*

Metal (9.8193 ± 4.8893) showed the highest mean Retention followed by to thermo (3.0995 ± 1.5530), Acetal (3.3129 ± 0.7124) and Val (2.4068 ± 0.2746) and the lowest for Versa (1.8504 ± 0.8753) at P = 0.012 at 3 months.

Metal (14.5209 ± 2.5468) and thermo (8.4239 ± 1.8059) showed the highest mean Retention followed by to Acetal (2.3163 ± 0.3646), Val (1.4516 ± 0.4099) and Versa (2.1581 ± 1.0241) at P = 0.001 at 6 months. Metal (10.1663 ± 4.2645) showed the highest mean Retention followed by to thermo (8.6016 ± 5.0946), Acetal (2.6660 ± 0.4394), Val (4.6698 ± 2.3431) and Versa (3.2561 ± 1.2570) at P = 0.039 at 9 months.

Metal (13.0802 ± 8.6684) showed the highest mean Retention followed by Acetal (2.2418 ± 1.9687), Val (2.0611 ± 0.66), thermo (4.1404 ± 1.5407) and Versa (1.3633 ± 1.1774) and at P = 0.037 at 12 months.

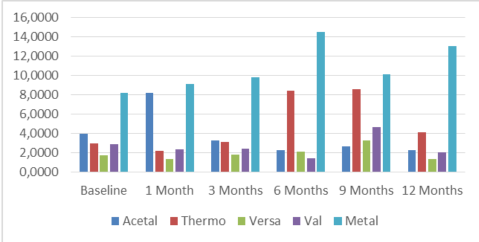

Figure 6: Histogram showing the mean Retention for different tested Materials

Mean Difference and Standard Deviation (SD) Between Baseline and Different Follow-Up Periods for Each Material

Mean Difference and standard deviation (SD) between baseline and different follow-up periods for each material were presented in Table 4 and Figure 7.

An insignificant difference after different evaluation periods for all materials except for after 1 months for ACETAL which showed a significant increase in mean retention at P = 0.043. And Thermo after 6 months at P = 0.043.

Table 4: Mean Difference and standard deviation (SD) between baseline and different follow-up periods for each material

		Paired Differences		Z	p-value
		Mean	Std. Deviation		
Acetal	Baseline - 1 Month	-4.2823930	2.0530038	-2.023	0.043*
	Baseline - 3 Months	.1614410	1.9629010	0	1.00 NS
	Baseline - 6 Months	1.1579828	1.6436127	-1.461	0.144 NS
	Baseline - 9 Months	1.2866424	1.5967715	-1.214	0.225 NS
	Baseline - 12 Months	1.2325433	1.6628911	-1.461	0.144 NS
Thermo	Baseline - 1 Month	.7549448	1.8965472	-0.405	0.686 NS
	Baseline - 3 Months	-.1297194	1.8294536	-0.405	0.686 NS
	Baseline - 6 Months	-5.4541192	2.7634226	-2.023	0.043*
	Baseline - 9 Months	-5.0927237	3.6755167	-1.604	0.109 NS
	Baseline - 12 Months	-1.0003463	2.8312038	-0.73	0.465 NS
Versa	Baseline - 1 Month	.3353628	.5346009	-0.944	0.345 NS
	Baseline - 3 Months	-.1345190	1.1697202	-0.405	0.686 NS
	Baseline - 6 Months	-.4421946	1.2282727	-0.674	0.5 NS
	Baseline - 9 Months	-1.5402088	1.3595830	-1.753	0.08 NS
	Baseline - 12 Months	.4449913	1.4839723	-0.365	0.715 NS
Val	Baseline - 1 Month	.5355882	1.7906744	-0.943	0.345 NS
	Baseline - 3 Months	.1601983	1.6170592	-0.365	0.715 NS
	Baseline - 6 Months	1.1153513	1.4992394	-1.095	0.273 NS
	Baseline - 9 Months	-2.1028110	2.9035494	-1.461	0.144 NS
	Baseline - 12 Months	.9795627	1.6585333	-1.069	0.285 NS
Metal	Baseline - 1 Month	-1.4141635	11.7759675	-0.447	0.655 NS
	Baseline - 3 Months	.1090153	6.4564111	0	1.00 NS
	Baseline - 6 Months	-5.6249250	7.3720054	-1.342	0.180 NS
	Baseline - 9 Months	-1.9649557	6.5059171	-0.535	0.593 NS
	Baseline - 12 Months	-4.8787943	10.0146186	-0.535	0.593 NS

** = Significant; NS = Non-significant.*

Difference between Different Tested Materials on Mean Deformation:

Mean, and standard deviation (SD) for the Deformation for different tested Materials were presented in Table 5 and Figure 7.

Table 5: Mean and standard deviation (SD) of Deformation for different tested materials

	Material										p-value
	Acetal		Thermo		Versa		Val		Metal		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Baseline	.55	.43	1.66	2.23	3.09	2.39	.73	.50	1.23	.71	0.348 NS
1 Month	.50	.31	2.66	2.15	2.58	2.48	5.07	.11	.66	.41	0.173 NS
3 Months	1.39	1.10	4.57	.60	2.21	2.44	2.97	2.34	.85	.61	0.354 NS
6 Months	.66	.52	2.82	1.89	3.75	2.50	.97	.98	.64	.43	0.363 NS
9 Months	.93	.46	1.00	.67	.89	.76	.97	.98	1.44	1.14	0.778 NS
12 Months	2.08	2.55	.98	.30	1.19	1.68	1.89	.67	1.35	.24	0.579 NS

*Means with the same letter within each row are not significantly different at P = 0.05; * = Significant; NS = Non-significant.*

An insignificant difference between tested materials for all different evaluation periods.

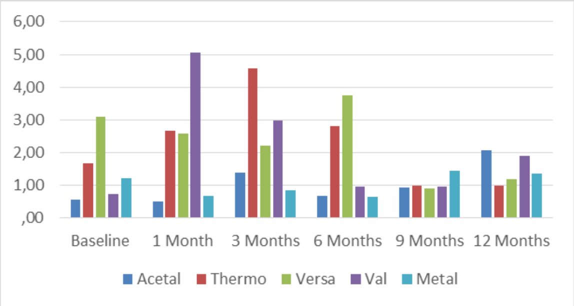

Figure 7: Histogram showing the mean Deformation for different tested Materials

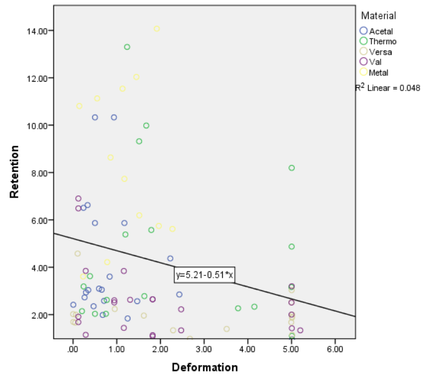

Figure 8: Scattered plot for the Correlation between Retention and Deformation

Mean Difference and Standard Deviation (SD) Between Baseline and Different Follow-Up Periods for Each Material:

Mean Difference and standard deviation (SD) between baseline and different follow-up periods for each material were presented in Table 6 and Figure 8.

An insignificant difference after different evaluation periods for all materials.

Table 6: Mean Difference and standard deviation (SD) between baseline and different follow-up periods for each material

		Paired Differences		Z	p-value
		Mean	Std. Deviation		
Acetal	Baseline - 1 Month	.05687	.60921	-0.365	0.715 NS
	Baseline - 3 Months	-.82736	1.53201	-0.73	0.465 NS
	Baseline - 6 Months	-.03126	.65298	0	1.00 NS
	Baseline - 9 Months	-.30465	1.03263	0	1.00 NS
	Baseline - 12 Months	-1.45135	3.07872	0	1.00 NS
Thermo	Baseline - 1 Month	-.99450	1.47213	-1.095	0.173 NS
	Baseline - 3 Months	-1.82127	3.78217	-0.447	0.655 NS
	Baseline - 6 Months	-.85927	3.87533	-0.535	0.593 NS
	Baseline - 9 Months	.96685	2.52155	-0.535	0.593 NS
	Baseline - 12 Months	-.54021	.21998	-1.342	0.180 NS
Versa	Baseline - 1 Month	-.12240	2.53189	0	1.00 NS
	Baseline - 3 Months	.88350	4.59077	-0.73	0.465 NS
	Baseline - 6 Months	-.65704	4.28074	0	1.00 NS
	Baseline - 9 Months	1.56253	3.23707	-0.535	0.593 NS
	Baseline - 12 Months	1.34495	5.18134	-0.447	0.655 NS
Val	Baseline - 1 Month	-4.19957	.45768	-1.604	0.109 NS
	Baseline - 3 Months	-2.24534	1.83802	-1.857	0.063 NS
	Baseline - 6 Months	-.24545	.47691	-0.743	0.458 NS
	Baseline - 9 Months	-.24545	.47691	-0.743	0.458 NS
	Baseline - 12 Months	-1.16345	.16988	-1.857	0.063 NS
Metal	Baseline - 1 Month	.56813	1.04913	-0.535	0.593 NS
	Baseline - 3 Months	.38367	.69116	-1.069	0.285 NS
	Baseline - 6 Months	.59026	1.09239	-1.069	0.285 NS
	Baseline - 9 Months	-.21568	1.82849	0	1.00 NS
	Baseline - 12 Months	-.48644	.67592	-1.342	0.180 NS

** = Significant; NS = Non-significant.*

There was negative significant correlation between the retention and deformation; r = -0.218; P = 0.032

Table 7: Pearson Correlation between the retention and deformation

		Deformation
Retention	Pearson Correlation	-0.218
	Sig. (2-tailed)	0.032*
	N	97

** = Significant; NS = Non-significant.*

Discussion

The removable partial denture's direct retainer is of particular importance as it affects the denture longevity during the function. In the current consideration, different materials employed as a clasp were compared mechanically to reach the decision of ideal clasp material for denture immortality.

The surface roughness of denture bases promotes adhesion of microorganisms and plaque accumulation. It is mainly stimulated by the material's deep-rooted countenances, polishing method and the operator's manual expertise.

It has been revealed in the current contemplate that CoCr clasps were of least roughness, this could be attributed to its superior resistance to corrosion, microhardness and modulus of elasticity as well as low density [13].

Another addition to the metal-free removable partial denture (RPD) market is polyoxymethylene (Acetal resins). In the present contemplate Acetal showed different roughness behaviour within the different follow-up periods but least non-metal roughness after one year of follow-up. This could be simply clarified as all Acetal resins are characterised by having superior abrasion resistance, limit water sorption and exhibit lower creep. Moreover, Acetal's resin superior solidity favours the imitative retainer's layout, connectors and other components with several restitutions desired [14].

Acetal resin proved to be superior in flexibility, strength as well as resistance to wear and fracture. Moreover, it is remarkable for its high creep resistance, fatigue endurance as well as its hydrophobic nature. Acetal resin is free from micro porosities or with rarely few ones reduces the accumulation of biological materials as plaque, which in turn resists odour and stains [15].

A broad extension to the metal-free RPD

emporium has been the polyamide (nylon) removable partial denture (Valplast). The current trial revealed both the worst and highest roughness in all the follow-up periods. On employing the polyamide base resin (Valplast), it revealed that both its surface roughness and difficulty that takes place during polishing leads to bacterial and fungal colonisation on its surface which is considered as its negative aspect as was reported by a previous study [16].

Regarding retention, in this trial, both the CoCr and Acetal clasps revealed the highest mean retention with the one-year follow-up period. The experimental design of this consideration tested a single-retainer system and documented that retention with CoCr alloy clasps is remarkably greater. It should be clarified that tremendous factors have a great impact on RPD's retention. Appropriate guiding plane on the proximal planes of abutment teeth is one of the retention enhancers. Clinical experience indicates that ineffective reciprocation may result in lack of both retention and stability [17] [18].

Acetal resins are highly versatile engineering polymers that bridge the gap between metals and ordinary plastics. Since they combine between both metal's strength and plastic's pleating and relief, they provide an ideal substance for the construction of dental prostheses specifically retainers [19]. It has been clarified that the Acetal's retention was the highest within the one-year follow-up period, this might be attributed to its combatively elevated proportional extent with the slight flow of viscosity allowing it to proceed elastically over abroad area to be employed as a favourable matter for providing retention [20].

Ulterior to three months follow up period it was revealed that, although retention declined in all parties, yet Acetal's clasp retention is still significantly superior (p≤0.05) than the cobalt chromium one. This coincides with results of another trial which mentioned that Acetal resin as a thermoplastic clasp enhancing they're positioning deeper into undercuts for preferable settlement and retention with minimal bulk which is also easily adjusted [21].

Abutment's teeth number and allocation, wax's block-out bulk and framework's fit are auxiliary agents that impress the degree of retention achieved. This contemplates employed an experimental design for single retainer system. Later on, Acetal resin retainers might be more adequate for clinical employment, when two or three Acetal resin retainers are utilised in RPD construction regarding all the factors above [20].

Acetal resin clasps can be expended in retaining Kennedy's class III RPD. However when utilised on molars it is recommended either to maximise the thickness of the retentive clasp arm or use deeper under the cut. On consuming Acetal as a direct retainer, it provides more retention qualities on premolars than on molar teeth, and this was followed in the current contemplate as premolar teeth were utilised for direct retention [22].

Aiming to adequate function of RPDs, it has been suggested that a retentive force of 5 N is desired. Moreover, a contemplate mentioned that the mean retentive force for the 1.0 mm thick thermoplastic resin retainers at the end of the cycling test ranged from 1.7 N to 3.7 N, while that for the 1.5 mm thick ones from 5.4 N to 10.8 N. Such outcomes revealed that thermoplastic resins could be utilized in generating RDPs' retainers, since they supply sufficient retention even in accordance with a decade of simulated employment [23] [24].

Custom made Acetal resin retainer provides a great difference between this contemplate and other studies since it is more adaptable and highly fitting to the undercut which consequently improves the retention. This is coinciding with another trial which described that Acetal resin as an injection moulding substance is suitable for RPDs with flexible esthetic retainers [18].

Thermoelastic resins (Versacryl) in this trial revealed the lowest mean retention within the same follow-up period, this was attributed to their viscoelastic properties as they are fabricated with emanant pliability, which is about ten times as that of the metal retainers, and they return to their current magnitudes in accordance with stretching as recommended by other considerations [28]. Moreover, a latter paramount merit for the thermoplastic retentive arm is remarkable for having a domestic remembrance to revert to its main posture as compared to the casted retainer which ordinarily in accordance with 500 times of insertion and removal becomes fatigued which is considered as an additional merit for Versacryl as reported by previous trials [26] [27].

There was the insignificant difference between all the different materials utilised regarding the deformation. This was simply explained as retainers afford both permanent deformation and fatigue which allows it to shatter following repeated flexures initiated by both denture insertion and removal as well as chewing [28] [29] [30] [31]. The fatigue life of CoCr proved to be the highest of all the casted clasps as those made of commercially-pure titanium and gold alloy clasps [32]. Permanent deformation and fatigue fracture result from the overwork that took place in the retainer [33] [34]. Alloy's modulus of elasticity, retainer's sizes and curvature [35] [36], and both the amount and direction of deflection about the abutment undercut are the main agents upon which load distribution depends on [37] [38]. The CoCr alloy's stiffness makes them unsuitable for their placement in deep undercuts, as they can induce stresses on the abutment teeth or may result in permanent deformation of the class [39].

It was concluded that though the flexural strength and modulus of elasticity were relatively low in the thermoplastic resins, they demonstrated great toughness and resistance to fracture; thermoplastic resins could afford forces till a considerable deflection limit which remarks to their adequate longevity for multiple intraoral insertions and removals [40]. Another contemplate mentioned that, if all other variables were equal, a 15 mm long CoCr clasp of one mm diameter would exhibit the same stiffness as an Acetal resin clasp of five mm in length and 1.4 mm in diameter which justifies that, thicker Acetal resin retainers were utilized for comparison in the current contemplate [22].

After one month of insertion, retention of both CoCr and Acetal declined, this was by results of other considerations as it proved that there was no deformation for the Acetal resin clasps after 36 months of simulated clinical employment, unlike the CoCr ones which presented an increase in the distance between its tips. Due to permanent deformation of CoCr retainers, the retentive force was lost within 730 cycles of placement and removal and continued to lose its retention during the remaining testing period [20]. In general, Polyamide resins utilised in dentistry exhibit superior flexibility, physical strength, heat and chemical resistance. On the other hand, all nylons revealed superior water sorption and crept than most dental polymers [41].

From the outcomes of this in-vitro study, it can be accomplished that Acetal resin proved to be the non-metallic material of choice due to its superior properties regarding roughness, retention and deformation, while Valplast is the lowest at the end of one year follow up period.

Recommendations: This contemplate recommends utilising Acetal resin as the best non-metallic partial denture clasp, while the Cr Co can be used as the metallic one.

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