The effect of two different types of removable partial dentures on chewing activity and muscle efficiency

Banu Hiwa Mohammed[(1)], Rizgar Mohammed Ameen Hasan[(2)]

Background and objectives: Cobalt chromium removable partial denture has been in use for years and despite of the advantages that cobalt chromium provides, it has many disadvantages. In the recent years flexible removable partial denture has been introduced to dentistry with many advantages over cobalt chromium removable partial denture . The purpose of this study was to evaluate the effect of cobalt chromium and flexible removable partial denture on chewing activity and muscle efficiency.

Methods: Ten patients were selected, all of them had completely edentulous maxilla and Kennedy Class I partially edentulous lower arch. eight male and two females with their ages ranging from 45 to 60 years. For each patient, an upper complete denture and two lower removable partial dentures (cobalt chromium and flexible) were constructed. Once the dentures were completed, muscle efficiency with the use of Electromyography and chewing activity by sieving method was performed in scheduled visits. Statistical analysis of data was achieved by means of (SPSS 25). And performing (independent sample T test, one-way anova test, and multiple comparison Tukey test).

Results: The chewing activity test, revealed a statistically significant difference ($P< 0.05$) between first and fourth visit concerning the flexible partial denture and improvement of chewing, for the cobalt chromium removable partial denture although there was improvement of chewing but it was not significant. Regarding the muscle efficiency test, this test revealed that there was no major significance between flexible and cobalt chromium removable partial denture and they are almost the same, but we can notice improvements of muscular efficiency specially in masseter muscle.

Conclusions: Within the limitations of this study, it has been concluded that the muscle efficiency is improved within one month of insertion of both types of removable partial denture . Both flexible and cobalt chromium dentures increased muscle efficiency. Flexible removable partial denture increased chewing activity slightly better than cobalt chromium, while cobalt chromium was marginally better at chewing of hard food comparing to flexible denture.

Keywords: Surface electromyography, cobalt chromium, chewing, fexible denture.

[(1)] Department of Prosthodontics , College of Dentistry, Tishk international University
[(2)] Department of Prosthodontics , College of Dentistry, Hawler Medical University.
Correspondent name: Banu Hiwa Mohammed
Email:Dr.banuhiwa@gmail.com

Introduction

Partial denture can be described as a removable partial denture or a fixed partial denture based on the patient's capability to remove or not remove the prosthesis.[1]

Removable partial dentures are the best practice therapy for many clinical scenarios, such as replacing lost and hard tissues. Given the correlation between edentulism and lower socioeconomic status, Removable partial dentures will likely remain an important treatment option compared with more costly alternatives, because secondary costs are related to the oral and systemic health consequences of wearing removable partial dentures, a significant

need exists to advance the material and technologies with these devices.[2]

However Removable partial denture esthetically is not desirable because Cobalt chromium RPDs have metal base or framework that rests on and around the natural teeth onto which denture teeth are attached by acrylic, which is fabricated by the lost- wax casting process. Alloy requires soldering and repairs are difficult and unpredictable, since it requires special equipment cobalt chromium is expensive and people with financial limitations cannot afford it.[3]

Thermoplastic dentures have been mostly identified as flexible dentures but other commonly used terms are non-clasp dentures, metal-free dentures, clasp free dentures and non- metal clasp dentures.[4]

One clinical benefit associated with flexible polymer (metal-free) RPDs is a reduction in the mouth preparation required. Flexibility reduces seating interferences, and guide planes and reciprocating surface are inconsequential. Patients report that distal extension RPDs made of polymer are more comfortable than metal framework RPDs. The brittleness of acrylics is a limitation, especially if there is no framework to reinforce the RPD. Plasticized acrylics are much less brittle, but they deform over time[5].

Electromyography (EMG) is an investigational technique concerned with the advance, recording and analysis of myoelectric signals. Myoelectric signals are created by physiological changes in the state of muscle fiber membranes. the focus of Kinesiological EMG can be defined as the analysis of the neuromuscular activation of muscles inside postural tasks, functional movements, work conditions and treatment, training routines. Besides essential physiological and biomechanical findings, kinesiological EMG is recognized as an assessment tool for practical research, physiotherapy/rehabilitation, sports training and interactions of the human body to industrial products. [7] Considering the increase use of flexible partial denture in the past few years and with its esthetic benefits still cobalt chromium remained the first choice for most dentists, in this study was designed to compared flexible and cobalt chromium partial dentures in two tests (chewing activity and muscle efficiency) in different time intervals.

Patients and methods

This study was designed to compare the masticatory efficiency and chewing activity of patients with two different types of removable partial dentures (RPD), ten patients were selected, two female and 8 males with their ages ranging from 45 to 60. Two sets of RPD was fabricated for each patient, one conventional cast metal removable partial denture and the other one with removable partial denture. The patients wore each set of partial dentures with the upper complete denture for one month. After choosing the patients for this study, an upper complete denture and two sets of lower removable partial denture, one cobalt chromium and the other flexible partial denture were fabricated.

In this study ten patients were selected according to the following criteria:

Inclusion criteria:

Patient's age ranging between 40 to 60 years.

Normal skeletal Class I relation.

Bilateral edentulous areas located in mandibular arch (Kennedy class I) with no modification presents.

Missing teeth including premolars and molars.

The edentulous areas must have opposing completely edentulous areas.

Patients with no prior encounter to removable partial denture.

Exclusion criteria:

Patients with systemic conditions and xerostomia.

Patient suffering from psychological diseases. muscular dystrophy. parafunctional habits.

Bony undercut present in the edentulous area

Chewing activity test. In this study, a sieve

system was used to measure the chewing activity of patients with cobalt chromium and flexible partial dentures. A sheet of woven wire, 10 mesh, A4 size, 2mm hole, 0.6 wire, heavy stainless steel, was converted in to a ten-mesh sieve by soldering it in to a stainlesssteel ring. During the chewing activity test, the patients were seated in a dental chair with their head unsupported, and three portions of almonds, each of 3gm was weighed using an electrical balance with an accuracy of 0.01g. the patients were asked to chew each portion of the almonds for fifteen seconds and then spit them on a plastic disposable bowel covered with an absorbent paper without swallowing the almonds, the chewed almonds were left to dry for 48 hours in a room temperature of 23±2^{o}C. The spitted almonds were weighed on the electrical scale, then the spitted almonds were put into the ten-mesh sieve, the sieve has been shaken enough until all the small particles of the almonds that could pass through the sieve mesh came out. The remained amount of the almonds was weighed on the electrical scale again. the amount of almonds that remained on

Figure 1: The measured Almonds on the electrical balance.

Muscle Efficiency Test. To complete the muscle efficiency test, the EMG device in Erbil Psychiatric Hospital is used with the help of a neurophysiologist, expert in the area of sEMG. Each patient was tested in three different times (after one week of insertion, after two weeks and after one month) and for each patient the muscles were tested (without food, with hard food and with soft food). Each time these four muscles were tested (Right and left temporalis, right and left masseter). And for each muscle we examined (Amplitude, phase, turn, area) of the muscle to compare each one for each denture differently.

Before starting the sEMG test for muscle efficiency, the male patients were instructed to shave their beards to increase the stability of skin-electrode contact and for high-input impedance amplifiers, the patient was seated in an upright position with the head unsupported in a relaxing position parallel to the floor. Soft food (banana) and hard food (carrot) were used during the muscle efficiency test by the patients to chew or clench on. The carrot was sliced into pieces of 2mm thickness, that is measured by a manual Vernier and the banana was sliced into small pieces so the patient could chew while recording the muscle efficiency.

Three electrodes. In which two were recording electrodes and one was reference electrode were used for each muscle on each side (right and left) for recording the muscle efficiency. The muscle efficiency of masseter and temporalis were recorded in this study. For the masseter muscle, the electrodes were placed antero-superiorly to the angle of the mandible over the muscle. While for the temporalis muscle, a line was drown from the upper ear-line to the canthus of the eye and the electrodes were placed above this line, Nishi et al.[9] The two recording electrodes were placed on the determined muscle location and the reference electrode was placed on the sternocleidomastoid muscle in the neck

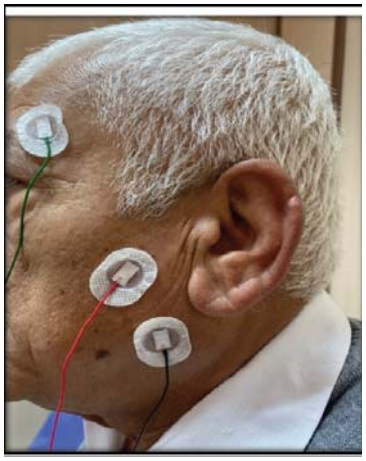

Figure 2: Set-up of the electrodes to the patient during the muscle efficiency test .

(Figure2) . The electrodes placed on the skin, connected to the sEMG device via the electrode cable and the sEMG device was connected to the PC.

Results

Regarding the chewing activity test, the amount of spitted almonds, remained and passed through sieve are considerably close to each other in both RPDs ($P > 0.05$). it can be noted that with time there was an increase in chewing ability of the patient between the first to the last visit, regarding both RPDs ,at the first visit the patient was-n't quite able to chew the almonds and had to try very hard to be able to chew since

Table 1: One Way ANOVA among visits for (spitted, remained on sieve, and passed through sieve) in both flexible and chrome.

Group			N	Mean G	Std. Deviation	F	P-Value
Flexible	Spitted	First	10	8.120	0.621	3.387	0.028
		Second	10	7.750	1.105		
		Third	10	7.150	1.318		
		Fourth	10	6.600	1.394		
		Total	40	7.405	1.251		
	Remained on Sieve	First	10	7.820	0.565	3.567	0.023
		Second	10	7.490	1.118		
		Third	10	6.770	1.209		
		Fourth	10	6.350	1.408		
		Total	40	7.108	1.225		
	Passed through Sieve	First	10	0.280	0.155	0.653	0.586
		Second	10	0.260	0.070		
		Third	10	0.380	0.432		
		Fourth	10	0.250	0.053		
		Total	40	0.293	0.230		
Chrome	Spitted	First	10	8.120	0.452	2.570	0.069
		Second	10	7.814	1.170		
		Third	10	7.554	1.050		
		Fourth	10	6.930	1.150		
		Total	40	7.585	1.046		
	Remained on Sieve	First	10	7.840	0.409	2.310	0.093
		Second	10	7.571	1.218		
		Third	10	7.315	1.065		
		Fourth	10	6.680	1.228		
		Total	40	7.333	1.072		
	Passed through Sieve	First	10	0.260	0.117	0.174	0.914
		Second	7	0.243	0.113		
		Third	13	0.246	0.052		
		Fourth	10	0.270	0.095		
		Total	40	0.255	0.090		

After performing the multiple comparison test, it can be noted that , There was an enhancement between the first to fourth visit, improvements of chewing ability of the patients from the first visit to fourth visit concerning the flexible partial denture, which indicated that the patient was well adapted to the flexible partial denture between the first and last visit which lead to improvements of the chewing ability of the patient, as shown in table 2.

Table 2: Improvements in chewing ability

	Group			Mean Difference g	Sig.
Flexible	Spitted	First	Second	0.370	0.889
			Third	0.970	0.252
			Fourth	1.520*	0.027
		Second	First	-0.370	0.889
			Third	0.600	0.651
			Fourth	1.150	0.133
		Third	First	-0.970	0.252
			Second	-0.600	0.651
			Fourth	0.550	0.710
		Fourth	First	-1.520*	.027
			Second	-1.150	0.133
			Third	-0.550	0.710
	Remained on Sieve	First	Second	0.330	0.912
			Third	1.050	0.173
			Fourth	1.470*	0.028
		Second	First	-0.330	0.912
			Third	0.720	0.485
			Fourth	1.140	0.123
		Third	First	-1.050	0.173
			Second	-0.720	0.485
			Fourth	.420	.836
		Fourth	First	-1.47000*	.028
			Second	-1.140	.123
			Third	-0.420	.836

Regarding the muscle efficiency test, Amplitude of both chromium cobalt and flexible partial dentures were reasonably similar to one another in the first week of muscle efficiency test, except for chewing of banana in the left temporalis muscle for both dentures, Regarding the second week, the same process was repeated for each denture in the same way. Independent sample T test was done to compare the amplitude of each muscle for both dentures, and (P >0.05) between the two dentures as the values were quite close to one another. Following one month since the denture insertion, the same procedure was done for both RPDs, and there were improvements of the amplitude of muscles with time as shown in table 3.

Table 3: Improvements of amplitude of muscles

				N	Mean N	Std. Deviation	P-Value
Without food	LT	Data	Flexible	10	0.403	0.130	0.362
			Chrome	10	0.494	0.131	
	RT	Data	Flexible	10	0.451	0.158	0.760
			Chrome	10	0.501	0.264	
	LM	Data	Flexible	10	0.508	0.357	0.608
			Chrome	10	0.400	0.179	
	RM	Data	Flexible	10	0.307	0.175	0.820
			Chrome	10	0.280	0.146	
Carrot	LT	Data	Flexible	10	0.658	0.215	0.528
			Chrome	10	0.742	0.130	
	RT	Data	Flexible	10	0.727	0.130	0.604
			Chrome	10	0.641	0.287	
	LM	Data	Flexible	10	0.522	0.315	0.819
			Chrome	10	0.567	0.208	
	RM	Data	Flexible	10	0.525	0.307	0.755
			Chrome	10	0.582	0.170	
Banana	LT	Data	Flexible	10	0.478	0.232	0.906
			Chrome	10	0.463	0.033	
	RT	Data	Flexible	10	0.392	0.065	0.557
			Chrome	10	0.453	0.196	
	LM	Data	Flexible	10	0.451	0.147	0.789
			Chrome	10	0.422	0.139	
	RM	Data	Flexible	10	0.316	0.106	0.566
			Chrome	10	0.377	0.162	

Discussion

In this study in order to decrease the confusion, an age limitation have been put with the condition that the patient didn't have a prosthesis experience before, but only those Patients were selected that visited Tishik International University / College of Dentistry-Prosthodontics department and accepted the protocol of this study and signed the consent of this study. Regarding the chewing activity test, the results of this

study revealed that both cobalt chromium and flexible RPDs increased the chewing ability but with different rates. Flexible RPDs increased the chewing ability with a higher rate and less time when compared to cobalt chromium dentures, this may due to more adaptation of the Flexible RPD because of its flexibility and also the satisfaction of the patients with this type of RPDs, This was somehow similar to the results of the study done by Bessadet et al[11] who investigated the chewing ability of cobalt chromium removable partial denture, a decrease in the median particle size of the test foods boluses and an increase in the chewing frequency were shown.

Ramadan [12] revealed that Increasing denture adaptation period improved the chewing efficiency with fewer chewing cycles only which coincides with this study, during the last visit chewing efficiency was improved and needed less chewing cycles comparing to the first visit.

Regarding the muscle efficiency test, the outcomes of the analysis revealed that the mean of masseter and temporalis muscle efficiency in flexible and cobalt chromium partial dentures denture were almost comparable to each other in the first visits, It's also more challenging for the patient to chew with new dentures than just clenching, since there is a higher chance of denture dislodgement during function, the muscle efficiency decreases more when chewing soft and hard food when comparing to the muscle efficiency without chewing food. that is why we recorded the muscle efficiency with dentures two days after insertion. De Araujoet et al[13] suggested that muscle fibers need an adaptation period of at least 2 weeks after the new prosthesis installation which coincides with this study, since the dentures started to adapt after two weeks of insertion and the patient's mastication improved.

Conflict of interest

The authors reported no conflict of interests.

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