EGYPTIAN DENTAL JOURNAL
www.eda-egypt.org
VOL. 71, 2211:2221, JULY, 2025
PRINT ISSN 0070-9484 • ONLINE ISSN 2090-2360
FIXED PROSTHODONTICS AND DENTAL MATERIALS
Submit Date : 06-03-2025 • Accept Date : 04-04-2025 • Available online: 10-07-2025 • DOI : 10.21608/edj.2025.364013.3401

RETENTION OF MANDIBULAR IMPLANT SUPPORTED OVERDENTURES USING CM-LOC AND LOCATOR ATTACHMENT SYSTEMS: A RANDOMIZED IN VITRO STUDY

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ABSTRACT

Aim: Implant supported overdentures have proved to be a better treatment option compared to conventional dentures in treating edentulous jaws. The present study was carried out to compare the retention of two different types of attachments used to retain single implant supported mandibular overdenture using universal testing machine after mechanical aging that was done by chewing simulator. The two attachments used in this study were Locator and Cendres and Meteaux Locator (CM-LOC).

Methods:. An epoxy model of completely edentulous mandible was constructed and prepared to receive single implant in the midline area by installing the implant analogue orthogonally using surveyor in the stone model then a silicone mould was created to be poured with the epoxy resin. Ten overdentures were constructed, randomization was carried out using a computer generated random sequence table each five models will be allocated into two groups. five containing PEKK matrix in Group A and other containing Nylon matrix in Group B. Pick up for both groups was carried out on the epoxy model using self cured acrylic resin under hand pressure. Then retention for both groups was initially measured at baseline using universal testing machine and then the overdentures in both groups were subjected to different chewing cycles 500, 100, 1500 and 2000 cycle. Retention was measured throughout after each cycle for both attachments.

Results: There was no Statistical significant difference between two groups except for retention after 500 cycles (3 months) (p-value=0.048). CM LOC group showed higher initial mean values compared with Locator group. Both attachment systems showed a significant decrease in retention over time.

Conclusion: Locator and CM-LOC attachment have shown acceptable retention values to support single implant mandibular retained overdentures. However both attachments have shown a decrease in retention when subjected to different chewing cycles , The CM-LOC attachment has shown significant better retention when compared to Locator attachment after 500 cycles .

KEYWORDS: Single implant, Mandibular, Overdenture , Retention

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INTRODUCTION

Implant-retained prostheses have solved the problems of complete denture, which improved quality of life, patient satisfaction and masticatory function. 1 Mandibular two implant overdentures have been recognized as the standard care of treatment for the edentulous patients. [2]

Single mandibular implant overdenture has been introduced by Cordioli et al., 3 1997 as an alternative cost effective treatment option , and proved to be a reliable treatment in the long term survival rates especially in the elderly population. [4-6]

The use of attachments in implant overdentures have resulted in better retention and stability comparing to conventional complete dentures. Different types of attachment systems such as ball and socket, bars and magnets are used in implant retained overdentures. Poper selection of the attachment system is of great importance to improve retention of overdenture. 7

The ball and Locator are the most commonly used retentive attachments with the single implant mandibular overdenture. 8 Recently polyetherketonketone (PEKK) was used in CM LOC attachment system as PEKK possess high chemical and mechanical properties such as good tensile , flexural and fatigue strength that reduces the wear. [9]

Retention is defined as the quality inherent in the dental prosthesis acting to resist forces of dislodgement along the path of placement. [10]

Retention together with stress distribution has a great effect on success of any prosthesis as it greatly affects patient satisfaction as it will ensure efficient chewing, acceptable appearance and good speech, patient complains are mostly related to lack of retention and stability. 11 Retention can be measured either subjectively or objectively, the subjective methods usually included patients and professional operator questionnaire, but it was proved to be universally unreliable, while the objective methods involved the construction of devices based on physical and mechanical principles as levers, pulleys, springs, dynamometers and strain gauges. [12]

The universal testing machine was used to assess the retention of the investigated prosthesis. Universal testing machines are capable of performing a variety of tests based on tension and compression especially those tests that can never be performed in vivo, Recently; in computer-controlled models, the computer provides automated control, data acquisition and analysis. [13]

The aim of this invitro study was to compare the retention between of Locator and CM LOC attachments system in retaining mandibular overdenture during simulation of insertion-removal cycles done using Robota chewing stimulator. [14]

METHODS

The main objective in the following study was to construct an epoxy resin model as a duplicate from a stone model with a single midline implant , to which two different attachment systems namely CM LOC and Locator will be screwed . Long term retention was compared between overdentures carrying corresponding matrices after pick-up.

1. Construction of Stone model

A definitive impression was made for a completely edentulous mandibular jaw, then poured to create stone model*. (Fig.1)

The stone model was placed on a surveyor table and drilled using milling surveyor in midline area by wide stone to create oversized hole compared to a diameter of analogue ** (3.5*10mm) [Zimmer Biomet Dental Implants, USA.] (Fig.2)

* Acrostone Dental & Medical Supplies, Heliopolis, Cairo, Egypt
** REPLISIL 22 NF Hersteller / manufacturer: dent-e-con e.K

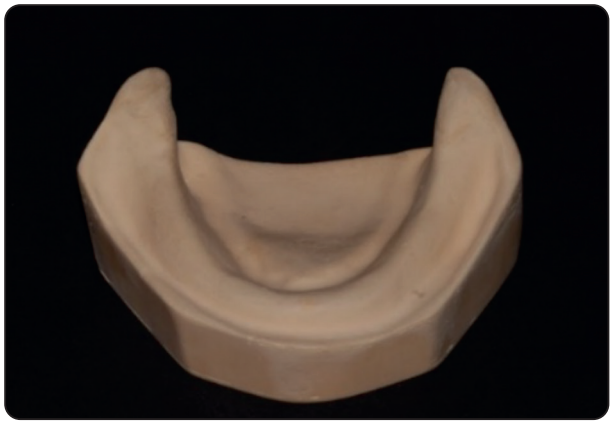

Fig. (1) Stone model

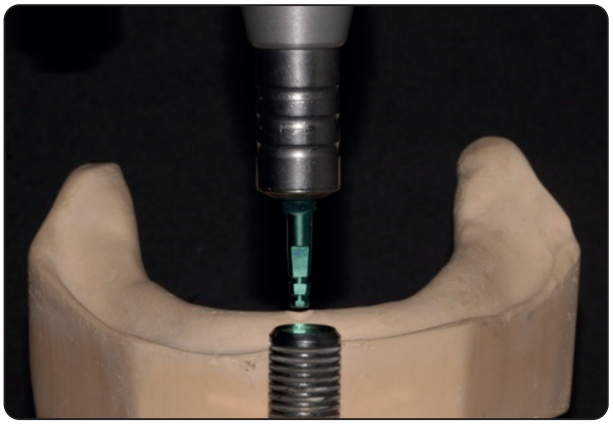

Fig. (3) Orthogonal placement

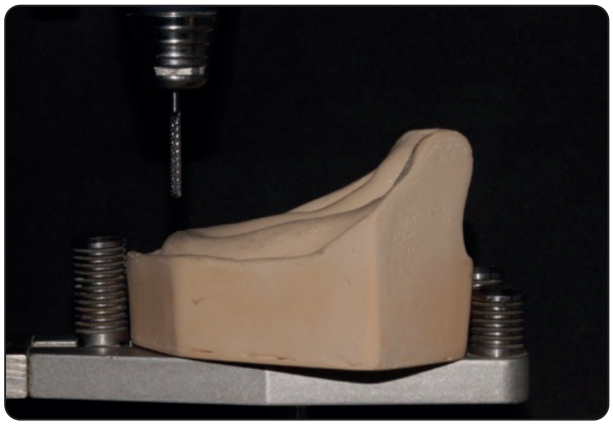

Fig. (2) Drilling using a milling surveyor

Fig. (4) Implant analogue & Coping

The implant analogue was attached to implant mount of surveyor to ensure orthogonal placement inside oversized hole also a plasticizer was used to ease it's removal during duplication (Fig 3).

After placement of analogue flushing with stone model the transfer coping was manually fastened into implant analogue (Fig 4).

2. Construction of epoxy resin model :

Duplication of obtained stone model was done using laboratory addition-curing 1:1 duplicating silicones * namely REPLISIL, after placement inside a duplicating flask that fits for obtained stone model (fig 5).

Fig. (5) Stone model in the duplicating flask

* Kemapoxy 150 JM, Chemicals for Modern Building International, Egypt

Then pouring into the flask constantly from a height of approximately thirty cm constantly until it's all round covered (fig 6).

After a curing period of approximately thirty minutes the obtained silicone mould was poured with transparent epoxy resin [iii] over a model vibrator to get rid of air bubbles and left overnight for setting (fig 7).

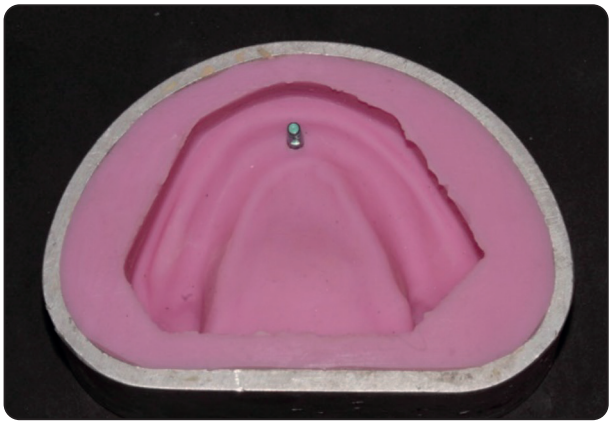

Fig. (6) Duplication mold

Fig. (7) Epoxy resin model

3. Construction of complete dentures :

Ten mandibular complete dentures were fabricated on ten stone models following the conventional manner (fig. 8) then the finished dentures were placed on the epoxy model (Fig 9).

Fig. (8) Waxed up denture

Fig. (9) Finished denture on epoxy resin model

4.Pick-up of matrix:

The ten fabricated overdentures were randomized into two groups A and B using sealed envelopes carried out by the principal investigator. Each group contained five dentures. Group A was set to receive the CM LOC attachment and group B was set to receive the Locator attachment (Zimmer)

CM LOC titanium abutment was screwed into implant analogue and tightened using a torque wrench (Fig10). To detect the exact position of attachment housing in the fitting surface of denture, a transferable mark was made on top of the CM LOC patrices with a pencil and the denture was seated. Depressions were prepared in the fitting of the denture to create space for the metallic housing with at least 0.25mm of space between the housings and the denture and a very small hole was made to allow for the escape of excess acrylic resin during pick up (Fig 11).

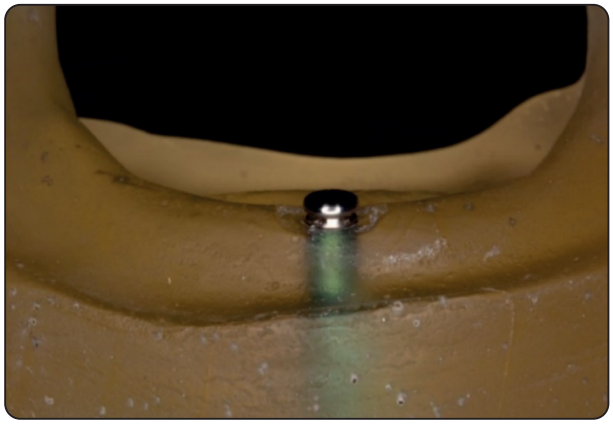

Fig. (10) CM LOC abutment on implant analogue

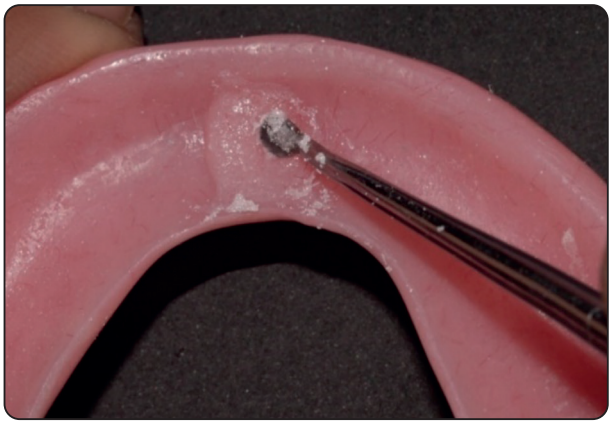

Fig. (12) Auto-polymerizing acrylic resin mix for attachment pick-up

Fig. (11) Denture preparation for pick-up

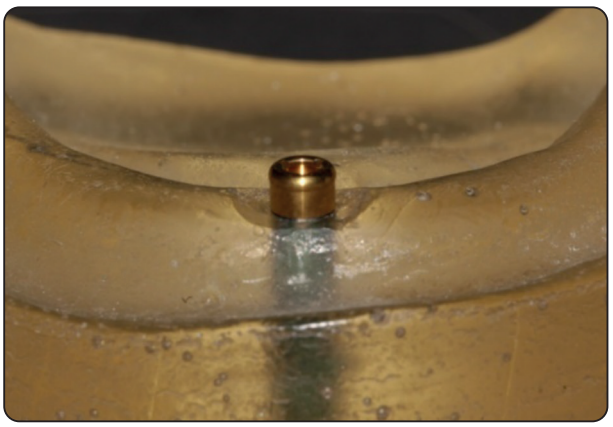

Fig. (13) Locator abutment on epoxy model

Self cured acrylic resin was used for attaching the CM LOC attachment housings into the denture (Figure 12). Little amount of material was placed into the depressed area of the fitting surface of the denture and around the titanium housings. The denture was seated and maintained in a passive position while the denture material sets. Finally the denture removed and the excess acrylic removed then finished and polished (Fig 14).

The locator abutment was placed on the implant analogue using the Locator core tool and then tightened to achieve optimum 30N-cm of torque using torque wrench (Figure 13) then the same previous pick up technique was done again to pick up the housing of locator inside the denture (fig 15)

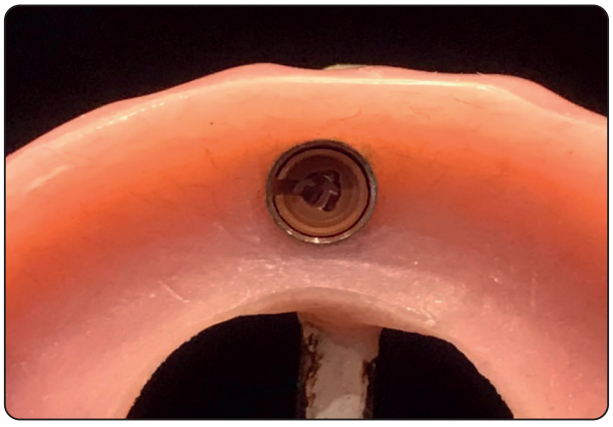

Fig. (14) CM housing with PEKKTON retention insert

Fig. (15) Locator housing with Nylon insert

5. Determination of the Geometric centre

Geometric center of the denture is identified by marking the midline on the polished surface and the center of the retromolar pads then a cardboard is cut to connect the space between the three fore mentioned marks. A line bisecting each angle of the formed triangle will be then drawn on the cardboard. The geometric center of the denture will be at the point of intersection of the previous three lines (Fig 16) .This method was previously used by many investigators 15,16 Afterwards , a tripod steel rod was prepared and attached to the denture using autopolymerizing acrylic resin.

Fig. (16) Geometric centre

6 . Baseline retention measurement :

After preparing the overdentures with geometric center, all the overdentures of both groups were subjected to tensile forces using universal testing machine to record the retention at the baseline. . The epoxy resin model with the overdenture was attached to the lower compartment of the universal testing machine [iv] While the upper compartment was attached to the overdenture (fig 17).

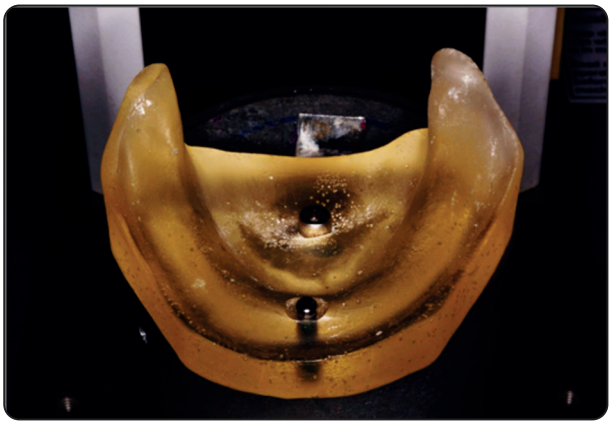

Fig. (17) Epoxy model fixed in place on the platform of the Instron machine

7. Chewing simulation:

Chewing cycles as well as insertion and removal cycles were done using programmable logic controlled equipment ROBOTA [*] a chewing simulator.

ROBOTA chewing simulator consists of four chambers that simulate the horizontal and vertical movements simultaneously in the thermodynamic condition. These cycles can be performed in wet environment simulating the saliva (Isotonic 0.9% sodium chloride solution at 22°C) (Figure 18).

The vertical movements done by upper compartment should be able to detach the metal housing with the retentive part away from the patrix, it was made 12mm (Table 1). A weight of 5 kg, which is comparable to 49 N of chewing force was exerted (Figure 19). which has been reported to approximate the speed of the movement of the

[v] Model ACH-09075DC-T, AD-Tech Technology CO., LTD., Germany

denture away from the ridge during mastication (Sarnat AE., 1983).

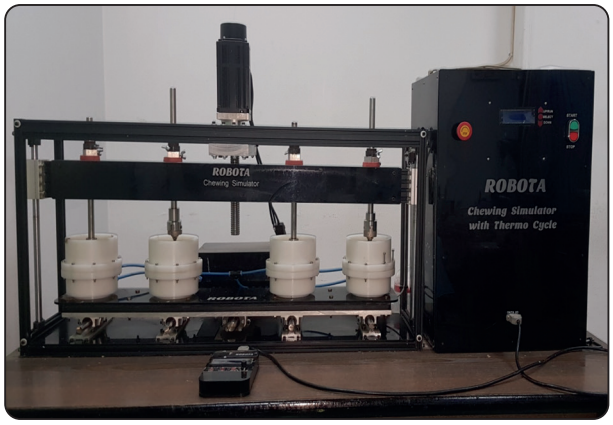

Fig. (18) Robota chewing simulator

Fig. (19) Denture in place on the chewing simulator

The test was repeated four times to obtain 500, 100,1500 and 2000 cycles of insertion/removal cycles according to previously performed studies (Table 1). This test was performed to every denture in each group (A and B).

TABLE (1) Chewing simulator parameters

Chewing simulator parameters	
Vertical movement: 12 mm	Horizontal movement: 0.2 mm
Rising speed: 90 mm/s	Weight per sample: from 5 kg
Descending speed: 40mm/s	Torque; 2.4 N.m
Cycle frequency 1.6 Hz	

8. Retention Measurement throughout the cycles:

The retention then will be measured at (0,500,1000,1500,2000) cycles which represents (0,3,6,9,12) month using the Instron universal testing machine [Model 3345; Instron Industrial Products, USA].

The epoxy resin model was fixed to the lower compartment of the universal testing machine by the aid of a hole made in the epoxy model to be fixed to the lower compartment by tightening screw (Figure 20). while overdenture tripod steels were fixed to the upper compartment of the machine. During the testing process, saliva is present as the epoxy model was placed in the bottom of a plastic deep pool while the vertical cylinder of testing machine penetrates the bottom of the pool to be attached to the lower compartment of the universal testing machine.

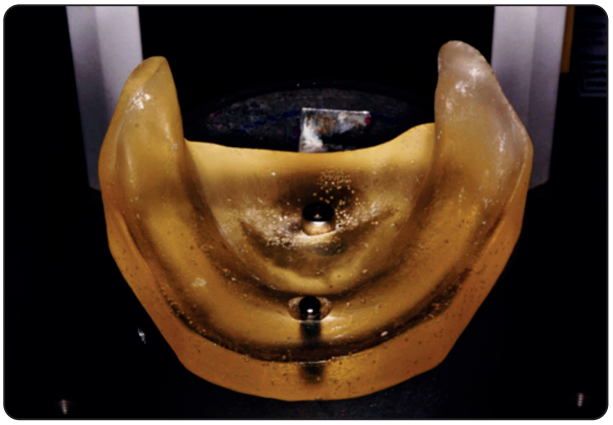

Fig. (20) Epoxy model fixed in place on the platform of the Instron machine

RESULTS

Results for the CM LOC group (A) showed a mean value of 52.3±14.7 N at the baseline, When the CM-LOC group was subjected to different cycles and the retention was evaluated, there was a general decrease in retention for each of the subjected cycles for the five tested overdentures .

There was a statistically significant difference between the different cycles p=0.001 (Table 2), therefore pairwise comparisons was carried out and it revealed that there was a statistically significant difference in retention at 500 cycles (3 month) and 1500 Cycle (9 month) (p=0.041).(Table 3).

TABLE (2) Mean retention for the CM-LOC group at base line and different cycles

Baseline (A)	500 Cycle (B)	1000 Cycle (C)	1500 Cycle (D)	2000 Cycle (E)	
Mean ±SD*	**Mean ±SD**	**Mean ±SD**	**Mean ±SD**	**Mean ±SD**	**p value**
52.3±14.7	49.9±16.1 [a]	20.3±6.7	13.8±3.4 [a]	15.6±2.9	0.001

SD*: Standard Deviation, similar letters are statically significant

TABLE (3) Pairwise comparison between the cycles of CM-LOC group

CM			
		500 c	**1.000**
		1000 c	**0.192**
		1500 c	**0.069**
		2000 c	**0.090**
	500 c	**Baseline**	**1.000**
		1000 c	**0.079**
		1500 c	**0.041***
		2000 c	**0.065**
	1000 c	**Baseline**	**0.192**
		500 c	**0.079**
		1500 c	**0.350**
		2000 c	**1.000**
	1500 c	**Baseline**	**0.069**
		500 c	**0.041***
		1000 c	**0.350**
		2000 c	**1.000**

(*) P value ≤0.05 is considered statistically significant.

For the Locator group (B) a mean value of 45.1±11.7 N was recorded at the baseline, While when the Locator group was subjected to different cycles there was a general decrease in retention throughout the 4 different cycles for the five tested overdentures.

There was a statistically significant between the different cycles (p= 0.001) (Table 4), therefore pairwise comparisons was carried out and revealed that baseline retention was statistically significant from 2000 Cycle (12 month) (p=0.011) while 500 cycle (3 month) was statistically significant from 2000 cycle (12 month) (p=0.024) (Table 5)

TABLE (4) Showing mean retention for the Locator group at the different cycles

Baseline (A)	500 Cycle (B)	1000 Cycle (C)	1500 Cycle (D)	2000 Cycle (E)	
Mean ±SD*	**Mean ±SD**	**Mean ±SD**	**Mean ±SD**	**Mean ±SD**	**p value**
45.1±11.7 [a]	30.7±9.2 [b]	19.5±3.4	16.3±6.2	12.5±5 [a-b]	0.001

****: SD: Standard Deviation, similar letters are statically significant***

TABLE (5) Pairwise comparison between the different cycles of Locator group

Pairwise Comparisons			p value
Locator	Baseline	500 c	0.292
		1000 c	0.154
		1500 c	0.055
		2000 c	**0.011***
	500 c	Baseline	0.292
		1000 c	1.000
		1500 c	0.055
		2000 c	**0.024***
	1000 c	Baseline	0.154
		500 c	1.000
		1500 c	1.000
		2000 c	1.000
	1500 c	Baseline	0.055
		500 c	0.055
		1000 c	1.000
		2000 c	1.000

(*) P value ≤0.05 is considered statistically significant.

When comparing the mean retention values between the attachments, At base line there was no statistically significant difference between them, showing a greater retention values for the CM-LOC attachment (52.3±14.7, 45.1±11.7 p=0.414) (Table 6). There was a statistically significant difference between the two attachments after 500 cycles =3 months (p=0.048) (Table 6), the CM-LOC attachment showed a statistically significant higher mean values when compared to Locator attachment at 500 cycles (49.9±16.1, 30.7±9.2 (p=0.048) (Table 6 Fig 21). No statistical difference was found at the following cycles 1000= 6 months, 1500= 9 months and 2000=12 months, having the CM-LOC attachment.

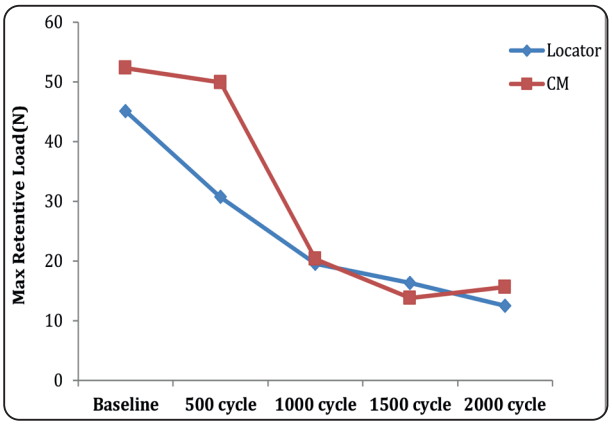

Fig. (21) Line graph representing Max Retentive Load (N) at baseline and different cycles between 2 groups

TABLE (6) Comparison of retention results for the two groups at different cycles

Max Retentive Load (N)	Locator		CM		
	Mean	SD	Mean	SD	P value
Baseline	45.1	11.7	52.3	14.7	0.414
500 cycle=3 month	30.7	9.2	49.9	16.1	0.048
1000 cycle=6 month	19.5	3.4	20.3	6.7	0.803
1500 cycle=9 month	16.3	6.2	13.8	3.4	0.452
2000 cycle=12 month	12.5	5	15.6	2.9	0.272

****: Significant at P ≤ 0.05, P values with different colors are statistically significantly different.***

DISCUSSION

Retention could be considered to be important for improving patient satisfaction as it will improve chewing efficiency, provides acceptable appearance and good speech. **Schweyen et al, 2015** mentioned that patient satisfaction is directly associated with denture retention.

One of the most important factors in selection of appropriate attachment system for implant supported mandibular overdentures is the retentive force and retention loss as Burns et al., 1995 proved in a cross-over experimental design that the attachment with superior retention is associated with strong patient preference.

In the present study, both attachment systems showed a statistically significant decrease in retention after mechanical testing (p=0.001), previous studies [17-19] revealed retention loss over time of an attachment due to the wear of the attachment occurring as a result of contact between retentive surfaces of attachment during insertion/ removal cycles of the overdentures subsequently leading to retention loss. The results of current study coincides with the all previous investigations, where the locator attachment showed a continuous loss of retention , while the CM-LOC have shown a slight increase in retention at 2000 cycle =12 month which coincide with two previous studies [20,21] the reason for this increase may be explained by prolonged surface deterioration that result in increase in surface roughness of the matrix producing micro mechanical friction and subsequently increasing retention. [22]

The results of this in vitro study revealed no significant difference between the initial retentive mean values of CM-LOC attachment (52.3±14.7) and the Locator attachment (45.1±11.7) at the installation time (p=0.414). Similarity of the morphology and design of the attachments in addition to the matrices material which is made of resin matrix owed to these results. The higher initial mean values of the CM LOC group (A) compared to Locator group (B) may be due to the water absorption property of the material of the matrix , as the nylons posses three to four times higher level of absorption than PEKK which are polymers known with low water absorption properties. [23-24]

CM LOC attachment showed a statistically higher significant mean when compared to Locator attachment after 500 cycles = 3 months only An explanation regarding the PEKK matrix design , there is a slot in the matrix , this slot expands when connecting the patrix and the martix and may act as a buffer, that accounts for the reduction in the deterioration of the matrix surface resulting in a less premature wear of the material, in addition to the material that high mechanical and good chemical properties . This would explain the reason for the higher mean retentive value of the CM LOC attachment when compared to the Locator attachment.[17]

CONCLUSION

Single implant overdenture is a simple, reliable treatment modality for treating edentulous mandible and both CM LOC and Locator attachments are good alternatives for such treatment modality. CM-LOC seemed to offer promising results, but care should be given to the frequency of matrix changing and maintenance.

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