



MUSCLE ACTIVITY OF IMPLANTS SUPPORTED OVERDENTURE USING BALL AND SOCKET VERSUS LOCATOR ATTACHMENTS: A RANDOMIZED CLINICAL CONTROL TRIAL.

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Abstract

Background: The high-profile design of ball and socket attachments lead to excessive occlusal vertical dimension which may have a bad effect on the muscle activity and also may lead to the denture breakage in completely edentulous patients. Therefore, will the use of locator attachment influence the muscle activity when compared to ball and socket attachment in mandibular implant overdenture?

Aim: This RCT is to evaluate the activity of masticatory muscles of implant supported mandibular overdentures using two different types of attachments (ball and socket versus locator) in completely edentulous patients after insertion of attachments by two weeks, three months and six months.

Methodology: The proposed number of the patients was 24, 12 per each group.

The patients were divided into two groups:

Group A: patients receive mandibular overdenture with ball & socket attachments

Group B: patients receive mandibular overdenture with locator attachments

Patients were recalled 2 weeks later after attachment placement, 3 months and 6 months for muscle activity measuring using a digital electromyogram device

Results: Implant retained mandibular overdentures with locator attachment system provide high muscle activity in comparison with implant retained mandibular overdentures with ball and socket attachment system.

Conclusions: Implant retained mandibular overdentures with locator attachment system provide high muscle activity in comparison with implant retained mandibular overdentures with ball and socket attachment system.

The muscle activity of masseter is higher than temporalis muscle and the activity of masseter and temporalis muscles increase with time.

Keywords: Edentulism, ball-attachments, locator-attachments, muscle activity.

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1. INTRODUCTION

Severe bone loss in the alveolar ridges occurs in individuals of complete dentures wearers because of the lack of retention and the instability of the denture.

(1) The use of dental implants supported over denture decrease the residual ridge resorption, increase the retention, the stability of the denture (2), the chewing and masticatory functions (3) resulting in improving the life and the function.(4,5)

Ball attachments are considered the simplest and cheapest one between all attachments as it not complicated as the bar and telescopic attachments.

However, the ball attachments need 10–12 mm minimum space compared with locators which need only 8.5mm result in too high constructed prosthesis and the teeth become bulge with high of occlusal vertical dimension and subsequently fracture of attachments, prosthesis or adjacent prosthetic teeth. (6, 7)

The muscle activity during mastication is induced by a force exerted in the masseter and temporalis muscles (8) measured by digital electromyogram device. (9) Electromyography has a potential to record and analysis the electric of the muscles

during eating different types of food either soft or hard food (10).

The issue with the ball and socket attachments is the high profile design that lead to excessive occlusal vertical dimension which may has adverse effect on the muscle activity. Therefore, the question which would arise; Will the use of locator attachment enhance the muscle activity in comparison with ball and socket attachment in mandibular implant overdenture?

2. PATIENTS

Study will be conducted in the Removable Prosthodontics Department, Faculty of Dentistry - Cairo University, Egypt. Patients will be selected from the outpatient clinic of the Department of Removable Prosthodontics- Cairo University. The inclusion criteria were as follows: 1. Age range from (45 to 65 years) with upper and lower completely edentulous patients. 2. Acceptance of the existing dentures if it is not older than one year after evaluation of their quality (denture base, extension of borders, teeth wearing and stability of denture). 3. Tooth extracted at the implant site not less than 6 month. While the exclusion criteria were as follows: 1- Young patients. 2- Diseases affecting neuromuscular coordination. 3- TMJ diseases. 4- Soft tissue abnormalities. 5- Bony exostosis. 6- Systemic disease (Parathyroid dysfunction or uncontrolled diabetes). 7- Psychological disabled patients. 8- Radiotherapy to the neck or head 9- Pregnancy. 10- Drug and alcohol dependency. 11- Smokers.

Patients those filling the inclusion criteria were be involved and signed on Arabic informed consent which was reviewed by the Ethics Committee of Faculty of dentistry Cairo University.

Sample Size:

In this study the proposed number of the patients was 24, 12 per each group as were calculated by the Medical Biostatistics Unit review report for sample size calculation of Faculty of Dentistry - Cairo University, Egypt.

Methods:

- Two implants in canine region in mandibular arch were be seated using implant Neo biotech company (Neo biotech system is II active fixture narrow dental implant, made in Korean, Implant code: BIS3508A).
- After three months, the implants were be uncovered by small crestal incisions. The cover screws were be removed and the healing abutments were be placed for maximum two weeks for the gingiva to heal.
- The patients were be divided into two groups:
Group A: patients receive mandibular overdenture with ball & socket attachments

Group B: patients receive mandibular overdenture with locator attachments

- After two weeks, the healing abutments were removed and the male part of the selected attachments were be inserted inside the implant body using appropriate torque (hex driver)
- A preparation of adequate space on the denture (housing holes) were be done which this were be the female part of the attachments.
- Patients were be recalled 2 weeks later after attachment placement, 3 month and 6 month for muscle activity measuring using a digital electromyogram device.

Ethics Approval:

The study protocol was approved by the Research Ethical Committee of Cairo University of Dentistry with the registration code number (19777).

STATISTICAL ANALYSIS RESULTS:

Statistically analysis was performed with SPSS 20®, Graph Pad Prism® and Microsoft Excel 2016. All quantitative information were explored for normality by using Shapiro Wilke Normal test and presented as minimum, maximum, median, means, standard error and standard deviation (SD) values.

3. Tests used

- Shapiro Wilk Normality test and Kolmogorov tests were used for data exploration of muscle activity (Quantitative data).
- Comparison between different groups regarding muscle activity (Quantitative data) was performed by using Independent t-test, comparison between different intervals and different food types were made by using (One Way ANOVA) test then (Tukey's Post Hoc) test for multiple comparisons.

Comparison between group I & II:

1. Masseter:

Mean and standard deviation of muscular activity of masseter muscle regarding cake, walnut and banana at different intervals were presented in table (1) and figure (1), Also comparison between ball and socket group and locator group at different intervals were performed by using Independent t-test.

- **After 2 weeks:** locator was significantly higher than ball and socket as $P < 0.05$, regarding all food types.
- **After 3 months:** locator was significantly higher than ball and socket as $P < 0.05$, regarding cake and walnut, while in banana there was insignificant difference between them.
- **After 6 months:** locator was significantly higher than ball and socket as $P < 0.05$, regarding walnut, while in cake and banana there was insignificant difference between them.

Table (1): Comparison between both groups regarding muscle activity of masseter muscle

Masseter Interval	Group	Cake		Walnut		Banana	
		M	SD	M	SD	M	SD
2 weeks	Ball and socket	251.00	13.44	295.25	18.74	258.00	20.51
	Locator	333.25	90.86	344.25	70.36	358.00	41.72
	P value	0.005*		0.02*		<0.0001*	
3 months	Ball and socket	351.25	13.79	401.25	8.84	345.25	11.67
	Locator	409.50	67.18	377.25	38.54	354.25	71.77
	P value	0.007*		0.04*		0.67	
6 months	Ball and socket	366.25	12.37	327.75	7.42	335.75	6.01
	Locator	363.50	101.12	369.75	29.34	316.00	70.71
	P value	0.92		<0.0001*		0.34	

M: mean SD: standard deviation *Significant difference as P<0.05

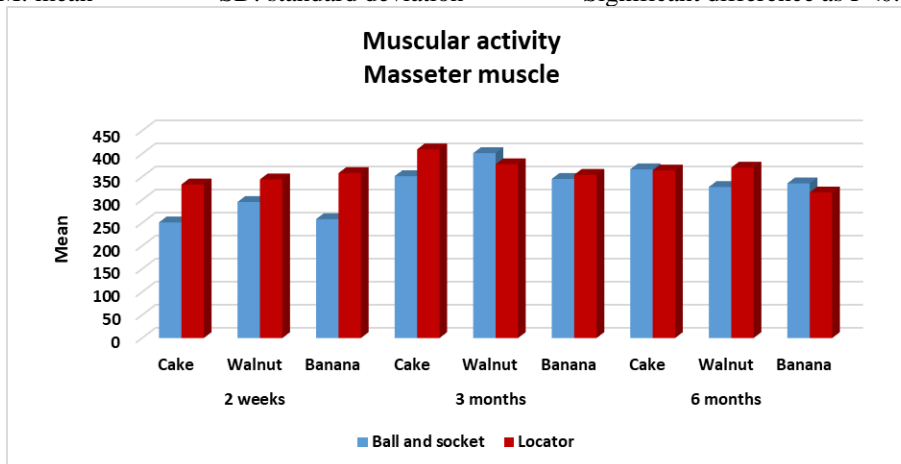


Figure (1): Bar chart representing muscular activity masseter muscle at different intervals regarding all food types in both groups

2. Temporalis:

Mean and standard deviation of muscular activity of temporalis muscle regarding cake, walnut and banana at different intervals were presented in table (2) and figure (2), Also comparison between ball and socket group and locator group at different intervals were performed by using Independent t-test.

•**After 2 weeks:** locator was significantly higher than ball and socket as P<0.05, regarding banana only as P

<0.05, while there was insignificant difference between them regarding cake and walnut as P>0.05.

•**After 3 months:** locator was significantly higher than ball and socket as P<0.05, regarding walnut and banana, while in cake there was insignificant difference between them as P>0.05.

•**After 6 months:** locator was significantly lower than ball and socket as P<0.05, regarding all food types.)

Table (2): Comparison between both groups regarding muscle activity of temporalis muscle:

Temporalis Interval	Group	C		W		B	
		M	SD	M	SD	M	SD
2 weeks	Ball and socket	164.50	26.87	192.25	18.74	154.25	5.30
	Locator	164.00	19.09	194.00	20.51	200.75	8.13
	P value	0.95		0.95		<0.0001*	
3 months	Ball and socket	222.50	7.07	226.75	5.30	185.75	8.13
	Locator	266.50	123.74	324.50	147.08	316.25	155.21
	P value	0.23		0.03*		0.008*	
6 months	Ball and socket	275.00	6.36	275.00	4.95	263.00	7.78
	Locator	200.00	57.28	234.50	27.58	194.50	58.69
	P value	0.0002*		<0.0001*		0.0006*	

M: mean SD: standard deviation *Significant difference as P<0.05

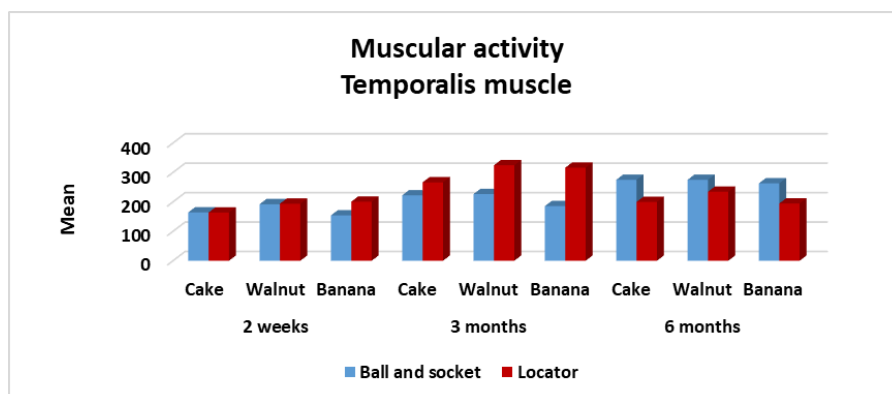


Figure (2): Bar chart representing muscular activity temporalis muscle at different intervals regarding all food types in both groups.

4. DISCUSSION

Prolonged absence of teeth results in decrease of the masticatory efficiency and perception leading to asymmetry of the masticatory musculature besides nutritional deficiency. (11) Previous studies showed that muscle activity is higher in two-implant retained overdentures compared to conventional dentures. (12).

The more stable and retentive the overdenture, the more active is the masticatory muscles due to the reorganization of the neuromuscular system leading to a more effective masticatory activity. (13) On these bases the retention and stability of attachment retained overdenture have a great effect on the muscle activity.

Regarding the difference between muscles (masseter and temporalis); masseter muscle activity was significantly higher than temporalis muscle in all-time intervals when chewing all types of food using ball and socket attachment and within time intervals except three months (no significance) when chewing all types of food using locator attachment.

Regarding the difference between the two attachments (ball and socket attachment and locator attachment); the muscle activity of masseter using locator attachment was significantly higher than ball and socket in all time intervals with chewing different food materials. As well as the muscle activity of temporalis using locator attachment was significantly higher than ball and socket in two weeks and three months only with chewing different food materials.

Shastri T et al., 2016. Revealed that locator attachment had the least amount of retention (33.5 ± 9.77 N) when compared to ball (40.3 ± 15.83 N) and bar attachments (46.9 ± 13.9 N). (14) And De Albuquerque et al., 2019 reported that the ball attachment has higher average retention than the other attachments with a difference of 5.0 N and no distinguishing for one type of attachment versus the other was observed. (15) In agreement with these studies Moustafa Elsyed et al, 2019 reported that ball attachment is recommended over Locator

attachments for improving the muscle activity. (16) But these conclusions are inconsistent to results of present research.

Artur Miguel et al., 2017 in a systematic review reported that; upper or lower overdentures with the locator attachment system provide good retention, feeling more comfortable and it is highly recommended clinically for prosthetic rehabilitation. (17) Sultana et al., 2017 reported that retention in locator retained overdentures was initially higher than ball attachments. (18) But due to cyclic loading with time both of attachments loss their retention. However, this is more pronounced with using Locator than ball attachments. Varshney N et al, 2019 reported that locator attachment exhibits increasing retentive capacities than ball and socket attachment and bar and clip one (19) while another Systematic review done in 2021 reported that bar attachment provided the most superior retention. (20) In agreement with these studies, Abdelhamid AM et al, 2016 reported that in designing two implant retained mandibular overdentures, the masticatory function in the Positioner (locator) attachment is more superior to Ball & Socket attachment. In addition the muscle activity of masseter was higher than the temporalis muscle in both types of the attachments which is consistent with the results of the present study. (21)

Shahinaz sayed et al, 2021 also reported that Implant retained mandibular overdentures with locator attachment system provide stability and retention of the overdenture which is much important than support. And thus, improving masseter and temporalis muscle activity in comparison to implant supported overdenture without attachments or conventional dentures. The muscle activity of masseter

and temporalis was significantly increased with the passage of time. (22) These studies are in consistent with the present study which showed the increase of muscle activity using locator attachment in comparison with ball and socket attachment system, the muscle activity of masseter was higher than the

temporalis muscle and there was an increase of activity of masseter and temporalis muscles with the time intervals.

The muscle activity of masseter was higher than the temporalis muscle which could be explained by Oliveira LF et al., in 2017 who reported that during dental clenching of peanuts, raisins, and Parafilm in healthy individuals, the masseter muscles exhibit myoelectric activity higher than the temporal muscles (23) since the temporalis and masseter muscles have the function of elevating the mandible and closing the mouth but the temporal muscle responsible in velocity as it is the first to be contracted in mandibular closure, it is considered a positioner of the mandible as it adjusts the direction of the movement, acting as a synchronizer of motions, while the masseter is a strong muscle with a power function that carries and supports the bones, protects and drives the motion, masseter has a small role in protrusion of the mandible considering as a power conducting muscle. (23), (24)

Increase of masseter and temporalis muscle activity with passage of time could be explained by Giannakopoulos NN et al., in 2017 who reported that; a significant improvement in masticatory performance after passage of 3 months using implant-supported mandibular overdentures manifested in maximum increase of muscle contraction and total work. This could be attributed to the increased neuromuscular adaptation to the dentures with time that lead to a better neuromuscular control acquired by patients with passing time, improving patient acceptance and adaptation to the prosthesis. (25)

The type of food has a great effect on muscle activity. The clenching time and stroke number increased by increasing the hardness level of food. (26) The harder food items record higher EMG amplitude than soft foods. (27) Therefore, increasing the muscle activity of hard food (walnut) compared to soft food (cake or banana) is in line with conclusions of the present research. (28)

Limitation within the study:

1. Follow up period was limited to 6 months, longer follow up periods is required.
2. Confounders may be found in the present study due to lack of sex categorization.

5. CONCLUSION

-Implant retained mandibular overdentures with locator attachment system provide high muscle activity in comparison with implant retained mandibular overdentures with ball and socket attachment system.

-The muscle activity of masseter is higher than temporalis muscle and the activity of masseter and temporalis muscles increase with time.

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Conflict of Interest:

There were no conflicts of interest to disclose.

Authorship Statement:

We confirm that all listed authors meet the authorship criteria and that all authors agree with the manuscript's content.

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