



## **THE EFFECT OF THE BILATERAL BALANCED OCCLUSION AND THE CANINE GUIDANCE OCCLUSION OF IMPLANT RETAINED MANDIBULAR OVERDENTURE ON BITING FORCE AND MASTICATORY EFFICIENCY**

Ahmed A. Abdallah<sup>\*</sup>, Ehab M.A. Halim<sup>\*\*</sup> and Mostafa A.S. Ali<sup>\*\*</sup>

### **ABSTRACT**

**Abstract:** Retention and stability are problems of the mandibular prosthesis causing complain of complete denture wearers. Mandibular implant over denture is a successful treatment in this group of patients. The occlusal scheme is an important factor in the design of complete dentures, the occlusal philosophies that are proposed for implant overdentures are based on those for conventional complete dentures. Two occlusal concepts exist in complete denture treatment: bilateral balanced occlusion and canine guidance both include simultaneous contact in centric occlusion, but they differ in eccentric movements.

**Materials and Methods:** Six completely edentulous male patients since two years ago were selected according to some criteria, each patient was received upper and lower complete dentures with bilateral balanced occlusion, then each patient was received two root form implants at the canine area, then the same patient's mandibular denture was modified to the overdenture, after the adaptation period exchange of the occlusal scheme and the recording procedures were made.

**Results:** Improved biting force and masticatory efficiency with implant retained mandibular overdenture, high values of biting force with bilateral balanced occlusion, better values of masticatory efficiency (less time & number of strokes) with canine guidance occlusion.

**Conclusion:** Improved biting force and masticatory efficiency with implant retained mandibular overdenture. The bilateral balanced occlusion in case of biting force has maximum biting force value than canine guidance occlusion. The canine guided occlusion in case of masticatory efficiency has less time and number of strokes than bilateral balanced occlusion.

**KEYWORDS:** Bilateral balanced occlusion, Canine guidance occlusion, Overdenture, Biting Force and Masticatory Efficiency.

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\* Dentist, Ministry Of Health, Luxor Directorate, Infection Control Team.

\*\* Associate Professor of Removable Prosthodontics, Removable Prosthodontics Department, Faculty of Dental Medicine, Al-Azhar University (Assiut).

## INTRODUCTION

Retention and stability are problems of the mandibular prosthesis often cause complain of complete denture wearers and masticatory function of these subjects is quite poor in comparison with that of healthy dentate subject .their maximum bite force is only 20-40% that of dentate subject. <sup>(1)</sup>

Mandibular implant overdenture treatment is a successful treatment modality in this group of patients. <sup>(2)</sup>

Improvement in bite force and chewing efficiency following implant treatment in edentulous patients has been demonstrated for many years. Most agree that one of the purposes of posterior tooth morphology is to aid the patient in the mastication of food while maintaining freedom of contact in all border movements. <sup>(3)</sup>

Biting force is defined as , the result of muscular force applied on opposing teeth ; the force created by the dynamic action of the muscles during the physiologic act of mastication ; the result of muscular activity applied to opposing teeth. <sup>(4)</sup>

The bite force measurements can be made directly by using a suitable transducer that has been placed between a pair of teeth. This direct method of force assessment appears to be a convenient way of assessing the submaximal force. An alternative method is indirect evaluation of the bite force by employing the other physiologic variables known to be functionally related to the force production. <sup>(5)</sup>

Masticatory efficiency is the effort required for achieving a standard degree of comminution. <sup>(4)</sup>After implant treatment, subjects needed only about half the number of chewing cycles as before treatment to comminute their food to a certain size. Jaw muscle activity during chewing did not significantly change after implant treatment. Thus, patients chewed more efficiently, a decrease in masseter muscle activity during swallowing was observed after implant treatment, which may indicate adaptation to the

new condition of more stability of the mandibular denture. <sup>(6)</sup>

The occlusal philosophies that are proposed for implant overdentures are based on those for conventional complete dentures. <sup>(7)</sup>

Occlusal scheme is defined as the form and the arrangement of the occlusal contacts in natural and artificial dentition. The choice of an occlusal scheme will determine the pattern of occlusal contacts between opposing teeth during centric relation and functional movement of the mandible. With dentures, the quantity and the intensity of these contacts determine the amount and the direction of the forces that are transmitted through the bases of the denture to the residual ridges. That is why the occlusal scheme is an important factor in the design of complete dentures. <sup>(8)</sup>

The occlusal scheme described as fully bilateral balanced articulation, this occlusal scheme is designed for the bilateral, simultaneous anterior and posterior occlusal contact of the denture teeth in the centric and eccentric positions with a cross-arch balanced articulation. <sup>(9)</sup>

Canine protected (guidance) occlusion is defined as a form of mutually protected occlusion in which the vertical and horizontal overlap of the canine teeth disengages the posterior teeth in the excursive movement of the mandible. <sup>(9)</sup>

The canine protected occlusion scheme was found to be more effective in reducing the muscle activity and this finding may indicates that it may be considered most physiological scheme as it avoids over loading of the muscles. This scheme also has the ability to direct the forces of mastication vertically onto the supporting structures. <sup>(10)</sup>

Two occlusal concepts exist in complete denture treatment: bilateral balanced occlusion and canine guidance both include simultaneous contact in centric occlusion, but they differ in eccentric movements. The fact that occlusal concept is the most appropriated for individual's needs is clinically and economically relevant. Procedures

involved in the construction of a set of dentures with bilateral balanced occlusion are much more complex and time-consuming than those for canine-guided dentures for dentist and dental technician. It is more complicated to achieve bilateral balanced occlusion during the arrangement of prosthetic teeth and clinical adjustments. Furthermore, studies suggest that the occlusal concept has little influence on clinical outcomes and patients' satisfaction. <sup>(11)</sup>

## MATERIALS AND METHODS

Six completely edentulous patients were selected from the outpatients clinic of Prosthodontic Department, Faculty of Dental Medicine, AlAzhar university (Assiut branch).

The patients were selected according to the following criteria:

Completely edentulous upper and lower jaws for at least two years and no previous history of oral implantology and the patients have problems with retention and stability of the lower denture, class 1 jaw relationship (normal maxillomandibular relationship), the bone height in the interforaminal region exceed 15 mm & free from any temporomandibular joint problems and the interarch space adequate for the over denture, free from any systemic disease (as cardiac, uncontrolled diabetes, chronic liver disease and other debilitating diseases) that may affect the prognosis of implant overdenture and the mucosa covering the ridge is firm and healthy and the edentulous ridge free of any infection, cysts or any impacted teeth. And all the patients selected were cooperative.

### Complete denture construction

Each patient was delivered a complete upper and lower dentures constructed by a conventional method; with bilateral balanced occlusal scheme.

### Recording procedures

A- After finishing the needed post insertion adjustments and adaptation period all the patients were recalled.

- B- Occlusal biting forces were recorded bilaterally at the canine and first molar regions by using the biting force device in the Faculty Of Dental Medicine Al-Azahr university(Assiut branch)
- C- The biting force measured at the right side then at the left side and the mean value calculated for both sides at the canine area and at the first molar area.
- D- Masticatory efficiency were evaluated by assessing the chewing time and the number of chewing strokes with different type of foods (Peanuts, Carrots and Cucumbers)
- E- Each patient instructed to start eating and the number and time of the chewing strokes till the first swallow is assessed then the same until complete clearance of the mouth.

### Surgical procedure

The lower denture will be duplicated into a clear acrylic to be used as surgical template. Each patient will receive two root form implant in the interforaminal region, the implant will be inserted according to the parameters established by the clear acrylic template with a restrict surgical protocol under supervision of a maxillofacial surgeon, the dentures processed to retrofit onto the implant.

### Over denture construction

- a- The housing placed over the ball abutments the denture coated with low-viscosity silicon and placed intraorally and evaluated for contacts with the housing and the desired relieve made.
- b- Removal of suitable amount acrylic resin by round bur from the fitting surface of the denture at the area corresponding to the site of the abutments.
- c- Then the housing removed and a piece of perforated an examination gloves was placed around the ball abutment connector acting as rubber dam and small wax sheet placed under the ball to block the undercut area.

- d- The lingual portion of the denture opposite to the attachment was perforated so the excess acrylic resin can escape.
- e- The housing was repositioned and coated with Autopolymerizing acrylic resin, the denture was placed under finger pressure then instructing the patient to close the mouth in centric occlusal position until polymerization completed.
- f- The denture was removed also the excess acrylic resin and the glove material were removed from the fitting and outer surface of the denture and around the attachment then try-in of the denture and instructing the patient about seating and removal of the denture .The fitting surface of the denture with the housing secured to the denture by Autopolymerizing acrylic resin.
- g- All the patients instructed to maintain high level of oral hygiene especially around the implant, keeping the denture out of mouth during sleep soaked in water.
- h- The patients will be recalled three months after overdenture use for the recording procedures.

**Recording procedures:**

The biting force and the masticatory efficiency recorded as mentioned above.

**Exchange of the occlusal scheme (Canine guidance occlusion):**

- In this scheme the canine is the only tooth that provides contact during protrusive and lateral excursion.
- The anterior teeth bear the entire load and the posterior teeth are disoccluded in any excursive position of the mandible.
- This done by adding wax to the palatal surface of maxillary canine until there’s posterior disocclusion during excursive movement.
- The cingulae of anterior teeth modified to ensure smooth eccentric movement and anterior

clearance during eccentric movement then the wax removed and replaced by tooth-colored acrylic resin. And the overdenture adjusted to eliminate any interference and delivered to the patient with three weeks resting period and the patient instructed not to use any other prosthesis during that period. The same as mentioned before the biting force and the masticatory efficiency recorded.

**The results of this study are presented as follow:**

**The results of biting force**

Table (1) & figure (1) show the mean value of the biting force (in kilograms) and standard deviation at the canine and first molar area for the conventional denture and the overdenture (with bilateral balanced occlusion).

Biting force	conventional denture	over denture	T- Test	Sig.
	Mean ± S.D	Mean ± S.D		
canine area	10.00 ± 1.23	14.27 ± 1.41	11.30**	0.000
First molar	10.08 ± 1.23	16.84 ± 1.71	11.38**	0.000

\*: a significant difference. \*\*: High significant difference. S.D = Standard deviation.

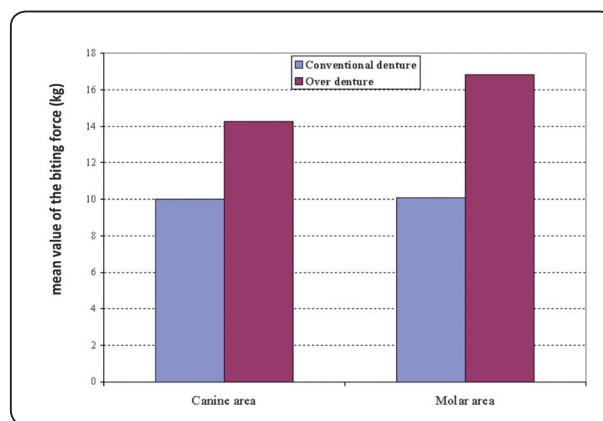


Fig. (1)

**Table (2) & figure (2)** show the mean value and standard deviation of the biting force (in kilograms) and the Duncan`s test at the canine and first molar area for Balanced occlusion, Canine guidance occlusion of the overdenture.

Biting force	occlusion	Mean ± S.D	DT
Canine area	Balanced occlusion	14.87 ± 1.48**	A
	Canine guidance occlusion	14.27 ± 1.41**	B
First molar area	balanced occlusion	16.84 ± 1.71**	A
	Canine guidance occlusion	16.15 ± 1.91**	B

\*: a significant difference. \*\*: High significant difference. S.D = Standard deviation.

**DT =Duncan`s Multiple Range Test.** Means with the same letter within each column are not significantly different at (p<0,05). (Value of A>B>C):

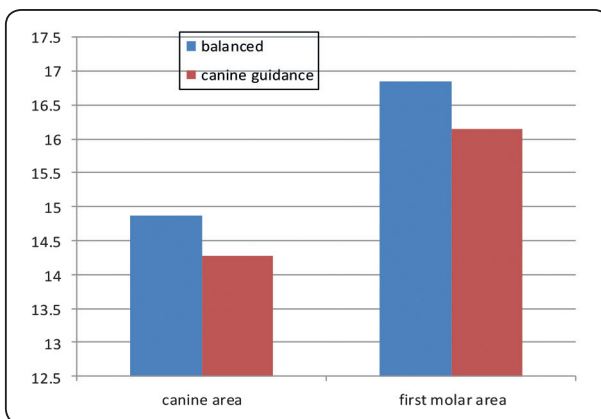


Fig. (2)

**The results of masticatory efficiency:**

**Table (3) &figure (3)** show mean time (in seconds) and standard deviation and the Duncan`s test until clearance of the mouth of Carrots, Cucumber and Peanuts with conventional denture and overdenture (with bilateral balanced occlusion).

Food type	Occlusion	Mean ± S.D	DT
Carrots	conventional denture	19.167 ± 2.229	B
	over denture	14.833 ± 1.329	C
Cucumber	conventional denture	24.833 ± 0.408	A
	over denture	14.500 ± 0.837	C
Peanuts	conventional denture	29.000 ± 3.033	A
	over denture	19.167 ± 2.639	B
F - test		49.17**	0.00

\*: a significant difference. \*\*: High significant difference. S.D = Standard deviation.

**DT =Duncan`s Multiple Range Test.** Means with the same letter within each column and food type are not significantly different at (p<0,05).

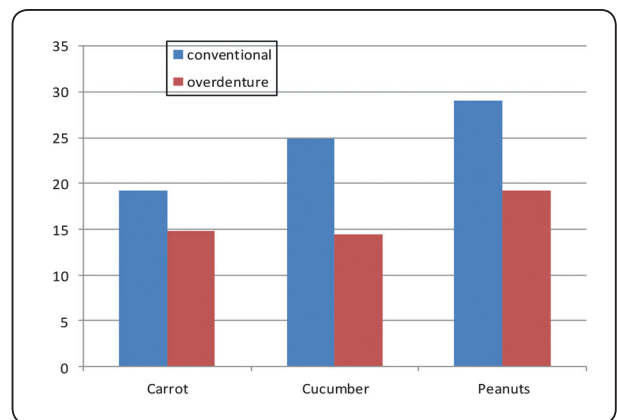


Fig. (3)

**Table (4) &figure (4)** show mean number and standard deviation of strokes and the Duncan's test until clearance of the mouth of Carrots, Cucumber and Peanuts with conventional denture and overdenture (with bilateral balanced occlusion).

Food type	Occlusion	Mean ± S.D	DT
Carrots	conventional denture	25.333 ± 2.422	A
	over denture	19.000 ± 2.608	B
Cucumber	conventional denture	25.333 ± 1.506	A
	over denture	15.167 ± 2.137	C
Peanuts	conventional denture	34.000 ± 4.472	A
	over denture	25.167 ± 4.535	B
F – test		24.93**	0.00

\*: a significant difference. \*\*: High significant difference. S.D = Standard deviation.

DT =Duncan's Multiple Range Test. Means with the same letter within each column and food type are not significantly different. at (p<0,05).

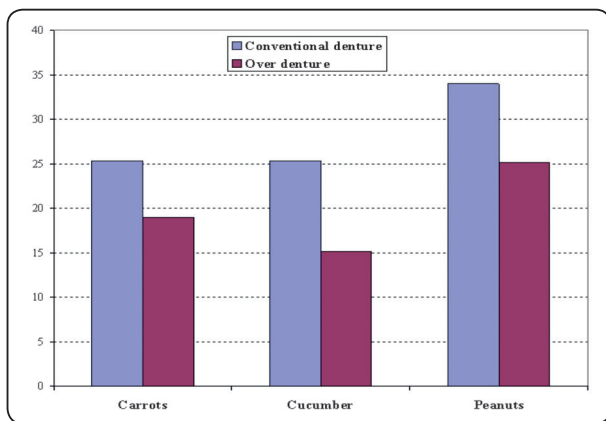


Fig. (4)

**Table (5) &figure (5)** show mean time (in seconds) and standard deviation and the Duncan's test until clearance of the mouth of Carrots, Cucumber and Peanuts with (bilateral balanced & canine guidance occlusion) of the overdenture.

Food type	occlusion	Mean ± S.D	DT
Carrot	Balanced	16.00 ± 1.329	C
	Canine guidance	12.67 ± 2.503**	E
Cucumber	Balanced	14.83 ± 0.837	D
	Canine guidance	10.67 ± 0.516**	F
Peanuts	Balanced	16.83 ± 2.639	B
	Canine guidance	13.5 ± 2.828**	E

\*: a significant difference. \*\*: High significant difference. S.D = Standard deviation.

DT =Duncan's Multiple Range Test. Means with the same letter within each column and food type are not significantly different at (p<0,05).

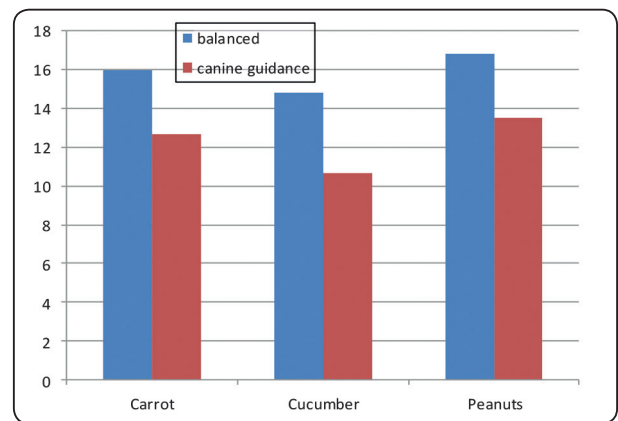


Fig. (5)

**Table (6) & figure (6)** show the mean number of strokes and standard deviation and the Duncan`s test until clearance of the mouth of Carrots, Cucumber and Peanuts with (bilateral balanced & canine guidance occlusion) of the overdenture.

Food type	occlusion	Mean ± S.D	DT
Carrot	Balanced	19.00 ± 2.608	C
	Canine guidance	15.17 ± 2.563**	D
Cucumber	Balanced	18.5 ± 2.137	C
	Canine guidance	12.83 ± 0.753**	E
Peanuts	Balanced	19.17 ± 4.535	C
	Canine guidance	15.83 ± 4.622**	D

\*: a significant difference. \*\*: High significant difference. S.D = Standard deviation.

DT =Duncan`s Multiple Range Test Means with the same letter within each column and food type are not significantly different at (p<0,05).

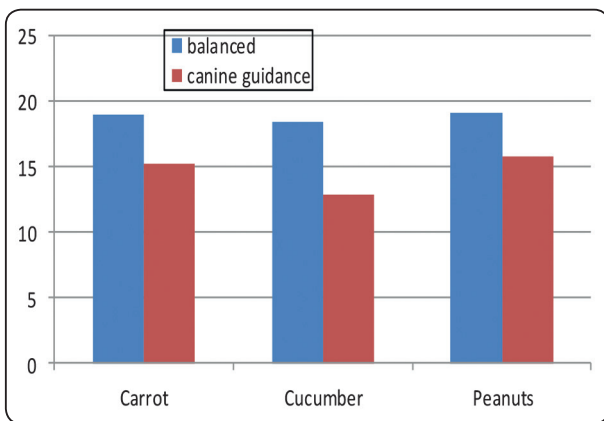


Fig. (6)

**DISCUSSION**

**A-Biting force:**

The results of the study showed that there was a significant increase in the maximum biting force after the mandibular dentures were attached to implants these results are in agreement with findings reported in previous studies; *Bakke; et al., (2002)<sup>(12)</sup>; k. Stellingsma; et al., (2005)<sup>(13)</sup>*. which revealed that directly after implant treatment, significant increase in maximum bite force and chewing performance were reported.

The results of this study showed that there were an increase in the biting force at the first molar area than at the canine area for both conventional denture and overdenture, these results are in agreement with *Tortopidis; et al., (1998)<sup>(14)</sup>* who stated that the more posteriorly the transducer is placed in dental arch, the greater the bite force, in addition greater bite force can be tolerated better in posterior teeth, because of larger area and periodontal ligament around posterior teeth roots.

The results of this study showed that a significant increase in the bite force with the bilaterally balanced occlusion than canine guidance these results in agreement with *Hidaka ; et al., (1999)<sup>(15)</sup>*,who stated that the number of teeth and contact appears to be an important parameter affecting the maximum bite force . the greater bite force in the posterior dental arch may also be dependent on the increased occlusal contact number of posterior teeth loaded during the biting action. And with *Bakke M, (2006).<sup>(16)</sup>*, who suggested that the number of occlusal contacts is a stronger determinant of muscle action and bite force than the number of teeth.

**B-Masticatory efficiency:**

The results of the present study shows a significant increase in the masticatory efficiency (decreased number of strokes and time until first



swallow also until clearance of the mouth) when the overdentures were used, these results are in agreement with *Bakke; et al., (2002)*.<sup>(12)</sup>

They stated that complete denture wearers need up to seven times more chewing strokes than subjects with a complete natural dentition to reduce the food to half of the original particle size. Oral function significantly improves after mandibular implant overdenture treatment. Most studies on implant treatment and oral function showed a significant improvement of the objective masticatory performance in the mandible. Also in agreement with *K.Stellingsma; et al.,(2005)*.<sup>(13)</sup> they stated that the masticatory performance significantly improved after implant treatment.

The results of the present study shows that the mean values of the masticatory efficiency measures were higher with canine guidance occlusion than bilateral balanced occlusion, this agrees with recent clinical trials made by *Perzo; et al., (2003)*<sup>(17)</sup>, *Heydeck ; et al., (2007)*.<sup>(18)</sup> they have found more preference for canine guidance.

Also this agrees with a randomized clinical trial by *Perzo; et al., (2003)*<sup>(17)</sup> comparing two occlusal schemes, balanced occlusion and canine guidance in 22 patients with complete dentures, the results of the assessment using a visual analog scale revealed that canine guidance was comparable to balanced occlusion in denture retention, esthetic appearance and chewing ability.

## CONCLUSIONS

Within limitation of this study, the conclusions are:

- 1- Improved biting force and masticatory efficiency with implant retained mandibular overdenture.
- 2- The bilateral balanced occlusion in case of biting force has maximum biting force value than canine guidance occlusion.

- 3- The canine guided occlusion in case of masticatory efficiency has less time and number of strokes than bilateral balanced occlusion.

## REFERENCES

- 1- Fontijn-Tekamp FA, Slagter AP, Van Der Bilt A, Van T, Hof MA, Witter DJ, Kalk W, Jansen JA. Biting and chewing in overdentures, full dentures, and natural dentitions. *J Dent Res.*2000;79 (7):1519-1524.
- 2- Fueki, K., Kimoto, K., Ogawa, T. & Garrett, N.R. Effect of implant-supported or retained dentures on masticatory performance: a systematic review. *Journal Of Prosthetic Dentistry.*2007;98:470-477.
- 3- Van Kampen FM, Van Der Belt A., Cune MS., Bosman F. The influence of various attachment types in mandibular implant-retained overdentures on maximum bite force and EMG. *J.Dent.Res.*2002;81:170-73.
- 4- Academy of Prosthodontics. The Academy of Prosthodontics. *J Prosthodont . Dent.* 2005 ; 97 : 94-110.
- 5- Ferrario VF, Sforza C, Zanotti G, Tartaglia GM. Maximal bite force in healthy young adults as predicted by surface electromyography. *J Dent.*2004;32:451-457.
- 6- Berretin- Felix G, Nary Filho H, Padovani, C.R, Trindade Junior A.S and Machado W.M. Electromyographic evaluation of mastication and swallowing in elderly individuals with mandibular fixed implant-supported prosthesis. *Journal of Applied Oral Science .* 2008 ;16:116-121.
- 7- Kim Y, Oh TJ, Misch CE, Wang HI. Occlusal considerations in implant therapy: clinical guidelines with biomechanical rationale. *Clin Oral Implants Res* 2005;16:26-35.
- 8- Van Blarcom CW, Bello A, Brown DT, et al. The glossary of prosthodontic terms 8th ed. *J Prosthet Dent* 2005;94:4-92.
- 9- The glossary of Prosthodontic terms . *J Prosthet Dent* 2005; 94(1):18-50.
- 10- Misch CE. Contemporary implant dentistry. 1st ed . The C.V. Mosby Co. St. Louis, Baltimore, Boston, Chicago, London, Philadelphia, Toronto. 1998:609.



- 11- Sutton AF, Glenny AM, McCord JF. Intervention for replacing missing teeth: Denture chewing surface designs in edentulous people. *Cochrane Database Sys Rev* 2005; CD004941.
- 12- Bakke M, Holm B, Gotfredsen K. Masticatory function and patient satisfaction with implant-supported mandibular overdentures: a prospective 5-year study. *Int J Prosthodont.* 2002; 15:575-581.
- 13- Stellingsma K, Slagter A.P, Stegenga B, Raghoe-bar, G.M and Meijer H.J.A. Masticatory function in patients with extremely resorbed mandible restored by mandibular implant retained overdentures: comparison of three types of treatment protocols. *Journal of Oral Rehabil .* 2005; 32:403-410.
- 14- Tortopidis D, Lyons MF, Baxendle RH, Gilmour WH. The variability of bite force measurements between sessions, in different positions within the dental arch. *J Oral Rehabil.* 1998; 25:681-686.
- 15- Hidaka O, Iwasaki M, Saito M, Morimoto T. Influence of clenching intensity on bite force balance, occlusal contact area and average bite pressure. *J Dent Res.* 1999; 78:1336-1344.
- 16- Bakke M. Bite Force and occlusion. *Semin Orthod.* 2006; 12:120-126.
- 17- Perzo I , Leuenberg A , Haustein I , Lange KP. Comparison between balanced occlusion and canine guidance in complete denture wearers a clinical randomized trial. *Quintessence Int* 2003; 34:607-612.
- 18- Heydecke G, Akkad AS, Wolkewitz M, Vogeler M, Turp JC, Sturb JR. Patient ratings of chewing ability from a randomized crossover trial. lingualized vs first premolar\canine guided occlusion for complete dentures. *Gerodontology* 2007; 24:77-86.