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Comparative Evaluation of Masticatory Performance and Swallowing Threshold of Patients with Mandibular Tooth Supported Overdenture, Implant Supported Overdenture and Natural Dentition- A Clinical Study

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Abstract

Background and Objectives: There are number of studies that have reported the benefits of over denture treatment, which includes TSO (tooth Supported Overdenture) and ISO (Implant Supported Overdenture), over CCD (Conventional Complete Denture) treatment. However there are very few studies that have compared the masticatory performance of the TSO and ISO. Therefore, this study was conducted to analyze and compare the masticatory performance and swallowing threshold of ISO, TSO and natural dentition.

Methods: Total of 120 patients were screened out of which 30 subjects of age group 40-60 years were selected and divided into three groups .Masticatory performance was evaluated using objective multiple sieve gravimetric method. The weights of the coarse particles of the test food on each sieve after a twenty chewing strokes was measured. Swallowing threshold was evaluated by recording the number strokes and the time taken by these three groups to reach the moment when the subject felt the urge to swallow the test food. All statistical analysis was performed using IBM SPSS 19.0 Software.

Results: Masticatory performance and swallowing threshold of TSO and ISO showed no significant difference ($p > 0.05$). Significantly higher masticatory performance and lower swallowing threshold was observed when ND was compared with TSO and ISO ($p < 0.05$).

Conclusion: Within the limitation of the study, it was concluded that the masticatory performance & swallowing threshold of T.S.O & ISO was comparable. The masticatory performance of natural dentition was significantly higher than TSO & ISO group. The swallowing threshold of ND was significantly lower than TSO & ISO group.

Keywords: Masticatory Performance, Swallowing Threshold, Tooth Supported Overdenture, Implant Supported Overdenture, Conventional Complete Denture.

Introduction

Mastication is the first phase of the digestive process in which the chewing breaks down the food that would be swallowed and digested. This mechanical breakdown of food that is done by the act of chewing, aids in the enzymatic digestive process.[1] Implementing and maintaining masticatory function is an important factor for promotion and preservation of good health. Chewing activity has been reported to directly influence nutritional status, overall health and activities of daily living in elderly.[2] The World Health Organisation has considered

the number of teeth to be a key indicator for oral health status.[3] Re-establishing the masticatory function is fundamental to preserve the patient's stomatognathic system's health loss.[4] Thus, the restoration of masticatory function is an important aim in restorative dentistry especially when the patients present with extensive tooth loss.[5]

To improve the masticatory function, it must first be evaluated. Masticatory functions can be evaluated by objective and subjective methods.[6] The term masticatory performance can be defined as the ability to grind certain portion of food with determined number of masticatory cycles.[7] Swallowing threshold is defined as that moment when the subjects feels the urge to swallow their food.[8] Swallowing threshold assesses the particle size distribution, number of strokes, and time that was taken for the subject to accept the food as ready to swallow in normal, unrestricted mastication.[9] Both masticatory performance and swallowing threshold have been used to measure masticatory function by previous researchers.[7, 9]

Good performance of mastication is stated to be related to the status of patient's dentition. Individuals with complete natural dentition show high masticatory performance rates, while edentulous individuals show minimal performance.[10, 11] Chewing problems are common in middle aged to elderly people. It has been found that 23 % of participants aged 45 and above who retained at least one tooth had difficulty in chewing and were dissatisfied with their ability to chew. It has been documented in surveys of elderly people that one third of participants had trouble in chewing or biting some food and this proportion rose as high as three fourth in edentulous elderly individuals.[12] Thus, edentulous subjects may attempt to compensate for their reduced ability by using more masticatory strokes or accepting larger particles for ingestion.[9] This results in the shift in food selection patterns, with concomitant changes in nutritional status.[13]

Conventional complete dentures (CCD) were the only kind of treatment for edentulous individuals for over a hundred years. CCD relies upon the residual alveolar ridge and mucosa for support and retention. Due to bone resorption many patients have difficulties of adaptation to mastication and often report dissatisfaction with their CCD, especially with the mandibular prosthesis.[14] Rehabilitation of many of these patients by means of CCD, no matter how perfectly done, can not completely solve their functional or psychological problems. It has been found that 5%-20% of the individuals remained dissatisfied after the complete denture treatment. Wearers of CCD have their masticatory performances reduced between 1/4 (one fourth) to 1/7 (one seventh) when compared to adults with natural teeth. Thus, theoretically denture wearers need seven times more masticatory cycles to reduce the food to half of its original size.[15] Hence CCD as a prosthetic treatment modality has been unsuccessful in restoring the masticatory function in edentulous patients.

An overdenture may be defined as removable prosthesis that covers the entire occlusal surface of a root or implant[20]. Such prosthesis has found ever increasing applications in Prosthodontics which may be a reflection on population trends and demand for better treatment. The extraction of teeth results in loss of mechanoreceptors from associated periodontal ligaments. The process of effective mastication requires propioceptive mechanism that serves as a feedback. Over the last 30 years, a wide range of reports have confirmed far greater discriminatory ability in dentate subjects compared to edentulous subjects. Even though receptors in the mucosa, propioception in muscles and TMJ may influence this

discrimination, the periodontal receptors appear to play a far more significant role.[20]

To maintain this sensory feedback of the periodontal receptors, the teeth are maintained in the alveolar ridge and serve as abutment for fabrication of prosthesis. Recent studies demonstrate a high success rate of tooth supported overdenture (TSO) even with reduced periodontal support.[17] It has been documented that increased masticatory function was observed in TSO compared to CCD patients.

Le chin et al inferred that the partially preserved periodontal receptors might be beneficial to the preservation of masticatory function.[18] Thus, TSO as a prosthodontic treatment option has been found to be beneficial in improving the masticatory function.

After the successful introduction of osseointegrated implants by Branemark et al in 1980s,

Keywords: Masticatory Performance, Swallowing Threshold, Tooth Supported Overdenture, Implant Supported Overdenture, Conventional Complete Denture. interest in ISO for edentulous jaws rapidly increased as is evidenced by the number of studies published since 1990.[19] Patient's satisfaction has been shown to be significantly higher in implant supported overdenture (IOD) when compared to CCD.[20] The benefits of an IOD include improvement in the chewing ability, increased stability and retention and significantly higher patient satisfaction.[21,22] Furthermore, the subjects with mandibular IOD need 1.5-3.6 times fewer chewing strokes than complete denture wearers to obtain an equivalent reduction in food particle size.[23] Thus, ISO as a prosthodontic treatment option has proved to be beneficial in improving the masticatory function.

Both TSO and ISO have shown to improve the masticatory performance of patients. There are number of studies that have reported the benefits of over denture treatment, which includes TSO and ISO, over CD treatment[24, 25, 18]. However there are very few studies that have compared the masticatory performance of the TSO and ISO. Thus, a clinical dilemma may arise that should teeth be saved to serve as an abutment for overdenture or be replaced with implants when both the methods are accessible and acceptable to a patient?[18]

Therefore, this study was conducted to analyze and compare the masticatory performance and swallowing threshold of patients with implant supported over denture and patients with tooth supported over denture. The null hypothesis was that there will be no significant difference in the masticatory performance and swallowing threshold of TSO and ISO and ND.

Materials And Methods

Armamentariums which were used in this study was:-

For Masticatory Performance (Fig. 4)

1. Dried peanuts ,Disposable paper cups ,Incubator, Standardized Mesh sieve 2.0 mm, 1.7 mm, 1.0 mm aperture (Bajaj Steel, Delhi),Weighing machine (Mfd by A & D Co. Ltd, Korea),Vibrator were used.

For Swallowing Threshold (Fig. 5)

Carrots ,Disposable paper cups, Stopwatch were used.

The present study was conducted in the Department of Prosthodontics and Crown & Bridge at The Mahatma Gandhi Dental College and Hospital, Jaipur. An ethical clearance was obtained from the Ethical committee of Mahatma Gandhi Dental College and Hospital . The subjects for this study were selected from the patients referred to the Department of Prosthodontics.

Selection of Subjects

A total of 120 patients were screened, out of which 30 subjects of age group 40-60 years were selected and divided into three groups depending on the inclusion criteria.

The groups made for the study were as follows:

N.D. (Natural Dentition) (Group I)- Consisted of ten healthy patients (3M, 7F) with full complement of natural teeth.

Inclusion Criteria

- Patients with no systemic history.
- Patients with no active dental disease including dental caries, periodontal disease and symptomatic tooth wear.

Exclusion Criteria

- Any missing tooth in the patient other than the 3rd molar.
- Patients wearing removable or fixed prosthesis.

TSO (Tooth Supported Overdenture) (Group II) - Consisted of ten patients (4M, 6F) with completely edentulous maxillary arch and two potential retained abutment teeth (canine region) in the mandibular arch.

Inclusion Criteria

- Patients with no systemic history.
- Partially edentulous patients indicated for mandibular tooth supported over denture.
- Patients having at two potential abutment teeth (canines), one on either side of the mandibular jaw with adequate alveolar bone support to serve as a TSO abutment.
- The patients who agreed for the endodontic treatment of the abutment teeth.

Exclusion Criteria

- Patients suffering from any systemic disease.
- Patients not willing for endodontic treatment of the abutment teeth.
- Smokers or patients having any habits.

ISO (Implant Supported Overdenture) (Group III) - Consisted of ten patients (7M, 3F) with completely edentulous maxillary and mandibular arches.

Inclusion Criteria

- Patients with no systemic history i.e. who were free from heart disease, diabetes, angina pectoralis, bone diseases (osteomalacia, pagets disease), immunological disease, mental disease, strongly irradiated jaw bones, alcohol or drug dependency and pregnancy.
- Patients willing for implant surgery and over denture treatment.
- Patients with adequate bone support in mandibular arch eliminating the need for any surgical bone augmentation procedures.

Exclusion Criteria

- Patients who were not willing for implant procedures.
- Smokers or patients having any habits.

Pretreatment clinical examination was performed that included a thorough medical and dental history, current general and oral health status for each of the thirty subjects. A pretreatment OPG was taken to rule out any soft or hard tissue abnormality for all the thirty subjects.

Treatment Protocol Of Each Group

ND: (Control group) (Fig. 1)

Oral prophylaxis was done for all the 10 subjects. The masticatory performance and swallowing threshold were then analyzed for all the selected ten subjects.

TSO: (Fig. 2)

The retained canines of the mandibular arch were endodontically treated. Post space preparation was done and following that over denture ball abutment (Essential Dental Systems, Inc) were cemented using glass ionomer cement.

(GC Corporation, Tokyo, Japan).

A conventional maxillary denture with mandibular TSO was fabricated in centric occlusion with balanced articulation. During the insertion appointment pressure disclosing paste was used to locate contact position of the male abutment on the tissue surface of the denture base. The nylon ring was then fitted onto the ball abutment. The

denture base was relieved and self-cure resin was mixed and placed onto the relieved areas. The denture was seated in occlusion. After the self-cure resin was cured completely the denture was removed, excess material was removed. Finishing and polishing was done and denture was delivered to the patient.

Post insertion instructions were then given to the patient. The patients were recalled after 24 hours of insertion to check for immediate tissue reaction. After the post insertion issues of the patient were addressed favorably, the patient was recalled after three months for analyzing the masticatory performance and swallowing threshold. The same treatment protocol was followed for all the selected ten subjects of this group.

ISO: (Fig. 3)

A conventional maxillary and mandibular denture in centric occlusion with balanced articulation were fabricated for each subject. Two implants (Dentin Dental Implant System, Israel) were placed in mandibular canine region or as close as possible to these regions. The implant sizes were determined using CBCT. Surgical template was fabricated using the existing conventional complete denture to ensure an optimal implant alignment and location. The patients were instructed not to wear the old denture, for two weeks after the implant placement. After removal of the sutures, the old denture was adjusted for use.

The patients were recalled after three months of implant placement to radiographically check for osseointegration. Any signs of infection, mobility, pain or tenderness, were checked.

The second stage surgery was performed and healing abutments were placed. One week later, a ball abutment which was torqued over implants (recommended torque is 25 N/cm). Silicon cap was fitted onto the abutments. Block out over the silicon cap was done using modeling wax. Marking on top of attachment was done and the conventional complete denture was placed to transfer the marking on the tissue surface of the prosthesis .After verifying the occlusion and easy seating of the prosthesis in mouth, self cure acrylic resin was mixed and placed onto the relieved areas and the denture was seated in occlusion. After the self cure resin was set, the processed denture was removed. Excess acrylic was removed and the implant supported over denture was finished, polished and delivered to the patient. The same treatment protocol was followed for all the selected ten subjects of this group.

The patients were recalled after three months of insertion of IOD for analyzing the masticatory performance and swallowing threshold.

Method for Evaluating Masticatory Performance

Three portions, each of 3 gm of peanuts were weighed for each subject in each group (Fig. 6). The portions were made by weighing the peanuts on a digital scale, labeled as P1, P2, P3 and kept in 3 paper cups. Masticatory performance was evaluated using these peanuts as a test food for all thirty subjects of the three groups. The subject was instructed to chew each of peanuts portion for twenty masticatory strokes from the subject's preferred chewing side. The strokes were manually counted by one investigator. The patient was asked to expectorate the chewed test portions into a paper cup (Fig.7) and the patient rinsed their mouth three times with water and spit the remains into a paper cup again. Intraoral examination was done to check that no pieces of test portion were left in oral cavity. The chewed samples were collected in a paper cup. Samples were washed and dried in an incubator at 60℃ for 24 hours (Fig.8) and then fractionated through a stack of three mesh sieves of 2.0, 1.7 and 1.0 mm aperture. The same procedure was repeated for the other two portions for each subject.

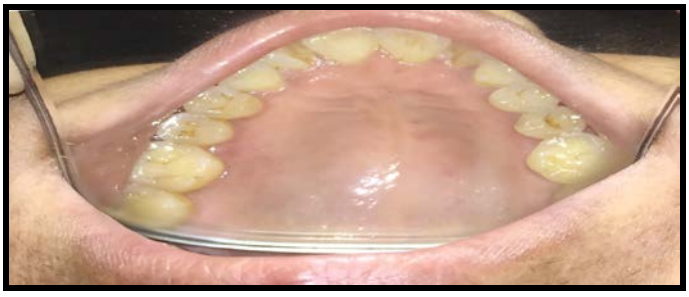
While the particles were sieved, the sieves were agitated by a dental vibrator set at half speed for two minutes (Fig. 9). The weight of the coarse particles of P1, P2, and P3 on each sieve was weighed on a digital scale (Fig.10). The readings were recorded for statistical analysis to evaluate masticatory performance. The same method was applied to all thirty subjects.

Method for Evaluating Swallowing Threshold

Using a digital scale, three portions, each of 3 gm of carrots were weighed for each subject in each group (Fig.11). They were labeled as C1, C2, C3 and kept in 3 paper cups. One weighed portion (C1) was given to each subject at a time. The subject were instructed to chew one portion until they felt the desire to swallow and instructed to expectorate the chewed carrots in a paper cup. The mouth and the dentures were carefully rinsed with water. The number of strokes and the time was counted from the start of chewing of one portion till the patient felt the desire to swallow .To avoid inter operator bias the counting was done by one investigator. The same procedure was repeated for the other two portions (C2 and C3) for each subject. The same method was applied to all thirty subjects.

Statistical Procedure

Mean and Standard Deviation of each variables was calculated for all the groups and one-way ANOVA test was used for comparison of group mean. For sake of multiple comparisons post hoc test was applied. All statistical analysis was performed using IBM SPSS 19.0 Software.



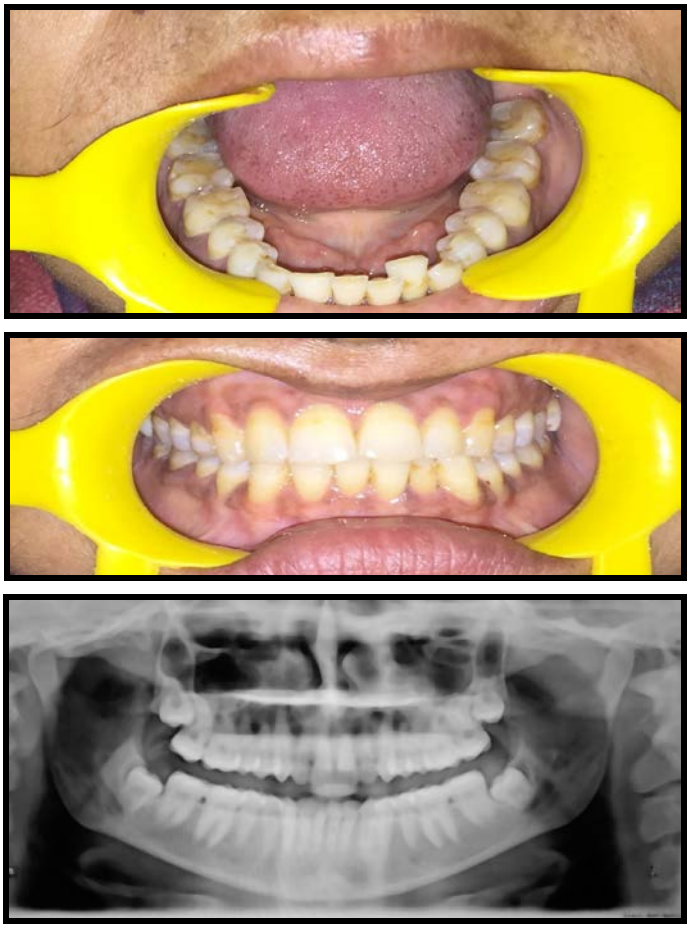
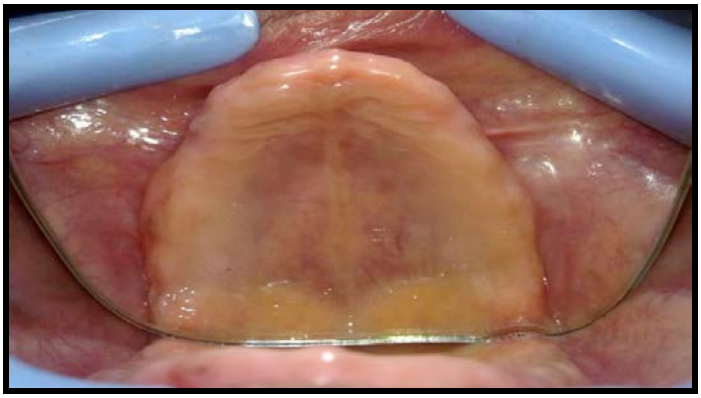
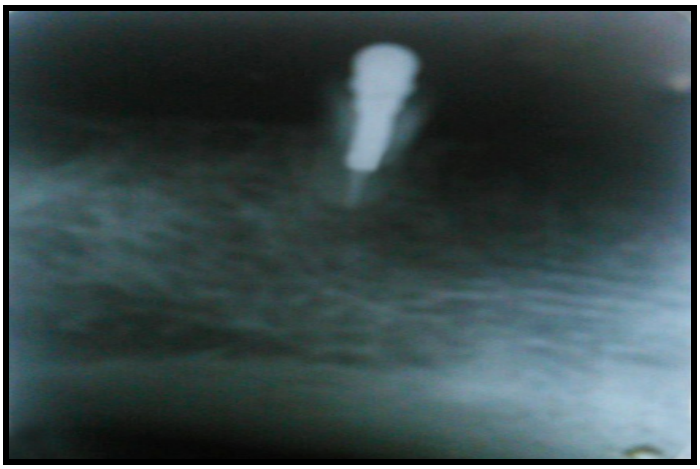


Fig. 1: Natural Dentition





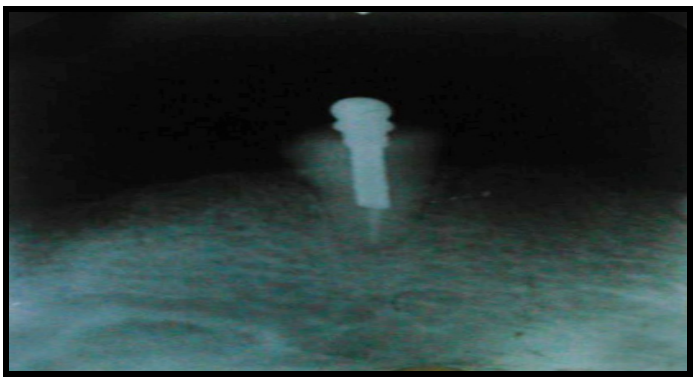


Fig. 2: Tooth Supported Overdenture

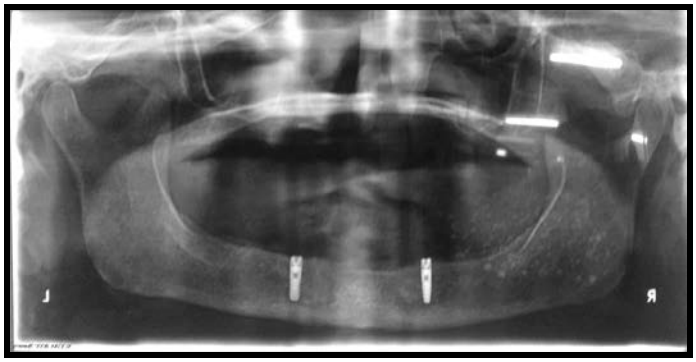


Fig. 3: Implant Supported Overdenture

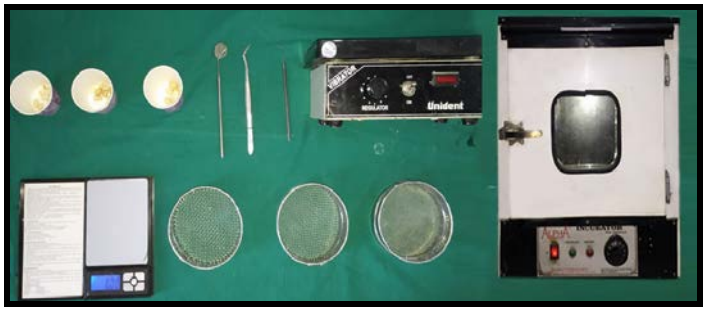


Fig. 4: Armamentarium for Masticatory Performance Test

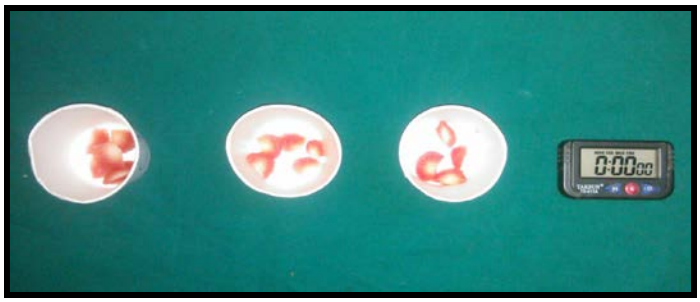


Fig. 5: Armamentarium for Swallowing Threshold Test

Fig. 6: Three Portions of 3 gm Peanuts Each.

Fig. 7: Subject Expectorating Chewed Peanuts

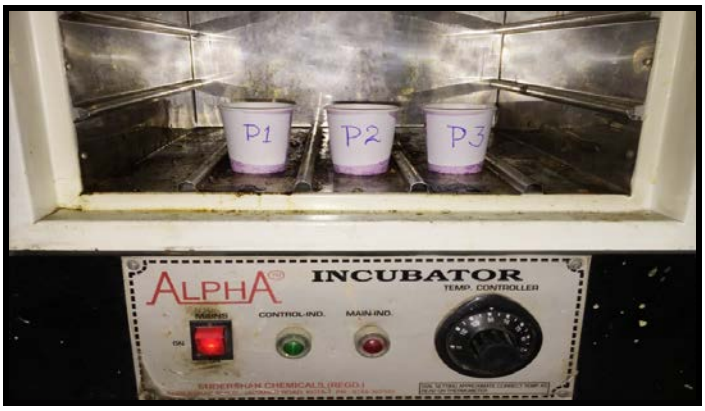


Fig. 8: Peanuts being dried in an Incubator

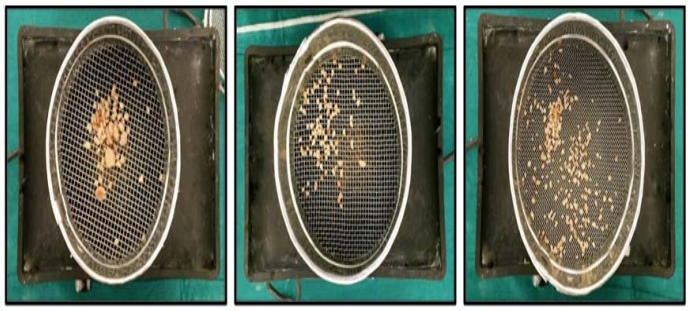


Fig. 9: Peanuts Fractioned Through Stack of Three Mesh Sieves 2.0 mm, 1.7 mm, 1 mm.

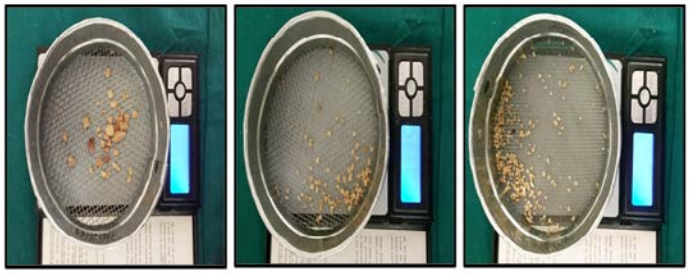


Fig. 10: Coarse Particles of Peanuts Being Weighed for Each Sieve.

Fig. 11: Three Portions of 3 gm Carrots Each

Results

Table No. 1: Mean & S.D. of Masticatory Performance for Three Groups

Dependent Variable	n	Group Name	Mean (wt in gm)	S.D.
>2 mm	10	TSO	1.006000	0.0848790
	10	ISO	0.977000	0.0543752
	10	ND	0.000000	0.0000000
>1.7 mm	10	TSO	0.816000	0.1172083
	10	ISO	0.856000	0.0596657
	10	ND	0.007000	0.0094868
>1 mm	10	TSO	0.655000	0.0882232
	10	ISO	0.696000	0.0715231
	10	ND	0.259000	0.0387155

*p<0.05: Significant

Inference- The data in the table shows the mean weight of coarse particles of peanuts in grams of all the three sieves (2 mm, 1.7 mm, 1 mm).

Table No. 2: Comparative Masticatory Performance of Three Groups After Applying Posthoc Test

Dependent Variable	n	(I) Group Name	(J) Group Name	Mean Difference (I-J)	p-value
>2mm	10	TSO	ISO	0.0290000	0.275
			ND	1.0060000	0.000
	10	ISO	TSO	-0.0290000	0.275
			ND	0.9770000	0.000
	10	ND	TSO	-1.0060000	0.000
			ISO	-0.9770000	0.000
>1.7mm	10	TSO	ISO	-0.0400000	0.250
			ND	0.8090000	0.000
	10	ISO	TSO	0.0400000	0.250
			ND	0.8490000	0.000
	10	ND	TSO	-0.8090000	0.000
			ISO	-0.8490000	0.000
>1mm	10	TSO	ISO	-0.0410000	0.197
			ND	0.3960000	0.000
	10	ISO	TSO	0.0410000	0.197
			ND	0.4370000	0.000
	10	ND	TSO	-0.3960000	0.000
			ISO	-0.4370000	0.000

*p<0.05: Significant

Inference: The data in Table indicate that intergroup variability is not significant amongst TSO and ISO for all the three sieves (p>0.05). However, highly significant difference can be seen when TSO and ISO are compared with ND in the three sieves (p<0.05).

Graph No. 1: Graphical Representation of Masticatory Performance for Three Groups

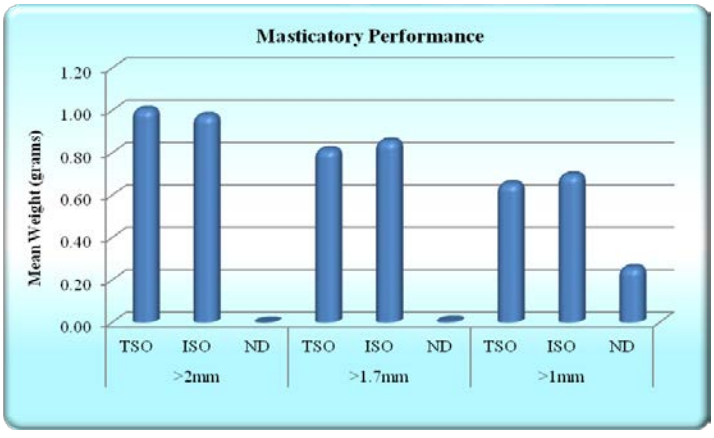


Table No. 3: Mean & S.D. for Swallowing Threshold for Three Groups

Dependent Variables	n	Group Name	Mean	S.D.
Strokes	10	TSO	27.301000	1.8023531
	10	ISO	28.066000	1.5241624
	10	ND	12.734000	1.0637272
Sec.	10	TSO	24.101000	1.7211201
	10	ISO	23.498000	2.5731295
	10	ND	9.733000	0.5174091

*p<0.05: Significant

Inference: The data in the table shows the mean of the number of strokes taken by all three groups to reach swallowing threshold. It also shows the mean of the time taken by all three groups to reach swallowing threshold.

Table No. 4: Comparative Swallowing Threshold of Three Groups After Applying Posthoc Test

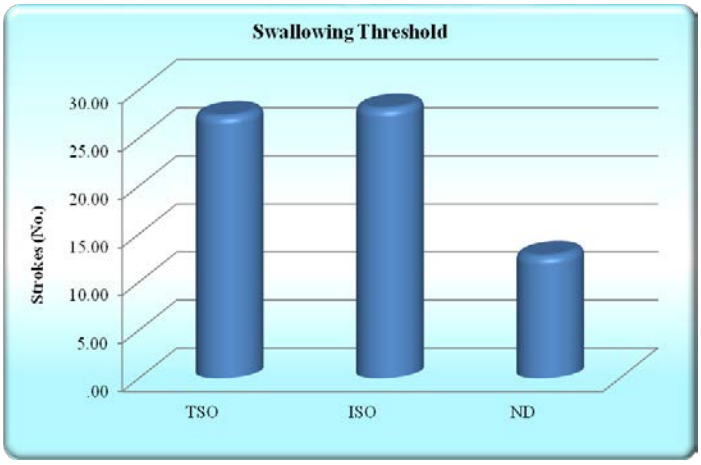
Dependent Variable	n	(I) Group Name	(J) Group Name	Mean Difference (I-J)	p-Value
Strokes	10	TSO	ISO	-0.7650000	0.263
			ND	14.5670000	0.000
	10	ISO	TSO	0.7650000	0.263
			ND	15.3320000	0.000
	10	ND	TSO	-14.5670000	0.000
			ISO	-15.3320000	0.000
Sec.	10	TSO	ISO	0.6030000	0.463
			ND	14.3680000	0.000
	10	ISO	TSO	-0.6030000	0.463
			ND	13.7650000	0.000
	10	ND	TSO	-14.3680000	0.000
			ISO	-13.7650000	0.000

*p<0.05 : Significant

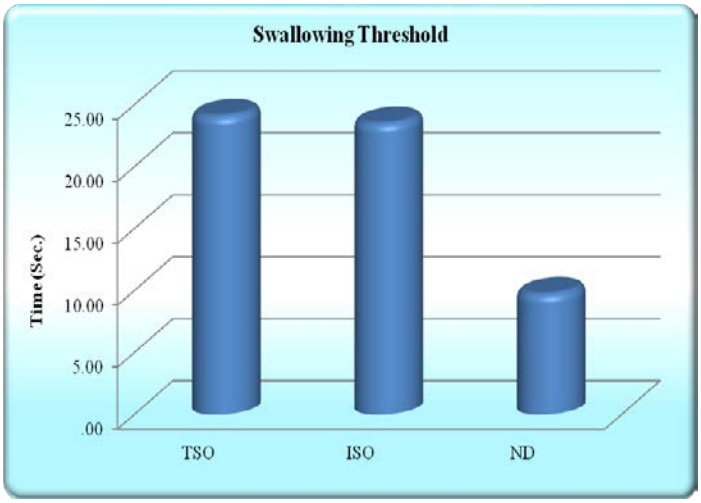
Inference: The data in Table no. 4 indicates that intergroup variability is not significant when comparing the number of strokes taken by TSO & ISO to reach swallowing threshold. Similarly, no significant difference was found for the time taken by TSO & ISO to reach swallowing threshold (p>0.05). However, significant difference was found for the time taken and the number of strokes made

to reach swallowing threshold between ND & ISO groups, as well as between ND & TSO group.

Graph No. 2: Graphical Representation of Number of Strokes Taken to Reach Swallowing Threshold for the Three Groups



Graph No. 3: Graphical Representation of Time Taken to Reach Swallowing Threshold for the Three Groups



Discussion &Summary

Masticatory Performance and Swallowing Threshold

The term masticatory performance can be defined as the ability to grind certain portion of food with determined number of masticatory cycles.[7]

Previous researchers have found that masticatory performance has possible effects on ingestion, dietary intake and social behavior. Furthermore, masticatory performance is the outcome of several other measured other key measures, including the ability to clear particles from the mouth, oral sterogenesis, occlusal force and masticatory muscle force.[26]

Swallowing threshold is defined as the moment that the subject feels the urge to swallow or normally swallow their food.[23] The masticatory performance test provides an effective means for making direct comparisons of relative ability to break down a bolus while controlling for masticatory sides and number of masticatory strokes employed. However, it is recognized that subjects may attempt to compensate for the reduced ability by using more masticatory strokes, longer time for each strokes, or accepting larger particles for ingestion. Thus, a test of swallowing threshold was included, it would help in assessing number of strokes and time taken for a subject to accept the food to ready to swallow, in a normal unrestricted mastication.[9]

In the present study masticatory performance and swallowing threshold of natural dentition, TSO and ISO was analyzed and compared.

Sieve Method

Various objective methods for testing masticatory performance have been described previously e.g. sieving method, colorimetric method, optical scanning method, image analysis. Among these, the use of sieves is the most indicated method for measuring masticatory performance. Fractional sieving as a technique of separating the food after chewing for a given time period is one of the oldest method used to test masticatory performance.[6]

In this study, objective assessment was done by using multiple sieves to obtain more appropriate average particle size distribution and more precise determination of the masticatory performance. Multiple sieve method has been found to be more reliable when compared to single sieve method. Standard sieve method was introduced independently by **Dhalberg** and by **Manly and Braley**

was most frequently used in researches. Its validity and reliability have been established in previous studies, and it is often used as 'gold standard' in order to demonstrate the validity of the newly developed methods.[10]

Sieves used were such that the chewed food particles would passed through various mesh sizes. The particles accumulated on each sieve were then weighed. The weights represent the distribution of particle size and are usually presented as a percentage of the total weight accumulated. This method has been used by many authors. Many studies had also been done to show the reliability of the sieve method and is still considered to be a viable method for measuring masticatory performance.[6]

The general principle is to pass the masticated material through a series of sieves of decreasing mesh size. Essentially, more efficient the mastication is, the greater the quantity of material will pass through the finest sieve. **Manly and Braley** concluded that using a 10 or 20 mesh U.S. standard screen in sieving peanuts is more sensitive than using finer screens, and that mastication is a selective process which tends to grind larger particles more than the fine particles. As yet, we do not know the optimal size of food particles to be swallowed, and consequently, there are no criteria for selection of the size of the mesh screen. Nonetheless, more detailed information on the distribution of particle sizes in chewed food can be obtained when more sieves are used.[6]

In this study, multiple sieve gravimetric method was used to record masticatory performance which is similar to the method used by **Niwatcharoenchaikul W** for comparing the efficiency of complete denture occlusal schemes on masticatory performance and maxillary occlusal force.[27]

In this study, three mesh sieves of 2 mm, 1.7 mm (US standard sieve), and 1 mm aperture were used.

Test Foods

The test foods used by previous investigators vary and include artificial as well as natural foods. The test food should not show solubility during the test, should be obtainable in standard quality throughout a period of time, and should break down when chewed without a change of consistency.[28] **Dahlberg** [29] listed a number of requirements for an ideal test material; (1) it should resemble ordinary food, i.e. Not so easy to chew that it can be crushed by the alveolar ridges or so difficult that persons with a poor dentition cannot take part in the test. (2) It should not swell or dissolve in water or saliva and it should pulverize in such a manner that the degree of pulverization can be clearly established. (3) It should not break along predetermined lines of cleavage or be tough or sticky. (4) It must be possible to standardize, be non-perishable and of good or at least indifferent taste. After having examined thirty-five different foodstuffs, **Yurkstas & Manly** found peanuts to be the material best suited for their method. **Manly & Braley** tested four foodstuffs with regard to loss of moisture on pulverization, [29] and found peanuts to lose least in weight (20%) by swallowing, solution, emulsification or by loss of moisture content[10, 28]. Therefore, peanuts were used as a test food for measuring masticatory performance in this study.

Edlund and Lamm[29] reported that the mean number of masticatory strokes necessary to achieve optimal pulverization of test material was 20.4. Therefore, twenty strokes were recommended to patients in study. The lack of correlation between soft and hard foods in complete denture wearers led to a further study by **Kapur, Soman & Yurkstas** to determine the procedures and the test foods that would be most reliable for measuring the masticatory performance of denture wearers. They used the method of determination described by **Yurkstas & Manly** and found that in those subjects mastication was a non-preferential process wherein particles of all sizes are ground at random.

Carrots were used in this study to measure swallowing threshold. It has been previously used on many researches.[9] It was chosen as it is similar to peanuts i.e. natural hard test food. Moreover, a different test food for measuring swallowing threshold helps the patient to easily distinguish and perform both the masticatory tests thus avoiding any confusion.

Subjects

Tooth-retained overdentures are a rehabilitative treatment option with the advantages that it provides greater retention offered by the retained abutment teeth. Overdentures using resilient anchoring systems are an alternative for the rehabilitation of partially edentulous cases wherein abutment teeth present favorable conditions to support removable partial dentures. This provides finer comfort through a more stable reconstruction.

The ideal retention system for over dentures should provide the prosthesis with good retentiveness and stability, so that no great loss of retention capacity occurs over time. It should have easy and inexpensive maintenance, if a replacement is needed. In addition, it should present little height so that it can be used in reduced intermaxillary spaces, which favors esthetics.[29]

It has been documented that two abutments on opposing sides of the arch, (canine) provides excellent results.[16] Among the possible roots to be used to support the over denture, the canine is a tooth that better exhibits characteristics associated with support. This occurs because if its large root with greater periodontal area for attachment and also due to localization in transitional area between anterior and posterior teeth.[30]

Thus in the present study group II consisted of mandibular TSO retained over canines.

ISO can be retained by various types of attachments e.g. Bar, LOCATOR, Ball/O-ring [31]. The attachment used in this study was Ball attachment with O-ring (Essential Dental Systems). It is mostly used when 2 independent implants are placed in mandibular inter-foraminal region as it facilitates the hygiene procedure by the patient, when compared to bar attachment[61] and is less technique sensitive, cost-effective and less fracture of component occurs than that of gold alloy bar **(Schmitt and Zarb[32]).** The Photoanalysis done by **Kenney and Richards** indicated that ball/O ring transfers less stress to the implants and also minimize the denture movement. However, it has been found that the type of attachment does not influence the masticatory performance, both bar and ball attachments allowed significant improvement in masticatory performance.[33] This is in agreement with results by **van Kampen et al[23]**. It has been documented that retention and stability of mandibular denture determine the individual's ability to chew which is greatly increased in ISO as compared to CCD. Hence in this study group III consisted of mandibular ISO with ball attachments.

In our study, the results of masticatory performance showed statistically significant difference between ND and TSO. Results have also shown statistically significant difference between dentate subjects and ISO. This implies superior masticatory function with natural dentition. Our results were in agreement with study conducted by **Muhittin Toman et al** who found better masticatory performance of natural dentition as compared to CCD and ISO [34]. The swallowing threshold of natural dentition was also found to be significantly lower than both the other groups the TSO and ISO. Thus, dentate subjects require lesser number of strokes and lesser time to reach the swallowing threshold as compared to TSO, ISO.

Studies have shown that the best masticatory performance is achieved with natural dentition as it has intact periodontal fibers. Dentate subjects also have higher bite forces that leads to better fragmentation of food particles

trapped between the posterior teeth[35,36]. Superior proprioceptive feedback mechanism and better oro-stereognosis of dentate subjects would be the reason for the results obtained. Thus, even though prosthodontic options like ISO and TSO improve the masticatory functions, but the outcome levels are not equal to those found for dentate subjects. Our results are in agreement with the study conducted by **Pocztaruk RL et al** who evaluated masticatory performance of patient rehabilitated with implant-supported overdentures.[37]

No significant difference was observed in the masticatory performance of patients with TSO and patients with ISO (p-value > 0.05) for 2mm sieve, 1.7 sieve and 1 mm sieve. Though, the masticatory performance of TSO was higher than ISO, swallowing threshold of TSO was found to be less than ISO though not statistically significant. The presence of intact periodontal fibers in the abutments of TSO helps in the proprioceptive mechanisms. This could be the reason for the observed increased masticatory performance and lower swallowing threshold.

No significant difference was observed in the swallowing threshold between patients with TSO and ISO. However, it was observed that TSO patients took lesser number of strokes as compared to ISO patients.

The higher swallowing threshold of TSO (though not significant) may be due to partially preserved propioceptors which in turn allows the subject to reach swallowing threshold with lesser number of strokes. It has been documented that the ability to discriminate thin objects between the teeth of overdentures was slightly better when overdentures are supported by roots than by implants[17].The opening reflex is activated by stimulation of propioceptors underlying skin, oral mucosa, periosteum, periodontal ligaments and adjacent tissues[18] further improves the mastication resulting in better results. Hence, this study rejects the null hypothesis as significant difference was seen when comparing masticatory performance and swallowing threshold of TSO & ISO with ND.

For more precise evaluation of the results, it is suggested that the study may be extended for a larger number of subjects and the patients should be followed up for extended periods of time. Further clinical studies are suggested for the same.

Within the limitations of the study, it can be concluded that there is no significant difference in between the masticatory performance and swallowing threshold of TSO and ISO, though masticatory performance and swallowing threshold was found to be better with TSO patients. Significant difference was found when masticatory performance and swallowing threshold of TSO and ISO was compared with ND.

References

1. Fontiin-Tekamp FA, Slagter AP, Bilt A, Witter DJ, Kalk W, Jansen JA. Biting and chewing in over dentures, full dentures, and natural dentitions. J Dent Res 2000; 79 (7): 1519-1524.

2. Miura H, Araki Y, Hirai T ,Isogai E, Hirose K , Umenai T. Evaluation of chewing activity in the elderly person. J Oral Rehab 1998; 25:190-193.

3. Nguyen TC, Witter J, Bronkhorst EM, Gerritsen AE, Creugers NHJ. Chewing ability and dental functional status. Int J Prosthodont 2011; 24: 428-436.

4. Apolinario ME, Junior WM, Dametto FR, Gade-Neto CR, Sousa de SA. Clinical assessment of masticatory efficiency in the rehabilitation of edentulous patients. Braz J Oral Sci 2011; 10(3): 217-220.

5. Goiato MC, Ribeiro PDP, Garcia AR, Santos DMD. Complete Denture Masticatory Efficiency: A Literature Review 2008; 36 (9): 683-6.

6. Ahmad S.F. An insight into masticatory performance of complete denture wearer. Annal Dent Univ Malaya

2006; 13: 24-33.

7. Kapur K, Soman S. Masticatory performance and efficiency in denture wearers. J Prosthet Dent 1964; 14: 687-94.

8. Fontijin –Tekamp FA, Slagter AP, Van der Bilt A, Van't Hof MA, Kalk W, Jansen JA. Swallowing threshold of mandibular implant retained overdentures with variable portion sizes. Clin. Oral Impl Res 2004; 15: 375-380.

9. Roumanas ED, Garrett N, Blackwell KE, Freymiller E, Abemayor E,
Wong WK et al. Masticatory and swallowing threshold performances with conventional and implant-supported prostheses after mandibular fibula free-flap reconstruction. J Prosthet Dent 2006; 96: 289-97.

10.Manly RS, Braley LC. Masticatory performance and efficiency. J Dent Res 1950; 29(4): 448-462.

11.Rissin L, House JE, Manly RS, Kapur KK. Clinical comparison of masticatory performance and electromyographic activity of patients with complete dentures, over dentures, and natural teeth. J Prosthet Dent 1978; 39: 508-51.

12.Inukai M, John T M, Igarashi Y, Baba K. Association between perceived chewing ability and oral health related quality of life in partially dentate patients.
Health Qual Life Outcomes. 2010; 18: 118.

13.Wayler AH, Chauncey HH. Impact of complete dentures and impaired natural dentition on masticatory performance and food choice in healthy aging men. J Prosthet Dent 1983; 49(3):427-33.

14.Awad MA, Lund JP, Eric D, Feine JS. Comparing the Efficacy of Mandibular Implant-Retained Over dentures and Conventional Dentures among Middle-Aged Edentulous Patients: Satisfaction and Functional Assessment. Int J Prosthodont 2003; 16: 117–122.

15.Pocztaruk R, Fontoura FLC, Rivaldo EG, Mattia PRC, Vidal RA, Fernandes Eduardo et al. Satisfaction level and masticatory capacity in edentulous patients with conventional dentures and implant-retained over dentures. Braz J Oral Sci 2006; 5(19): 1232-1238.

16.Prieskel H .W. Over dentures made easy. Pg 5-6.

17.Tarlow JL. Over dentures with roots or implants for elderly patients: a comparison J Prosthet Dent 1996; 75(3): 346.

18.Chen L, Xie Q, Feng H, Lin Y, Li J. The masticatory efficiency of mandibular implant-supported over dentur es as compared with tooth-supported over dentures and complete dentures. J Oral Implantol 2002; 28(5): 238-43

19.Stern RM. Treatment outcomes with implant-supported over dentures: Clinical considerations. J Prosthet Dent 1998; 79: 66-73.

20.Demers M, Bourdages J, Brodeur JM, Benigeri M. Indicators of masticatory performance among elderly complete denture wearers. J Prosthet Dent 1996; 75: 188-93

21.Burns DR. The mandibular complete overdenture. Dent Clin North Am 2004; 48: 603–623.

22.Sadowsky SJ. Mandibular implant-retained over dentures: A literature review. J Prosthet Dent 2001; 86: 468-73.

23.Van Kampen FMC, Bilt AV, Cune MS, Fontijn-Tekamp FA, Bosman F. Masticatory Function with Implant-supported over dentures. J Dent Res 2004; 83(9): 708-711.

24.Allen PF, McMillan AS, Walshaw D. A patient-based assessment of implant-stabilized and conventional complete dentures. J Prosthet Dent 2001; 85: 141-7.

25.Geckili O, Bilhan H, Mumcu E, Dayan C, Yabul A, Tuncer N. Comparison of patient satisfaction, quality of life, and bite force between elderly edentulous patients wearing mandibular two implant-supported over dentures and conventional complete dentures after 4 years. Spec

Care Dentist 2012; 32 (4): 136-41.

26.Garrett N, Rroumanas ED, Blackwell KE, Freymiller E, Abemayor E, Wong WK, Gerratt B, Berke G, Beumer J, Kapur KK. Efficacy of conventional and implant supported mandibular resection prosthesis: study overview and treatment outcomes. J Prosthet Dent 2006 ; 96(1): 13-24.

27.Niwatcharoenchaikul W, Tumrasvin W, Arksornnukit M. Effect of complete denture occlusal schemes on masticatory performance and maximum occlusal force. J Prosthet Dent 2014 ; 112(6): 1337-42.

28.Bates FJ, Stafford G, Harrison K. Masticatory function— A review of the literature. J Oral Rehabil 1976; 3: 57-67

29.Busetti J, De Carli JP, Rodrigues Neto DJ, Pereira JR. Overdentures and masticatory efficiency: literature review. Dental Press Implantol 2013; 7(4): 34-7.

30.De Souza BV, De Faria AD, Junior Joel Ferreira S, Gonçales VA, Piza PE, Fellipporamos V. Root-supported overdentures associated with temporary immediate prostheses- A case-report. Oral Health Dent Manag. 2014 ; 13(2): 159-63.

31.Fueki K, Kimoto K, Ogawa T, Garrett NR. Effect of implant-supported or retained dentures on masticatory performance: A systematic review. J Prosthet Dent 2007; 98: 470-477.

32.Misch CE. Contemporary Implant Dentistry. 3rd edition; Elsevier, St. Louis.

33.Cune M, Burgers M, Kampen FV de, Putter C, Bilt A. Mandibular Overdentures Retained by Two Implants: 10-Year Results from a Crossover Clinical Trial Comparing Ball-Socket and Bar-Clip Attachments. Int J Prosthodont 2010; 23: 310-317.

34.Toman M, Toksavul S, Saracoglu A, Cura C, Hatipoglu A. Masticatory performance and mandibular movement patterns of patient s with natural dentitions, complete dentures, and implant-supported overdentures. Int J Prosthodont. 2012; 25(2): 135-7.

35.Lindquist LW, Carlsson GE, Hedegård B. Changes in bite force and chewing efficiency after denture treatment in edentulous patients with denture adaptation difficulties. J Oral Rehabil 1986; 13: 21-9.

36.Carlsson GE. Masticatory efficiency: The effect of age, the loss of teeth and prosthetic rehabilitation. Int Dent J 1984; 34: 93-7.

37.Pocztaruk RL, Vidal RA, Fontoura FLC, Rivaldo EG, Gaviao MBD, Bilt A. Satisfaction level and masticatory performance of patient rehabilitated with implant-supported Overdentures. Rev Odonto Cienc 2009; 24(2):109-115.