Assessment of swallowing and masticatory performance in obturator wearers: a clinical study

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PURPOSE. To assess function by identifying changes in swallowing and masticatory performance in maxillary obturator prosthesis wearers. **MATERIALS AND METHODS.** Sixty subjects were recruited for the study, of which 20 were obturator wearers, 20 were completely dentulous and 20 had removable partial/complete dentures with similar Eichner's Index. Swallowing ability was evaluated with and without obturator using the "Water Drinking Test"; Masticatory performance was evaluated with the Sieve test; and maximum occlusal force was recorded with the help of a digital bite sensor. The data was analyzed using the Statistical Package for Social Science version 15.0 with a confidence level at 95%. **RESULTS.** Profile, behavior of drinking and time taken to drink were significantly improved ($P<.001$) in subjects after wearing obturator. Masticatory performance was not significantly different ($P=.252$) in obturator wearer when compared with dentulous or removable partial/complete denture wearer, but significantly ($P<.001$) high inter group difference in maximum occlusal force existed. Correlation between masticatory performance and maximum occlusal force was not significant ($P=.124$). **CONCLUSION.** Swallowing ability was significantly improved after wearing obturator but masticatory performance was not significantly different from those having similar occlusal support zone in their dentition.
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KEY WORDS: Masticatory performance; Obturator; Swallowing; Mastication; Occlusal force; Maxillectomy

INTRODUCTION

Maxillary defects are created by surgical treatment of benign or malignant neoplasm or by trauma.[1] The local and regional spread of disease is controlled with maxillary and palatal resection, but it results in open communication between the oral and nasal cavities.[2,3] Traditionally, obturator prostheses have been used to occlude areas of the palate that have been resected to restore esthetics and to diminish difficulties associated with mastication, swallowing and speech intelligibility.[4]

The advantages of obturator prosthesis include immediate rehabilitation and less procedure time. The surgical site can be easily examined after removing obturator prosthesis, and tumor recurrence, if any, may be detected in time. Obturator prosthesis may therefore still be the privileged treatment modality after maxillectomy.[5,6]

It is clinically important to evaluate the oral function such as mastication, swallowing and estimate the improvement provided by obturators.[7] Eating is known to be a complex function that consists of taking food, mastication, forming boluses, and swallowing. Various studies has been conducted to assess the swallowing ability of patient who have undergone resection of tongue or floor of mouth,[8-10] but it has been observed that evidence are lacking in maxillectomy subjects. Also, most of the studies on mixing abili-

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ty test and mastication were subjective in nature and compared with completely edentulous subjects.[11] Hence this study was planned to assess the swallowing ability in obturator prosthesis wearers and to compare the masticatory performance with similar occlusal support control group.

MATERIALS AND METHODS

Subjects were selected and recruited in this study amongst patients and their attendant who visited department of Prosthodontics of the medical university from June 2011 to December 2012. Selected samples were explained about the need and procedures to be employed in this study and were requested to sign a written consent form to indicate their acceptance and willingness to participate. Ethical approval was taken from the institutional ethical committee.

Twenty subjects were obturator wearer in case group. Two control groups were selected. Control group 1 included twenty healthy completely dentate subjects from patient attendants or matched subjects. Control group 2 had twenty removable partial denture/complete denture wearer having similar natural (as Eichner's index)[12] occlusal support zone from removable Prosthodontics clinic of department. Eichner's index is based on the number of occlusal support zones in posterior contact area. There were four occlusal support zones (two premolar and two molar zones) if contact occurs with the opposing arch. This index includes three main groups (A, B, and C) and subgroups A1-A3, B1-B4, C1-C3 (Table 1).

Inclusion criteria for case group were

1. Patients who had undergone maxillectomy and were obturator wearers
2. Patients undergoing maxillectomy who would require obturator
3. Age group of 18 years and above
4. Class I to VI maxillectomy defect[13]

Exclusion criteria were

1. Maximum jaw opening of 15 mm or less because the superolateral extension of the obturator may be limited, compromising the seal[14]
2. Physical and mental disability that would interfere with the study

Fabrication of obturator and tests were done by a qualified prosthodontist who has more than eight years of clinical experience. Open top design of obturator was preferred.[15,16] Extension along posterior and lateral margins of defect was emphasized to enhance retention, stability, and support. Vertical extension in the postero-medial region of the defect was carefully designed to minimize leakage.[17,18] Swallowing ability and masticatory performance was checked under supervision of a qualified otolaryngologist.

Swallowing ability was evaluated by "Water drinking test" in obturator wearers with and without wearing the obturator. In water drinking test, subjects were instructed to drink 30 mL of water in one swallow with 5 seconds as cut-off point for normality and their profile were evaluated

Table 1. Distribution of patients according to Aramany's classification and Eichner's index

Aramany's classification	No. of patients	Percentage
Class I	5	25
Class II	7	35
Class III	2	10
Class IV	3	15
Class V	0	0
Class VI	3	15
Eichner's Indices		
Group A (Four occlusal supporting zone)	2	10
A1 (no missing teeth)	1	5
A2 (at least one missing tooth in maxilla/mandible)	1	5
A3 (at least one missing teeth in maxilla and mandible)	0	0
Group B (Three to one occlusal support zone)	14	70
B1 (three occlusal support zone)	9	45
B2 (two occlusal support zone)	4	20
B3 (one occlusal support zone)	1	5
Group C (No occlusal contact)	4	20
C1 (at least on tooth in maxilla and mandible)	2	10
C2 (at least one tooth in maxilla/mandible)	1	5
C3 (completely edentulous)	1	5

with combination of time required for drinking water (from pouring of water in mouth to original position of larynx was return back) and incidence of cough reflex while drinking. The test was done with and without wearing the obturator.[7] The profile of each subject was categorized in accordance with specific criteria as followed:

- Normal: Able to drink in one swallow within 5 seconds without a cough reflex
- Suspected disability: Able to drink in one swallow in >5 seconds without a cough reflex, or able to drink in several swallows without a cough reflex
- Disability: Unable to drink without experiencing a cough reflex

Behavior of drinking was observed as natural drinking, sucking, holding, compulsory drinking, careful drinking and episode of drinking as drooling and nasal leakage; and characterized as

- Natural drinking: Able to drink water without problems
- Sucking: Sucking water (sip and/or sucking)
- Holding: Holding water in the mouth
- Compulsory drinking: Drinking water compulsorily with unnatural head posture
- Careful drinking: Drinking water carefully
- Drooling: Drooling water from the mouth
- Natural drinking: Leaking water into the nose

Subjects who exhibited natural drinking without any compensatory behavior and peculiar episodes were categorized as "normal" and the ones who exhibited at least one of the above mentioned behaviors and episodes were categorized as "abnormal".[7]

Chewing function was assessed by evaluating masticatory performance and maximum occlusal force. In masticatory performance, obturator wearers were compared with completely dentate (control group 1) and removable partial or complete dentures wearers of similar Eichner's index[12] (control group 2). Masticatory performance was obtained by sieve method using Agar hydrocolloid as a test material of one cm^3.

In this test, subjects were asked to chew the test material for 10 and 20 strokes. After completion of each chewing session, a glass of water was given to the subject to rinse his/her mouth and expectorate the chewed or masticated particles onto 1.70 and 1.40 mm mesh sieves respectively. Particles smaller than the sieve mesh was washed away in running tap water and remaining bigger particles in the sieve were counted. The counting was done three times for each subject, and masticatory performance was calculated by the formula: [19]

Masticatory performance = [B - A]/10

Where, A = number of particles collected in 10 strokes
B = number of particles collected in 20 strokes

Maximum occlusal force was measured with a digital Gnathodynamometer (Load Master, Model: BT 100, Sl. no 014831211, and Load Master Digital Indicator Model: LI450, Sl. no 014841. Bangalore, India) at subject's best biting location within the parameters of Eichner's classification of occlusal support zones as per mentioned in the table below.[20,21]

- Case group: Between artificial IInd Premolar and natural IInd premolar except class III and IV where it was measured between natural IInd premolar teeth
- Control group 1: Between natural IInd premolar teeth
- Control group 2: Between natural and artificial IInd premolar (removable partial denture) and between artificial IInd premolar (complete denture)

The measurements were done three times in every participant and the mean maximum occlusal force was derived by:

Maximum occlusal force = Total of three recordings/3

The data was analyzed using the Statistical Package for Social Sciences Version 15.0. Values have been shown as frequencies and proportions for categorical data. Data was assessed for distribution. Data that were parametric has been represented as Mean and standard deviation and analyzed by analysis of variance (ANOVA) and "t"-test; for non-parametric data Mann-Whitney U test and Wilcoxon signed rank test have been used. The confidence level of the study was kept at 95%.

RESULTS

Prevalence of Class I and II defects were higher (60%) as compared to that of Class V and VI defects (15%). Total of five (25%) patients classified as Aramany's Class III and IV (Table 1). Maximum numbers of cases were from Group B (70%), while minimum were from Group A (10%) Eichner's index (Table 1).

Subject's profile during water-drinking test while wearing obturator was significantly improved than without wearing obturator (P<.001)(Table 2). Mean drinking time with and without wearing prostheses was significantly shortened after wearing obturator (P<.001) from 6.60 ± 1.39 to 5.20 ± 0.52 (Table 2). A significant change in behavior and episode of drinking was observed (P<.001). Majority subjects were of careful (30%) and compulsory (30%) drinking, whereas rest of the subjects showed drooling/holding/sucking (40%)(Table 2).

Masticatory performance ranged from 0.09 to 1.33 in different groups. Mean masticatory performance was maximum in control group 1 (1.06 ± 0.09) and minimum in obturator wearer (case group)(0.96 ± 0.20). Mean masticatory performance in control group 2 was 1.01 ± 0.23 (Table 3). Analysis of variance and box plot thereafter showed no statistically significant inter-group difference in masticatory performance in different groups (F=1.41; P=.252). Masticatory performance values in different groups were overlapping in nature (Fig. 1). Maximum difference was observed between case group and control group 1 while

Table 2. Swallowing ability without and with definite obturator

S. No.	Variable	Without obturator		With obturator		Significance of change
		No.	%	No.	%	
1	Profile of water drinking test					
	Disability	2	10	0	0	z=4.000; *P*<.001 (Wilcoxon signed rank test)
	Suspected disability	15	75	3	15	
	Normal	3	15	17	85	
2	Time taken (Mean±SD) (seconds)	6.60±1.39		5.20±0.52		t=5.085; *P*<.001 (Paired t-test)
3	Behavior and episode of drinking					
	Natural	3	15	18	90	x^2=22.556; *P*<.001 (Chi-square test)
	Abnormal	17	85	2	10	
	Careful	6	30	2	10	
	Compulsory	6	30	0	0	
	Drooling	2	10	0	0	
	Holding	2	10	0	0	
	Sucking	1	5	0	0	

Table 3. Comparison of mean masticatory performance, analysis of variance and between group comparisons of masticatory performance in different groups

Comparison of mean masticatory performance in different groups		No. of cases	Mean	SD	Minimum	Maximum
	Case group	20	0.96	0.2	0.56	1.33
	Control group 1	20	1.06	0.09	0.9	1.23
	Control group 2	20	1.01	0.23	0.09	1.23
	Total	60	1.01	0.18	0.09	1.33
Analysis of variance for masticatory performance in different groups		Sum of squares	df	Mean square	F	Sig.
	Between groups	0.09	2	0.05	1.41	0.252
	Within groups	1.9	57	0.03		
	Total	1.99	59			
Analysis of variance for masticatory performance in different groups	Comparison	Mean difference	SE	"*P*"		
	Case vs control 1	-0.097	0.06	.221		
	Case vs control 2	-0.048	0.06	.685		
	Control 1 vs control 2	0.049	0.06	.674		

minimum difference was observed between case group and control group 2. There was no statistically significant difference between groups (*P*>.05).

Analysis of variance and box plot showed a statistically significant inter-group difference in maximum occlusal force (F=67.95; *P*<.001)(Table 4). It was observed that subjects in case group had lower order of occlusal force whereas subjects in control group 1 had the highest order of occlusal force followed by control group 2. No overlapping interquartile values were observed on the box plot (Fig. 2). Maximum difference was observed between case group and control group 1 while minimum difference was observed between case group and control group 2. All differences between groups were statistically significant (*P*<.001).

None of the correlations between masticatory performance and maximum occlusal force were statistically significant (Table 5)(Fig. 3).

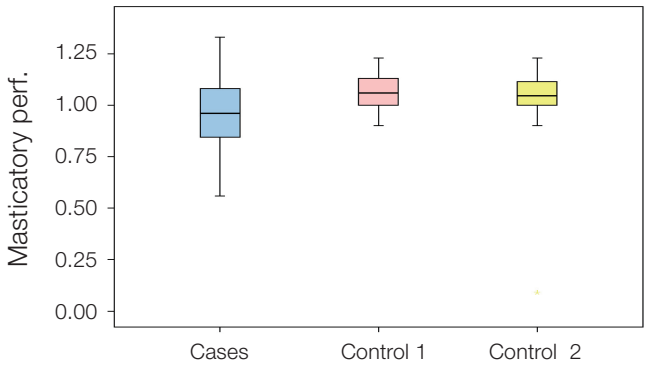

Fig. 1. Analysis of variance for masticatory performance in different groups.

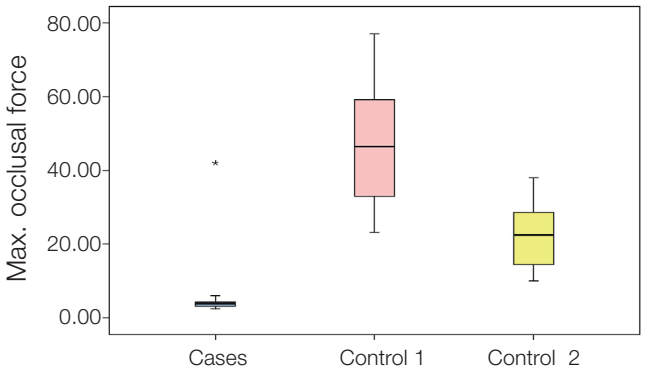

Fig. 2. Analysis of variance for occlusal force in different groups.

Table 4. Analysis of variance for maximum occlusal force and between groups comparison of maximum occlusal forces in different groups (Tukey HSD test)

	Sum of squares	Df	Mean square	F	*P* value
Between Groups	17366.44	2	8683.22	67.95	<.001
Within Groups	7283.978	57	127.79		
Total	24650.41	59			

Between group comparison of maximum occlusal forces in different study groups

S. No.	Comparison	Mean difference	SE	*P* value
1	Case group vs Control group 1	-41.39	3.57	<.001
2	Case group vs Control group 2	-16.48	3.57	<.001
3	Case group 1 vs Control group 2	24.91	3.57	<.001

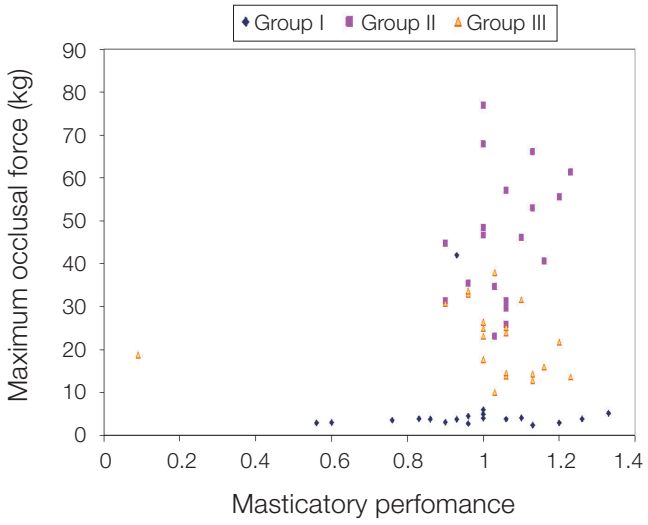

Fig. 3. Scatter diagram showing correlation between masticatory performance and maximum occlusal force.

Table 5. Showing correlation between masticatory performances and maximum occlusal forces in different study groups

S.N.	Variable	Correlation "r"	*P*
1	Overall	0.201	.124
2	Case group	-0.006	.981
3	Control group 1	0.304	.192
4	Control group 2	-0.099	.679

DISCUSSION

The direct effect of maxillary defects, which were created by surgical intervention of neoplasm has a profound impact on the functional abilities of a patient.[1] Maxillary defect which causes functional disability due to oral and sino-nasal cavity communication can be restored by prosthetic replacement with a pressure resistance seal of an obturator bulb against the mucosal lining and skin graft covering the defect.[22,23]

Use of artificial substitutes to replace anatomic structures has long been an accepted method of treatment for patients with maxillectomy defects.[21] Major goal of cancer therapy is not only to eradicate the disease but also to restore patients to a reasonably normal quality of life.[24] Psychological well-being and patient's vitality are an increasing contribution to evaluation of success of maxillectomy patients, and a good obturator function has been previously reported to contribute to the improved quality of life.[25]

This study objectively assessed swallowing and found significant improvement in swallowing ability and also significantly reduced drinking time in maxillectomy patients while using an obturator. The reason of significant improvement of drinking with the obturator may be due to the closure of oro-antral communication of the defect. After wearing the obturator, most of the subjects having compensatory behavior could drink naturally whereas 10% subjects still showed compensatory behavior of drinking which may be due to the large size defect (such as class IV), leading to lesser retention and stability in obturator prostheses. Kreeft *et al.*[11] had also found swallowing problems (subjective assessment) in obturator wearer and reason for this he stated was adjuvant radiotherapy complications. Moreno *et al.*[26] have found a comparable swallowing with microvascular free flap reconstruction versus palatal obturator. Few other authors[27,28] also assessed swallowing ability but as a subjective component in Quality of life questionnaire.

No significant inter group difference was seen in different groups for masticatory performance. This is because masticatory performance may be dependent on occlusal stops and tooth morphology.[21] Though studies by Anita Wedel *et al.*[20] have shown poor chewing ability (subjective assessment) in 14% of maxillofacial obturator cases, but in our study 85% subjects were of class I, II, III & IV and 80% were of Eichner's index A & B type so most of the natural teeth are present which help in mastication. It was also documented that preferable chewing side by the patient follow the side where natural teeth are present[29] and agar being a material softer than materials used in other studies,[20] we have found no significant difference in masticatory performance. Despite this agar was selected because of the advantages of reproducibility, simple routine application and with implication that it can be crushed to the same degree in case and control groups.[19,30-32]

Occlusal force ranged from 2.44 to 77 kg in different groups. Our study showed statistically significant intergroup difference in maximum occlusal force. This may be explained best by the fact that age variation factor and condition of occlusal support were of major influence for the maximum occlusal force.[33,34] Majority of control group 1 (complete dentate) subjects were of lower age compared to control group 2 (removable partial/complete denture) subjects and case group in this study. Between inter-group comparisons; maximum difference was found between case group and control group 1; minimum difference was observed between case group and control group 2. These significant differences may be because of multiple reasons like age, gender, condition of occlusal support, occlusal morphology of the biting location, and varying activity of jaw musculature in the subjects.[35-37]

The present study also found that there is no significant statistical correlation between masticatory performance and maximum occlusal forces since maximum occlusal force was not required by the subject to chew a test material.[29,38] As discussed, masticatory performance has no significant differences in different study groups as it is influenced by the number of existing teeth, morphology of teeth and the number of occlusal supports. Whereas, maximum occlusal force is influenced by age, gender, tooth morphology and jaw musculature with significant variation in different study groups.

Certain limitations of the present study were short duration of study period (one year) and small sample size due to tertiary referral centre. Inclusion of all different classes of maxillectomy defect and recruitment of irradiated and non-irradiated subjects may have resulted in selection bias. Maximum occlusal force was measured at subject's best biting location at a unilateral single contact area and hydrocolloid chewing material may still not be the ideal test material to assess masticatory performance.

Therefore, in order to improve upon the accuracy, further elaboration of this study with larger sample size and improvised methodology including other chewing test materials is recommended.

CONCLUSION

Obturator will improve swallowing ability as well as reduce drinking time in maxillectomy subjects. Masticatory performance was not depending on occlusal force and it is not significantly changed compared to normal, healthy adult having similar occlusal support zone.

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