

Influences of Size and Form of Maxillectomy Defect, and Remaining Maxillary Teeth on Oral Functions of Patients Receiving Prosthetic Therapy with Obturator

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Abstract: *Background:* Maxillectomy defect causes an oro-nasal opening affecting oral functions; inability to chew and swallow disorders in phonation, aesthetics and psychological depression of patients. Obturator prosthesis can result improvement in oral functions by re-establishing oro-nasal separation. *Objectives:* The study was done to investigate the effects of maxillary defect form, size, and remaining maxillary teeth on oral functions in post-maxillectomy patients. *Materials and Methods:* The study was conducted over 16 post-maxillectomy patients, age (mean \pm SD = 37.56 \pm 13.07 years) ranged from 18 to 70 years, male 9(56.20%) and female 7(43.80%), partially dentate, treated with obturator prosthesis at the prosthodontic department of Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh. All patients had continuously worn the obturator prostheses for at least 3 months during the study. Data of each patient were recorded on the basis of size and form of maxillary defect, and remaining maxillary teeth, and mastication, speech and swallowing. The data were tested with statistical software (SPSS V.19). *Results:* Form and size of the maxillectomy defect has significant relationship with the masticatory performance ($P=.007$ for defect form & $.003$ for defect size) and articulation of speech ($P=.003$ for defect form & 0.001 for defect size). Remaining maxillary teeth has no significant relation to masticatory performance ($P=.66$) and articulation of speech ($P=.386$). Form and size of the maxillectomy defect, and remaining maxillary teeth has no significant relationship with the swallowing obturator function ($P\text{-value}=.13$ for defect form $.09$ for defect size and $.49$ for remaining teeth). *Conclusion:* Size and form of maxillary defect significantly influence the masticatory performance and articulation of speech, they also affect in swallowing efficacy but it is not statistically significant. Remaining maxillary dentition has not significant effects on oral function of obturator.

Keywords: Maxillectomy Defect, Maxillary Teeth, Oral Functions, Prosthetic Therapy, Obturator

1. Introduction

The maxillae are important structure for both function and cosmetic appearance of the face. It maintains phonation, mastication and swallowing, and aesthetics of facial contour. The maxilla may be defective due to congenital or acquired

causes. Acquired causes for maxillary defect are usually resulting from surgery or trauma.¹ Almost all acquired maxillary defects caused by resection of oral neoplasm. Oral malignant tumor is the eleventh most common cancer in the world; third most in Indian sub-continent² and 20% of all cancer in Bangladesh,³ among them, 17.5% is maxillary lesion.⁴

Maxillectomy defect causes a communication between the oral and nasal cavities affecting oral function;^{5,6} inability to chew and swallow, disorders in phonation, aesthetics and psychological depression of patients.^{7,8} Maxillary defect can be restored with either tissue grafting or using prosthesis. Although, surgical reconstructions have some advantages but it is not always possible because of the condition of the patient.⁹ So, prosthetic reconstruction may be one of the possible solutions.

An obturator is a prosthesis which closes an opening or defect of the maxilla as a result of a cleft palate, trauma or removal of the maxilla due to pathologic mass.¹⁰ Obturator can result improvement in speech, mastication, swallowing and aesthetic by re-establishing oro-nasal separation.¹¹ Furthermore, it is suggested that obturator prosthesis may improve the psychological status of the patients as well as their quality of life.^{12,13}

Factors concerning obturator functions are- retention, stability and support of obturator. Retention and stability of obturator is gained from remaining teeth by placement of direct retainer. Residual maxillary arch, palatal structures and tissue undercut around the defect are also act as indirect retainer, and take part in stability and support.¹⁴

The structures in the remaining maxilla provide retention. The teeth are the great asset for providing retention of the obturator prosthesis as they receive the direct retainer. The number, position, and periodontal status of the remaining teeth are the most critical factors of retention, stability and support.¹¹ There are some factors such as residual soft palate, residual hard palate, anterior nasal aperture, and lateral scar band, height of lateral wall of the defect that may provide retention, stability and support to the obturator itself.¹⁵

Preservation and treatment of remaining teeth and residual structures may provide a better retention and stability of the prosthesis. With proper patient preparation, orofacial prostheses may prove to be a significant and positive factor in the physiologic and psychological rehabilitation for the patient with acquired defects.¹⁶ However, there is a lack of evidence correlating oral function with maxillary defect size, form, and remaining teeth in post-maxillectomy patients. The aim of this study was to investigate the maxillary defect form, size, and remaining teeth in relation to oral functions in post-maxillectomy patients.

2. Materials and Methods

The cross-sectional study was conducted over 16 post-maxillectomy patients, age (mean \pm SD = 37.56 \pm 13.07 years) ranged from 18 to 70 years, male 9(56.20%) and female 7(43.80%), partially dentate, treated with obturator prosthesis (table-I) at the prosthodontic department of Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh, from January 2009 to December 2010. Patients with congenital maxillary defect, debilitated patients, extreme xerostomia, restricted mouth opening, severe periodontal disease, and patients with other intraoral surgery along with maxillectomy were excluded from the study. All patients had been

rehabilitated with obturator prostheses. Prosthodontic procedures were carried out by a well-trained prosthodontist. No surgical reconstruction was performed. Status of the opposing teeth were evaluated. Decayed or missed teeth were restores or replaced accordingly. All patients had continuously worn the obturator prostheses for at least 3 months during the study. The study was undertaken with the understanding and consent of each subject. Data of each patient were recorded from medical and dental history, diagnostic casts, and clinical examinations. The patients were interviewed for the survey by a prosthodontist who was not involved in these prosthetic treatments.

2.1. Evaluation of Remaining Structures

The *maxillary defect form* was assessed according to the Aramany's classification of acquired maxillary defect. Aramany^{5,17} classified maxillectomy defects into six classes. These are- class I: the midline resection of the maxilla, the teeth are maintained on one side of the arch; class II: the unilateral defect, retaining the anterior teeth on the contra lateral side up to 2nd pre-molar; class III: the defect occurs in the central portion of the hard palate and may involve part of the soft palate; class IV: the defect crosses the midline and involves both sides of the maxillae up to 2nd pre-molar on contra lateral side; class V: the bilateral defect and lies posterior to the remaining abutment teeth; class VI: the bilateral defect and lies anterior to the remaining abutment teeth.

The *size of the defect* area in each patient was assessed as resection less than half of hard palate, half of hard palate and more than half of hard palate.¹⁸ Remaining maxillary teeth were recorded as their number and position. Position of existing teeth are divided according to Eichner's classification.¹⁹⁻²¹ This method classify the teeth as A-four supporting zone, B1- three supporting zone, B2- two supporting zone, B3-one supporting zone and B4 no supporting zone but occlusal contact on anterior teeth, and C-no occlusal contact.

2.2. Prosthetic Procedures

Patients were examined in seating upright position; special attention was given to the healing surface, size of the defect, scar tissue band and remaining teeth. A gauze piece was tied with thread and dipped with petroleum jelly, and packed into the defects. Primary impression was made with stock tray and irreversible hydrocolloid impression material. Primary cast was prepared with dental stone. Special tray was prepared with auto cure acrylic resin. Final impression was made by silicon impression material and special tray. Master cast was prepared with dental stone. Unfavorable undercut was blocked out, and the prosthetic design was done. Trial base was prepared by auto cure acrylic resin. Wax pattern and record block was prepared with modeling wax. Jaw registration was done. Teeth were arranged. Try-in was performed. Half flasking, full flasking, dewaxing, and deflasking was done sequentially. Separating media (cold

mold seal) was applied on the master cast and plaster surface. Mould space was packed with heat activated acrylic resin. Curing was done. Trimming, finishing and polishing of obturator denture was done. The obturator was inserted into patient's mouth. The patient was instructed for maintenance of prosthesis. The post insertion follow-up and patient care was carried out at the prescribed intervals of time.²²

2.3. Record of Oral Functions

Masticatory function was evaluated using the Sato's questionnaire.^{5,23} Each patient was asked a questionnaire by a dentist who was not involved in this prosthodontic work. Questionnaire was as follows – whether specific foods (used foods for each patient – apple, hard biscuit, bread and carrot) were 'easy to masticate', 'difficult to masticate', or 'unable to masticate'. The masticatory performance was recorded as the foods were masticated and reported by patient as- easy to masticate, difficult to masticate or unable to masticate.²⁴

Articulation of Speech: Speech of the respondents was categorized in to three groups like good, fair, and poor on the basis of Listener Judgments. Three healthy and sound listeners who were not involved in this prosthetic work listened to the patient's speech and rated the defectiveness and adequacy of speech. Their judgments were made on a 3 points scale such as good, clear speech with no nasality; fair, speech with some nasality; and poor, speech not clear at all.^{25,26}

Swallowing integrity of liquid was checked. In case of improper swallowing, liquid came out through the nasal cavity. Responses were recorded according to different grading such as good, no leaking of liquid through nasal cavity; and poor, leaking of liquid through nasal cavity.^{27,28*}

Data Analysis: The data were tested with statistical software (SPSS V.19). χ^2 test was done to detect the relationship between form and size of maxillary defect, and remaining teeth and oral function. P-values <0.05 were deemed statistically significant.

3. Results

Form of the maxillectomy defect has significant relationship with the masticatory performance of obturator ($P = .007$). Class III defect has the highest influence on masticatory performance for easy mastication. Class I & II defects are same in relation to masticatory performance. In class IV defects, patient are unable to masticate with obturator. Size of the maxillectomy defect has significant influence on masticatory performance of obturator ($P = .003$). As the size of the defect increases masticatory performance decreases from easy mastication to difficult to mastication.

Location of remaining maxillary teeth has no significant effects on masticatory performance of obturator function ($P = .66$) (table-II).

Form of the maxillectomy defect has significant relationship with the articulation of speech of obturator ($P = .003$). Class III & II defect has the highest influence on good speech. Class I defects have same effects on good and fair speech. In class IV defects, patient speaks poor with obturator. Size of the maxillectomy defect has significant relation to articulation of speech of obturator functions ($P = .001$). As the size of the defect increases speech articulation decreases from good to poor. Location of remaining maxillary teeth has no significant impact on articulation of speech of obturator function ($P = .386$) (table-III).

Form and size of the maxillectomy defect, and remaining maxillary teeth has no significant influence on swallowing of obturator function. P-value of form of the defect, size of the defect and remaining maxillary teeth for swallowing are 0.13, 0.09 and 0.49 respectively (table-IV).

Table I. Characteristics of the patients (n=16).

Parameters	n	%
Age Group		
≤ 20 years	2	12.5
21 to 30 years	3	18.8
31 to 40 years	5	31.3
41 to 50 years	4	25.0
51 to 60 years	1	6.3
≥61 years	1	6.3
Total	16	100.0
Sex		
Male	9	56.3
Female	7	43.8
Therapy Taken		
Surgery only	7	43.8
Surgery +radiotherapy	9	56.3
Total	16	100.0
Number of Remaining Teeth		
6	2	12.5
7	6	37.5
8	1	6.25
11	2	12.5
12	2	12.5
14	1	6.25
16	2	12.5
Total	16	100
Used Obturator		
Surgical+Interim+Definitive	7	43.8
Interim+Definitive	7	43.8
Definitive only	2	12.5
Total	16	100.0

Table II. Distribution of patients according to masticatory performance (n=16).

		Masticatory Performance				P value
		Easy to masticate n(%)	Difficult to masticate n(%)	Unable to masticate n(%)	Total n(%)	
Defect type	class I	6(37.5)	2(12.5)	0	8(50)	0.007
	class II	3(18.75)	1(6.25)	0	4(25)	
	class III	3(18.75)	0	0	3(18.75)	

		Masticatory Performance				P value
		Easy to masticate n(%)	Difficult to masticate n(%)	Unable to masticate n(%)	Total n(%)	
Defect size	class IV	0	0	1(6.25)	1(6.25)	0.003
	Total	12(75)	3(18.75)	1(6.25)	16(100)	
	<1/2 of palate	6(37.5)	1(6.25)	0	7(43.75)	
	1/2 of palate	6(37.5)	2(12.5)	0	8(50)	
	>1/2 of palate	0	0	1(6.25)	1(6.25)	
	Total	12(75)	3(18.75)	1(6.25)	16(100)	
Remaining teeth	B2	6(37.5)	2(12.5)	1(6.25)	(56.25)9	0.66
	B3	4(25)	0	0	(25)4	
	A	2(12.5)	1(6.25)	0	(18.75)3	
	Total	12(75)	3(18.75)	1(6.25)	(100)16	

Table III. Distribution of patients according to speech (n=16).

		Speech				P value
		Good n(%)	Fair n(%)	Poor n(%)	Total n(%)	
Defect type	class I	5(31.25)	3(18.75)	0	8(50)	0.003
	class II	4(25)	0	0	4(25)	
	class III	3(18.75)	0	0	3(18.75)	
	class IV	0	0	1(6.25)	1(6.25)	
	Total	12(75)	3(18.75)	1(6.25)	16(100)	
Defect size	<1/2 of palate	7(43.75)	0	0	7(43.75)	0.001
	1/2 of palate	5(31.25)	3(18.75)	0	8(50)	
	>1/2 of palate	0	0	1(6.25)	1(6.25)	
	Total	12(75)	3(18.75)	1(6.25)	16(100)	
Remaining teeth	B2	5(31.25)	3(18.75)	1(6.25)	9(56.25)	0.386
	B3	4(25)	0	0	4(25)	
	A	3(18.75)	0	0	3(18.75)	
	Total	12(75)	3(18.75)	1(6.25)	16(100)	

Table IV. Distribution of patients according to swallowing (n=16).

		Swallowing		Total n(%)	P value
		Good n(%)	Poor n(%)		
Defect type	class I	7(43.75)	1(6.25)	8(50)	0.13
	class II	4(25)	0	4(25)	
	class III	2(12.5)	1(6.25)	3(18.75)	
	class IV	0	1(6.25)	1(6.25)	
	Total	13(81.25)	3(18.75)	16(100)	
Defect size	<1/2 of palate	6(37.5)	1(6.25)	7(43.75)	0.09
	1/2 of palate	7(43.75)	1(6.25)	8(50)	
	>1/2 of palate	0	1(6.25)	1(6.25)	
	Total	13(81.25)	3(18.75)	16(100)	
Remaining teeth	B2	7(43.75)	2(12.5)	9(56.25)	0.49
	B3	4(25)	0	4(25)	
	A	2(25)	1(6.25)	3(18.75)	
	Total	13(81.25)	3(18.75)	16(100)	

4. Discussion

This study results revealed that form and size of the maxillectomy defect significantly correlate with oral function of patients treated with obturator, and remaining maxillary dentition also influence the obturator functions for post maxillectomy patients. Sema *et al.*²⁸ and Keyf¹¹ stated that the residual maxillary structures have an impact on the degree of obturator movement during functions. The abutment teeth essentially absorb the stress generated by functional movement of the obturator prosthesis and play an important role in retention and stability of the prosthesis. When dealing with extensive and unfavorable defects, the

prosthesis is extended more into the defect, and therefore might be heavier. It exert continuous force to tissues, and affects their health, compromises the function of the prosthesis and patients may feel discomfort.²⁹⁻³¹ Hüseyin *et al.*³² added that, not only the location, extension and design, and volume of surgical resection of maxilla but also the status of unresected structure around the defect and distribution of remaining teeth are important factors for regulation oral function with obturator.

This study found form and size of the maxillectomy defect significantly affect the masticatory performance, but remaining maxillary teeth has no significant relation to masticatory performance of obturator function. These are may be due to various degrees of obturator's movement

depending on the residual maxillary structures such as configuration and size of the defect, amount and contour of the remaining palatal shelf, height of the residual alveolar ridge, and the undercuts. The post-maxillectomy patients presents different type of defect configuration and size of defect area, and number and position of teeth. So, prosthesis movement can be reduced by preservation of remaining teeth for using direct retainer, utilizing the remaining palatal structures for to stabilize the prosthesis and achieve support from around the defect area.

Koyama et al.⁵ reported that the presence of teeth, the size and configuration of the defect influence the masticatory function of post-maxillectomy patients treated with obturator prostheses. They found the masticatory function scores are differed significantly with the different types of defect configurations and significant correlation between the masticatory function score and the size of the defect area, and there was no significant correlation between the masticatory function score and the number of remaining teeth. Takahiro et al.¹⁸ found that extent of the hard palate defect has high correlation with masticatory function. Masticatory functions have a tendency to increase above the range of average when defects size tends to decrease. Takahiro et al.¹⁹ showed in another report that there are strong correlation between masticatory performance, and extent of hard palate and posterior maxillary teeth.

In this study, it was observed that, form and size of the maxillectomy defect has significant relationship with the articulation of speech of obturator functions. Remaining maxillary teeth influence the articulation of speech of obturator but not significantly. Adisman³³ stated that the defect limited to the hard palate area, is sufficient to cover the defect and create a seal by engaging a minimal amount of undercuts. Aramany and Drane³⁴ indicated that the use of small nasal extension sections in hollow obturators in patients with large palatal defects tends to improve voice quality, but with smaller defects, the size of the nasal extension section has little effect on voice quality. The degree of extension into the defect varies depending upon the configuration of the defect, healing surface, and functional requirements for retention, support, and stabilization of the prosthesis.³⁵⁻³⁷ In large defects with lacking palatal support, the obturator is mostly extended vertically and horizontally to engage the surgical defect. So, it expands of its size and weight. Remaining structures are subjected to continuous stresses from such large, heavy obturators, and reduce patient's function and comfort.³⁶

Vivine de et al.³⁸ mentioned that, the extension of maxillectomy defect as the first factor for speech quality of patients receiving obturator prosthetic therapy. Patients with wider resections of the maxilla comprising the length of the alveolar border had low speech quality and better speech with smaller resection. Bohle et al.^{38,39} demonstrated that as the percentage of resection of palate increased, the intelligibility of speech decreased. Sullivan et al.^{38,40} observed individuals with hard defects may vary speech intelligibility depending on involvement of soft palate

surgery. In addition, maxillectomies, particularly the larger ones, restrict the contact between the tongue and palate, impairing speech intelligibility.

Arigbede et al.⁴¹ showed an improvement in the speech score from class I to class VI after insertion of interim and the definitive obturator. This improvement may be a result of the addition of teeth to the obturator, a proper seal produced by the obturator. They also have shown that larger defects with few teeth remaining are difficult to obturate and, hence, may present with greater disability in speech than smaller defects. El-Dakkak⁴² found articulation significantly and inversely related to orifice size; increasing orifice size reduced the adequacy of speech articulation. They indicate that this improvement in articulation and intelligibility of speech following prosthetic management as result of reduction in velopharyngeal closure.

The current study found that form and size of the maxillectomy defect and remaining maxillary teeth affect the swallowing of obturator function but not significantly. Kornblith et al.¹² and Vivine et al.³⁸ reported that obturators were more functional during communication and swallowing in patients with smaller resections of the hard palate. Suha et al.³⁶ stated that to prevent liquid and food leakage into the nasal cavity, the obturator is placed tightly into the defect area; however, the surrounding soft tissue changes its shape during the very common activities of oral functions. In large defects, lacking palatal support, the obturator is essentially extended to engage the surgical defect, so, it is fatty in size and heavy in weight as a result it is less effective in functions.

5. Conclusion

Within the limits of this study, it can be concluded that size and form of maxillary defect significantly influence the masticatory performance and articulation of speech, they also affect in swallowing efficacy but it is not statistically significant. The presence of teeth in the maxillary dentition has not significant effects on oral function of obturator.

Authors' Contributions

All authors designed the study; S. Islam, M. Rahman, P. Islam & Hayet conducted the study and collected data; S. Islam analyzed data; S. Islam, A. Rahman & Azam drafted the paper, and all authors read and approved the manuscript.

References

- [1] Kiran KT, Suchita T, Anulekha ACK and Rajyalakshmi R. A prosthodontic rehabilitation of a partial maxillectomy patient with hollow bulb obturator. *IJDA* 2010; 2(4), 383-6
- [2] Khan Z. An overview of oral cancer in Indian subcontinent and recommendations to decrease its incidence. *Webmed Central CANCER* 2012; 3(8): WMC003626
- [3] Akhter M, Ali L, Hassan Z & Khan I. Association of human papilloma virus infection and oral squamous cell carcinoma in Bangladesh. *J Health, Population and Nutrition* 2013; 31(1): 65-9

- [4] Azam SM, Rahman BQ, Akhter M, Hossain SM, Asadullah M, Rahman AS, Islam SM. Detection of cervical lymphnode metastasis in oral squamous cell carcinoma by ultrasonogram guided fine needle aspiration cytology (FNAC) and comparison with computed tomographic (ct) findings. KhwajaYunus Ali Med Coll J 2014; 4(2): 391-7
- [5] Koyama S, Sasaki K, Inai T, Watanabe M. Effects of defect configuration, size, and remaining teeth on masticatory function in post-maxillectomy pataients. J oral Rehabil 2005; 30:635-41.
- [6] Dhiman R. Rehabilitation of a rhinocerebral mucoromycosis patient. Indian J Proshod Soc. 2007; 7:88– 91.
- [7] Tirelli G, Rizzo R, Biasotto M, Di Lenarda R, Argenti B, Gatto A, Bullo F. Obturator prostheses following palatal resection: clinical cases; ACTA otorhinolaryngologica italica 2010; 30:33-9
- [8] Hayet SMA, Islam MS, Azam MS, Rahman SA, Rahman MM and Akhter M. Prosthetic rehabilitation of acquired total maxillectomy patient with obturator prosthesis – a case report. Bangladesh Dent J 2011; 27:36-8.
- [9] Roumananas ED, Nishimura RD, Davis BK, Beumer J III. Clinical evaluation of implants retaining edentulous maxillary obturator prostheses. J Prosthet Dent. 1997; 77:184–19.
- [10] Chalian VA, Drane JB & Standish SM Maxillofacial Prosthetics. Multidisciplinary practice, The Williams & Wilkins Co., Baltimore 1971; pp. 133-148.
- [11] Keyf F. Obturator prostheses for hemimaxillectomy patients. J Oral Rehabil 2001; 28:821–29
- [12] Kornblith AB, Zlotolow IM, Goonen J, Huryh JM, Lerner T, Strong EW, Shah JP, Spiro RH, Holland JC. Quality of life of maxillectomy patients using anobturator prosthesis. Head Neck. 1996; 18:323–34.
- [13] Islam MS, Rayhan MA, Hayet SMA. Obturator prosthesis for post-maxillectomy patients. Rangpur Dent Coll J 2013; 1(2): 26-31.
- [14] Parr GR, Tharp GE & Rahn AO. Prosthetic principle of the framework design of maxillary obturator prostheses. J Prosthet Dent 1989; 62: 205-12.
- [15] Curtis TA, Beumer JIII. Restoration of acquired hard palate defects: etiology, disability and rehabilitation. In: Beumer J III, Curtis TA, Marunick MT , editors. Maxillofacial rehabilitation.prosthetic and surgical considerations. St. Louis: Medico Dental Medico Intl; 1996. p. 225-84
- [16] Ernest L. DaBreo. Chapter 80: Maxilloacial Prosthetic Rehabilitation of Acquired Defects. www.famona.tripod.com/ent/cummings/cumm080.pdf Down loaded on 14/11/2013
- [17] Aramany MA. Basic principles of obturator design for partially edentulous patients. Part I: Classification. J Prosthet Dent. 1978; 40:554–7.
- [18] Takahiro O, Hideli K, Kazuhiro H & Takashi N. Masticatory performance in postmaxillectomy patients in edentulous maxillae fitted with obturator prostheses. Int J Prosthodont 2007; 20:145-50
- [19] Takahiro O, Hideli K, Kazuhiro H & Takashi N. Predecive factors of Masticatory performance in postmaxillectomyobturator wearer with soft palate defect that is either absent or limited to the anterior part. Prosthodont Res pract 2007; 6:181-187.
- [20] Yamashita S, Sakai S, Hatch JP & Rugh JD. Relationship between oral function and occlusal support in denture wearers. J Oral Rehabil 2000; 27: 881–6.
- [21] Yeshino K, Kikukawa I, Yoda Y, Watanabe H, Fukai K, Sugihara N, Matsukubu T. Relationship between Eichner index and number of present teeth. Bull Tokyo Dent Coll 2012; 53(1): 37-40
- [22] Rahman MM, Sultana A, Rahman MM, Haider IA; Difference of techniques for preparation of obturators in Bangladesh, J Oral Health 2005; 7(1):24-8
- [23] Sato Y, Minagi S, Akagawa Y, Nagasawa T. An evaluation ofmasticatory function of complete denture. J Prosthet Dent.1989; 62:50–53.
- [24] Islam MS, Chowdhury F, Nessa J, Rahman MM, Azam MS and Hayet SMA. Effectiveness of obturator with radicular attachment on masticatory performance of patients following maxillectomy. Bangladesh Med Coll J 2013; 18 (1): 19-23.
- [25] James F, Lubker, James W, Schweiger. Nasal Airflows an Index of Success of Management of Cleft palate.J Dent Res 1969;48:368.<http://dx.doi.org/10.1177/00220345690480030801>
- [26] Islam MS, Chowdhury F, Yazdi KS, Azam MS, Rahman MM, Nessa J. Articulation of speech of patients treated with radicular attachment assisted obturator following maxillectomy. Bangladesh J Med Sc 2014; 13(3): 298- 301. doi:10.3329/bjms.v13i3.19152
- [27] Jacob RF, Maxillofacial prosthodontics for the edentulous patient; Zarb GA, Bolender CL, Prosthodontic treatment for edentulous patients; St.luis, Mosby; 2004. p-453
- [28] Sema M, Ayhan G, Abufaz I, Bahadir D, Unsun C. Enhanced retention of a maxillofacial prosthetic obturator using precision attachments: Two case reports. Eur J Dent 2012; 6:212-7.
- [29] Yue ZH, Zhi H, Hong QY and Yong SZ. Inflatable hollow obturator prostheses for patientsundergoing an extensive maxillectomy: a case report. Int J Oral Sc 2012; 4:114–8; doi:10.1038/ijos.2012.22
- [30] Wu YL, Schaaf NG. Comparison of weight reduction in different designs of solid andhollow obturator prosthesis. J Prosthet Dent 1989; 62(2): 214–217.
- [31] Oh WS, Roumanas ED. Optimization of maxillary obturator thickness using a double processing technique. J Prosthodont 2008; 17(1): 60–63.
- [32] Hüseyin K, Hamit SÇ, Övül K, Faith Ö. Evaluation of speech intelligibility with maxillary resection obturators: a clinical study. SÜ Dişhek Derg 2007; 16:10-4.
- [33] Adisman IK. Prosthesis serviceability for acquired jaw defects. Dent Clin North Am. 1990;34:265–284.
- [34] Aramany MA, Drane JB. Effect of nasal extension sections on the voice quality of acquired cleft palate patients. J Prosthet Dent.1972; 27:194–202.
- [35] Oral K, Aramany MA, McWilliams BJ. Speech intelligibility with the buccal flange obturator. J Prosthet Dent. 1979;41:323–328.

- [36] Suha T, Timucin B, Asim AM and Mustafa OM. Articulation performance of patients wearing obturators with different buccal extension designs. *Eur J Dent*. 2009; 3(3): 185–90.
- [37] Brown KE. Peripheral consideration in improving obturator retention. *J Prosthet Dent*. 1968; 20:176–81
- [38] Viviane de CT, Maria IPK, José RPL. Speech evaluation with and without palatal obturator in patients submitted to maxillectomy. *J Appl Oral Sci*. 2006; 14(6):421-6
- [39] Bohle G 3rd, Rieger J, Huryn J, Verbel D, Hwang F, Zlotolow I. Efficacy of speech aid prostheses for acquired defects of the soft palate and velopharyngeal inadequacy-clinical assessments and cephalometric analysis: a Memorial Sloan-Kettering Study. *Head Neck* 2005; 27(3):195-207.
- [40] Sullivan M, Gaebler C, Beukelman D, Mahanna G, Marshall J, Lydiatt D, et al. Impact of palatal prosthodontic intervention on communication performance of patients maxillectomy defects: a multilevel outcome study. *Head Neck*. 2002; 24(6):530-8.
- [41] Arigbede AO, Dosumu OO, Shaba OP, Esan TA. Evaluation of speech in patients with partial surgically acquired defects: pre and post prosthetic obturation. *J Contemp Dent Pract* 2006; (7)1:089-096.
- [42] El-Dakkak M. Adequacy of velopharyngeal closure and speech competency following prosthetic management of soft palate resection. *Saudi Dent J* 1991; 3(1): 3-7.