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RETENTION AND FUNCTIONALITY ASSESSMENT FOR TWO DESIGN OF INTERIM MAXILLARY OBTURATOR

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ABSTRACT

Objectives: Maxillary obturator wearers suffer from improper retention and function of maxillary obturator. The aim of the study is to evaluate the conventional design of interim obturator utilizing multiple wrought wore clasps versus extended hinged-buccal-flange utilizes soft and dental tissue for retention.

Materials and Methods: fifteen participants with maxillary palatal defect were included in this crossover clinical study based on inclusion criteria. Each participant received conventional interim obturator with multiple wrought wire clasps (Design I); and was replaced with interim obturator retained by hinged-buccal flange extended form the sulcus full depth to the engage the labial and buccal undercuts of remaining teeth in the intact side. (Design II). The retention was evaluated at insertion (T_1), after 30 days (T_2) and after two months of insertion (T_3). The oral function was evaluated by obturator functioning scale (OFS).

Result: At comparing the reported difficulties with obturator designs at different function, there was a significant difference for items 11, 13, 14, 15 ($p = 0.001$, 0.09, <0.01 and 0.19 respectively). For retention evaluation, there was a significant reduction in retention with each group based on obturator design ($p < 0.001$). At comparing retention of both designs, there was significant increase of design II at the terminal of the study.

Conclusion: Within the limitation of the study, utilizing soft and dental undercuts by hinged-buccal flange design enhances retention, esthetic feedback and manipulation of the interim maxillary obturator comparing to the conventional multiple wrought wire clasps design.

KEYWORDS: Obturator, wearers, , multiple wrought wire clasps, hinged-buccal flange

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INTRODUCTION

Maxillofacial defects resulting from trauma, tumor resection, or congenital abnormalities can significantly impact a patient's quality of life, affecting their ability to speak, eat, and maintain facial aesthetics. The use of maxillary obturator, which is removable prosthetic device, can restore function and improve the overall well-being of these patients. However, the effectiveness of obturator require careful consideration of various factors, including retention, stability, and patient satisfaction.

After surgical intervention, the defect is blocked with the time of surgery with surgical obturator to preserve the intact of palatal plate and reduce the liability for infection. The interim obturator follows the surgical obturator. The interim obturator is a midway before the definitive obturator construction. The importance of interim prostheses is to enhance the healing and to adapt the patient on the new health situation.[1]

The design of the interim obturator based mainly to keep the prostheses in site by soft liner engaging the undercut of the defect. Also, the multiple clasping of the remaining teeth of the intact side is a cofactor to enhance retention. For multiple clasping, mouth preparation is mandatory to create alleyway for passing of the clasp palato-buccally. (2) Unfortunately the complicated design of the conventional interim obturator leads to unfavorable feedback from the patient due to difficulty of manipulation. Thus, dropping of the interim obturator is significant with time due to increase the weight of the obturator due to accumulation of secretions and weak clasping.

Using a buccal component for enhancing the retention of prostheses in the prosthetically compromised patient is a line of treatment. For instance the swing lock design uses the buccal bar for grasping the remaining teeth and utilizes the buccal undercut in case of little remaining teeth and limitation of supporting structure.[3] Also, the using of reverse and flex acrylic resin is useful to solve the problem of insertion and removal of prostheses and also to exploit the soft tissue undercut rather than blocking. [4] In this study, a buccal flange is attached to the main base of the obturator by wrought wire and utilizes the bony and dental buccal undercut for the intact side. The design is proposed to enhance the retention, reduce mouth preparation and facilitate the manipulation of the interim prostheses comparing to the conventional design with multiple wrought wire clasps.

To examine the hypothesized flanged interim prostheses, the retention and functionality of the obturator were evaluated. Retention of maxillary prostheses is evaluated by different subjective and objective methods. a dead-weight dislodging device was used to measure retention but the process is complicated for connecting device with maxillary prostheses.(5) The most appropriate way is to measure the displacement forces by digital force-meter. Digital forcemeter is easily to hand and simple to be attached to the maxillary denture and suitable for cases with limited mouth opening. (6) Another objective way to determine the retention and stability was used to evaluate the biomechanics of obturator. [7] For general functional assessment of performance of maxillary obturator, self-assessment measurement scales were used.

The Obturator Functioning Scale (OFS) was developed as a tool of self-reported functioning assessment of an obturator. The scale consists of 15 questionnaires that evaluate a patient's ability to speak and eat with the obturator and their satisfaction with esthetic provided by the obturator. A 5-point Likert scale represents each item on the OFS questionnaire, with descriptors for each question and way of grading under each point.[8]

The aim of this study was to evaluate the retention and functionality between the conventional and flanged design interim obturator. The null hypotheses

are that there is no difference in retention or OFS between both designs. The design of the study was crossover study extended for 4 months.

MATERIALS AND METHODS

Participants and study design

Fifteen maxillofacial patients were selected from outpatient clinics Faculty of dentistry, Delta University to involve this study. All patients finished surgical phase at least one month before delivery of interim obturator. The selection criteria of the patients were the presence of sufficient teeth preserving vertical dimension of occlusion and dependence of patience form desire for post-operative chemo or radiotherapy. The extension of maxillary defect and the socio-demographic data were represented in table I. Each patient received a conventional interim denture with multiple wrought wire clasps (Design I). After two months, the patient replaced the prostheses with another interim denture retained by a scalloped shaped hinged-buccal flange attached to the body of the obturator with wrought wire extended from full depth of the sulcus to engage the labial and buccal undercuts of the remaining teeth at the intact side (Design II). Randomly, eight patients received design I first then design II and the opposite sequence for the rest of patients. Through using each obturator design, retention and patient's function were assisted. The design of the study was approved by ethical committee, Delta University, under number (DU-2022-00111)

Construction of maxillary obturator

For making primary impression, suitable size and shape of maxillary stock tray was trimmed form the defect side. The border and the extension of the defect were registered by baseplate wax (Elkods, Egypt). Gently, vaslinated gauze (Yasmin medical, Egypt) was inserted to block undercuts of defect. Thick mix alginate (Caves, Holland) was loaded on tray and maxillary impression was recorded with caution not let patient swallow impression material. The impression was disinfected and poured with hard stone (MD Dental, Egypt) to create obturator design. Two Special trays were constructed on primary cast to make secondary impression for each patient twice. The auto-polymerized acrylic resin (Acrostone, Egypt) was mixed and spread over teeth and defect side after blocking the undercut of the defect area. After set of resin, medium size stone was used to perforate tray for mechanical retention of alginate. Before impression making, fine taper stone was used to widen the embrasure between adjacent teeth to facilitate through and through passage for clasps of design I. Secondary impression was made with alginate by the same sequence of primary impression. Bite was recorded and maxillomandibular casts were mounted on articulator. Artificial teeth (Acrostone, Egypt) were set out of occlusion on defect side after construction of trial denture base.

For design I, multiple 0.7 wrought wire clasps were expended buccally from the denture base to the buccal undercut of the all remaining teeth. Dental surveyor (VRight, China) was used to determine the survey line of each tooth and mark the position of the 0.03 inch depth on the buccal surface of each to receive the termination of the wrought wire.

For design II, two pieces of 0.9 wrought wires, one anterior and one most posterior, were extended from the palatal portion buccally to carry the hinged-buccal flange. The buccal flange was waxed up to engage the buccal vestibule soft tissue undercut and extend to maximum contour of teeth determined by surveyor. The escalloped shape of extended flange was extended interdental to the embrasure of remaining teeth (Fig 1 and 2).

The rest of the trail denture was waxed up and flasked with heat cure acrylic resin (Acrostone, Egypt); and the denture was deflasked, finished and polished.

At delivery visit, the denture was tried and modified for any minor defects; and occlusion was

refined. Base and catalyst of silicon-based soft liner (Promedica, Germany) were mixed according to manufacture. After loading on the intaglio of the denture at the defect side, the denture was seated gently on site. After setting of soft liner, the denture was removed and any excess of soft liner was trimmed by sharp scalpel.

Retention measurement

U-shaped (3cmx3cm) wrought wire was attached by auto-polymerized acrylic resin to the middle of the palatal denture base form the polished side. The middle of the palate was determined taking the half of distance measured from the anterior teeth to the anterior vibrating line. Digital forcemeter device (EXETEC, Germany) was calibrated to zero and a retention hook was mounted to the obturator from the U-shaped attached wire (Fig 3). The obturator was gently grasped downward until full slippage. The orientation of grasping was a little right or left shift to accommodate the limited mouth opening for some patient. The reading of required retain forces to dislodge the obturator was read. The process was repeated five times and the mean of reading was recorded and the reading of the prior of follow up. The retention was measured at insertion (T_1), after 30 days (T_2) and after two months of insertion (T_3).

Function evaluation

Obturator Functioning Scale is 15-item scale was designed evaluate speech ability, eating ability, speech performance and cosmetic satisfaction. A 5-point Likert scale was used to rate each item. The higher scores reflect greater difficulty with obturator function. The items and scores recorded by patients were mentioned in table 2. The score of each item was recorded at T_3 to guarantee full experience of using prostheses.

Data collection and statistical analysis

Data were collected and analyzed by SPSS version 23 (IBM, England). The mean and standard deviation were used for descriptive statistics for socio-demographic presentation of participants. For OFS comparing between both designs, Wilcoxon sign rank test was used. While paired *t* test and independent *t* test were used to compare retention within and between groups respectively.

Fig. (1) Polished side view for maxillary obturator with hinged-buccal flange.

Fig. (2) Intraoral view for maxillary obturator with the hinged –buccal flange

Fig. (3) Grasping maxillary obturator with forcemeter

RESULTS

Table 1 shows the socio-demographic and Medical Characteristics. Fifteen patients joint all stages of study. Ten men and eight of participants were married. The age ranged from 30-57 years (mean = 43.7±8.5). Four of participants had hard and soft defect and four patients only had radiotherapy eight months before obturator insertion. Nine patients had more than eight maxillary remaining teeth. Ten patients had gingival recession of 50% of their remaining teeth. At comparing the reported difficulties with obturator designs at different function, there was a significant difference for items 11, 13, 14, 15 (p =0.001, 0.09, <0.01 and 0.19 respectively). For retention evaluation, there was a significant reduction in retention with each group based on obturator design (p< 0.001). At comparing retention of both designs, there was significant increase of design II at the terminal of the study (Table.3).

TABLE (1) Socio-demographic and medical characteristics of participants (n=15)

Sex		**N(%)**
	male	10(66)
	female	5(34)
Age		
	30-40	7(46)
	40-50	4(27)
	>50	4(27)
Marital state		
	Married	9(53)
	Not-married	6(47)
Surgical extension		
	Hard palate only	11(74)
	Hard and soft palate	4(27)
History of radiotherapy		4(27)
Systematic disease		
	free	10(66)
	Diabetic	4(27)
	Cardiac	1(7)
Remaining maxillary teeth		
	>8	9(60)
	6-8	6(40)
Gingival recession		
	<50% of remaining teeth	10(66)
	>50% of remaining teeth	5(34)

TABLE (2) Reported difficulties with obturator prosthetic f unctioning with both obturator design

Item number		Mean of score	Sig.
Eating problems subscale			
1-difficulty in chewing food	Design I	2.60	.252
	Design II	2.33	
2-Leakage when swallowing foods	Design I	2.33	.162
	Design II	2.00	
Speech problems subscale			
3- Voice different from before after surgery	Design I	2.80	.679
	Design II	2.73	
4- Difficulty talking in public	Design I	2.80	1.000
	Design II	2.80	
5- Speech in nasal	Design I	2.80	1.000
	Design II	2.80	
6- Difficulty pronouncing words	Design I	2.60	1.000
	Design II	2.60	
7- Speech difficult to understand	Design I	2.33	.716
	Design II	2.40	
8- Difficult talking on the phone	Design I	2.33	.716
	Design II	2.40	
Other items in scale			
9- Mouth feel dry	Design I	1.40	.776
	Design II	1.47	
10- Dissatisfaction with	Design I	2.60	.025
	Design II	2.20	
11- Clasp on front teeth notification	Design I	2.60	.001*
	Design II	1.73	

Item number		Mean of score	Sig.
12-any area feel numb	Design I	1.87	.591
	Design II	1.73	
13-avoidance family or social events	Design I	2.67	.009*
	Design II	2.20	
14-difficult to insert or remove obturator	Design I	2.53	.000*
	Design II	1.33	
15-upper lip look funny	Design I	1.73	.019*
	Design II	2.33	

**** Significant difference by Wilcoxon sign-rank test.***

TABLE (3) Comparison of retention within and between obturator deigns *

	Design I	Design II	Between group (*p*-value)
T_1	20.78^{A}	24.26^{A}	0.053
T_2	20.14^{B}	23.5^{B}	0.08
T_3	$19.63^{C,c}$	$22.3^{C,c}$	0.02
within group significance (*p*-value)	<0.001	<0.001	

****dissimilar capital letter revealed significant difference in same column***

Similar small letter revealed significant difference in same row

DISCUSSION

Discussion of material and method

Patient with maxillofacial tumor needs special planning and care before, through and after surgical intervention. The maxillary defect is blocked by surgical obturator ligated introrally within the time of the operation. The surgical obturator is replaced with interim denture prostheses which is a midway between the surgical and permanent phase. [1] Due to loss of most of palatal porting during surgical intervention, the interim prostheses losses most of support and retention on the contrary in case of treating intact palate. This requires more engaging by retentive means for the remaining teeth by multiple clasping of intact teeth after massive mouth preparation and revealed difficulty during insertion and removal of the obturator.[9] Also, the continuous increases of the weight of the prostheses due to accumulation of secretions over the bulb portion leads to more dropping of obturator during function. The esthetic consideration is minor comparing to the multiple clasping to enhance the biomechanical aspects. Retention is augmented by soft liner which engages the defect undercut. As an invented design from swing-lock design [3] and disjunct denture [10], the design II of interim prostheses is created and was under probation through our study.

The Obturator Functioning Scale was designed to cover the serviceability of the obturator from different perspective as eating, esthetic and social considerations. Difficulty talking by phone was added as an item to assess difficulties at communication in the absence of visual connection. [11] The questionnaire was used in previous study revealing validated inspection of function among obturator wearers. [12]

Discussion of result

The result revealed significant increase in retention with design II. This may be due to the involving of more undercuts from the soft tissue of the ridge at the intact side. A possible way to augment the denture retention is by extending flanges to engage an existing soft-tissue undercut.[13] However, extension of conventional denture bases to undercuts should be kept conservative due to the rigidity of acrylic resin of acrylic resin. Flexible acrylic resin flange may enhance the chance for extension of denture base deeper to engage more soft-tissue undercut which, in turn, increase the retention of maxillary denture.[4,14] While hard acrylic resin denture base is used for construction of the interim denture of the study, but the flexibility of the denture flange is not due to the flexibility of the denture base itself but from the flexibility of the connection (by wrought wire) between the body of

the denture base and the extended hinged-buccal flange which utilizes the soft and dental undercuts. Also, the increases extension of the wrought wire connection increase the flexibility and retention of the hinged-buccal flange.[15]

Other factor could support the significance of retention with design II is the improvement of the muscle action against the extended acrylic flange compared to design I. As the proper waxing-up of the polished surface of the flange, the buccinators muscle finds a pad to seat and add pressure of the denture bucco-lingually which stabilizes the denture in its place.[16] Muscle can stabilize maxillary denture by two routes either by allowing the action of muscles without interact passively by the denture base or by utilizing natural action of muscle which help in the seating of the denture base to enhance stability.[15] The outline of the hinged-buccal flange is concave to permit positive seating by cheeks. Thus, the proper contouring of the denture polished surface permits the horizontal direction of forces that occur during contraction of these muscles to be transmitted as seating forces.[18] The muscle fibers extend longitudinally in antero-posterior direction, permitting rest on the denture base to grasp rather than displace it.[17]

The thickness of the buccal flange assists muscle grasping of the denture and enhance the muscle action. The assistance stimulates the proprioceptive receptors of the stomatognathic system to coordinate with the function movement of the denture due to prove the sensation of the movement of obturator. As it has a good outline to act as a seating pad for buccinator muscle. In maxillofacial patients, loss of ordinal masticatory performance even after restoration and the loss of teeth of resected side have a drastic effect on the periodontal receptors which relay information from the oral cavity to the central nervous system to regulate the activity of the masticatory muscles.[19] This decreases the inter-occlusal perception and decrease the control of any restoration during function. Additionally, the reduction of proprioception receptors can cause a loss of spatial representation in the somatosensory cortex. [20] Studies revealed mastication as a brain-driven behaviors which was validated by a reduction in case of reduction of neuronal activity.[21] Thus, any activation of the representative areas in the sensorial and motor cortex elaborates improvement of masticatory after proper restoration.[22] Suggestions revealed that the sensory cortex can be substantially improved after the critical development period of the brain through training or new form of mastication[23]; which can explain the improve of retention with design II which based on the improve of the sensation and receptors of muscle.

Other factor can explain the increase of retention at design II is the exploitation of multiple forms of undercut. The acrylic flange designed in escalloped shape to engage the interdental undercuts of the stand teeth to restore the reduction of retention. Different partial denture design exploits the interdental undercut such as ball clasp.[17] Also in dental compromised patient, swing lock design augment the retention if the denture by grasping the interdental and labial undercuts of the remaining dentition. [18]

The load of the obturator enhances the vertical display and dropping of the conventional design. With the accumulation of secretion and the food remnants, the weight of the obturator increases the vertical display of prostheses.[24] Also, maxillary obturator prosthesis will tend to be displaced by gravity. This displacement is resisted mainly by the retentive elements of the framework. A maxillary obturator should have a clasping system to retain the obturator in a passive position to the remaining hard and soft tissues. [9] For conventional design, designs I, there are retentive terminals of buccal clasps. Accordingly, the action of dropping is not purely vertical dropping. The orientation of obturator dislodgment is transferred to be a Class I lever

system is in function. When allowed to rotate, the buccal retentive arm is forced and dislodged out of its undercut.[25] On the other hand, for design II, the clasping system turns the biomechanics of obturator to be class II lever system rather than pure vertical displacement and dropping due to the resistance of dropping forces by the retentive terminal of the clasp arms.[26] The vertical component of rotational force acts to anchor the hinged-buccal flange more to the bony undercut and deflect the flange into more labial and interdental undercuts. Also, the resistance and the fulcrum point orientation allow more control of the force arm and consequently sustain the obturator in place. Additionally, the transferred pattern of movement to rotation rather than vertical drop down enhances the long arc rotational friction from the buccal flange to the lateral pad of resected side. [27]

The items related to esthetic and social activities of obturator wearers revealed significant increase within design II. The obturator engages the buccal and labial soft and dental undercuts of the remaining teeth of the intact side with acrylic portion with the same color of mucosa rather than cast or wrought wire clasps. This color of the flange mimic the color of mucosa and minimal appearance of the metal parts of the clasp is the main reason behind the superiority of design II in this point. One on the drawbacks of any maxillary obturator is the bad esthetic of anterior clasping and multiple clasps engaging the labial undercut. The anterior clasping of the obturator is essential to prevent the sagittal rotation.[9] While in design II, the rotation is prevented by encirclement of the cervical third of abutments.

Also, the results revealed favorable significance towards design II regarding the insertion and removal. In conventional design, the multiples clasping of design I requires mouth preparation to widen the interdental embrasures to include 0.7 inch wrought wire. [9] Additionally, the prostheses require high patient control to tune the insertion of the buccal and bulb part of the obturator within almost the same time at path of insertion. While at design II, the connection of the acrylic flange part with the base of the obturator is by long wrought wire which enhances the flexibility and reduce insertion and removal problems. [1]

On the other hand, patients revealed drawbacks for design II which reflects on the non-significant difference between both designs. This may be due to the flexibility of the wrought wires attaching the flanged portion to the obturator. As the wrought wire increases the flexibility increases.[1] Although this flexibility is favorable for simplicity of insertion, it may be a vulnerable point due to deflection and dropping of obturator under the force of gravity. It is notices that patients had little teeth on the non-resected side reported improper experience with design II. As, design II depends mainly on the buccal undercuts of the remaining teeth, the engagement on the soft tissue only may be not sufficient to tolerate the missing teeth.

During working through the study, the authors reported some drawbacks. The limited number of the patient is one of important points of study. The standardization of defect and/or the number of teeth was crucial. Also, the limited time of follow up could be a cofactor for the result. Further extended with more number of participants researches could support or deny our outcomes. According to our knowledge, design II did not tried as a design for definitive obturator which could be a proposed research point.

CONCLUSION

Within the limitation of the study, utilizing soft and dental undercuts by hinged-buccal flange design enhances retention, esthetic feedback and manipulation of the interim maxillary obturator comparing to the conventional multiple wrought wire clasps design.

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