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Review Article

Dentistry Section

Management of Velopharyngeal Defects: A Review

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ABSTRACT

Success in Maxillofacial Prosthetics depends on full cognizance of the principles that underlie facial harmony, anchorage and retention, weight bearing and leverage, durability, tissue compatibility and tolerance. The maxillofacial prosthodontist normally provides appliances to restore aesthetics and function to the patients who cannot be restored to normal appearances or functions by means of plastic reconstructions. The velopharynx is a dynamic anatomic structure which is essential for normal breathing, eating, and speaking. The soft palate acts as a separator between oral and nasal cavities. Impairment of velopharyngeal function can be caused by insufficiency or incompetency. This article describes in brief about velopharyngeal defects and their management.

Keywords: Maxillofacial prosthesis, Hollow obturators, Velopharnygeal complex, Velopharnygeal obturators

INTRODUCTION

Maxillofacial Prosthetics is the art and science of anatomic, functional or cosmetic reconstructions carried out by means of non living substitutes of those regions in the maxilla, mandible, face and even other body parts that are missing or defective because of surgical interventions, trauma, pathology or developmental or congenital malformations [1].

The Maxillofacial Prosthodontist normally provides appliances and devices to restore aesthetics and function to the patients who cannot be restored to normal appearances or functions by means of plastic reconstructions. Despite, remarkable advances in surgical management of oral and facial defects, they cannot be satisfactorily repaired by surgery alone. Further, the increased lifespan of individuals and the growing demand for health care services put additional obligations on the maxillofacial Prosthodontist [2].

Hypernasality and decreased intelligibility of speech are a result of congenital or acquired defects of the velopharyngeal mechanism. 'Obturator' is derived from the Latin verb, 'obturare', which means "to close" [3]. It is defined as a maxillofacial prosthesis which is used to close a congenital or acquired tissue opening, primarily, of the hard palate and/or contiguous alveolar/ soft tissue structures [1].

The palatopharyngeal valving mechanism regulates resonation and speech utterance and it partakes in non-speech oral activities such as swallowing, blowing, sucking, and whistling [3,2]. Palatopharyngeal insufficiency implies the presence of hypernasality, inappropriate nasal escape and decreased air pressure during the production of oral speech sounds (weak pressure consonants) [4]. In maxillofacial prosthetics, the clinician has the responsibility of re-establishing velopharyngeal integrity to provide the potential for acceptable speech. This article describes in brief about the velopharyngeal mechanism, defects and its prosthodontic management.

Characteristic velopharyngeal closure above the palatal level with anterior-posterior elevation of the soft palate is displayed by adults. The extent of closure of the soft palate with the posterior pharyngeal wall varies with head position. Pattern of soft palate movement varies between men and women. Soft palate in men is longer, elevation is greater, amount of contact with the posterior pharyngeal wall is less, and inferior point of contact with the posterior pharyngeal wall is higher [3].

Ali Aram et al., studied the normal velopharyngeal function in an effort to acquire some information which was relative to the positioning of a prosthetic pharyngeal extension. They reported that the soft palate moved in upward and backward directions to create a velopharyngeal closure. The degree of velar movement from rest to closure was found to increase with increment in age [5].

Gust of Passavant described a horizontal "cross roll" on the posterior pharyngeal wall, which occurred during speech and swallowing. This forward bulging which corresponded to the level of the atlas was termed as Passavant's ridge or pad. Some of the upper fibres of the palatopharyngeus circulated deep into the mucous membrane of the pharynx, and they constituted Passavants muscle, which on contraction, raised a ridge (Passavants ridge) on the posterior wall of the nasopharynx. When soft palate was elevated it would come in contact with this ridge, thus closing the pharyngeal isthmus. Passavant's pad would extend forward and superiorly as much as 5mm. Passavant's pad would serve as a guide for the placement of the soft palate obturator prosthesis [3].

VELOPHARYNGEAL CLOSURE

Classically, when velopharyngeal closure was required, the middle one-third of the soft palate would arc upward and backward to contact the posterior pharyngeal wall at or above the level of the palatal plane. The lateral pharyngeal walls would move medially to contact the margins of the soft palate at or slightly below the level of the torus tubarius (the medial bulging of the pharyngeal terminus of the Eustachian tube), and posterior pharyngeal wall would move anteriorly to facilitate contact with the elevated soft palate [3].

Movement of the posterior pharyngeal wall would blend with the movements of the lateral pharyngeal walls and elevation of the soft palate. A complete or nearly complete velopharyngeal closure would be required for normal deglutition and the production of some speech sounds [3].

VELOPHARYNGEAL DEFECTS

Velopharyngeal deficits may result from

- Congenital malformations (such as cleft palate),
- Developmental aberrations (such as a short hard or soft palate, or a deep nasopharynx).
- Acquired neurological deficits, or
- Surgical resection of neo-plastic disease.

CLASSIFICATION [3]

Velopharyngeal deficiencies may be classified on the basis of physiology and/or structural integrity into:

- Palatal insufficiency and
- Palatal incompetency

Palatal insufficiency refers to patients with inadequate length of the hard and/or soft palate which affect velopharyngeal closure, but with movement of the remaining tissues within normal physiological limits.

Palatal incompetence refers to patients with essentially normal velopharyngeal structures, but in whom the intact mechanism is unable to affect velopharyngeal closure.

It is seen in patients with neurological diseases such as myastenia gravis or neurological deficits which are secondary to cerebrovascular accidents or closed head injuries.

In velopharyngeal incompetence or insufficiency, the posterior wall movement or passavant ridge is more, which help in obtaining a velopharnygeal seal. Passavant ridge is associated only with a circular type of closure.

PROSTHODONTIC REHABILITATION

A prosthesis which is placed following resection of portions of the bony maxillae and adjacent structures is basically a covering prosthesis which re-establishes the oral-nasal partition. Obturator prosthesis which is fabricated for patients with velopharyngeal defects varies with the location and nature of the defect or deficiency.

OBJECTIVES OF OBTURATION

- To provide the capability for the control of nasal emission during speech.
- To prevent the leakage of material into the nasal passage during deglutition.
- If soft tissues which are peripheral to the defect do not display some movement, speech will not be normal with prosthetic obturator prosthesis.
- Movement of the lateral and posterior walls and movement of the residual soft palate are essential for rehabilitation

IMMEDIATE SURGICAL OBTURATOR

Immediate surgical obturation is most useful in dentulous patients, where the entire soft palate has to be resected. The principle advantage of using immediate surgical obturators for soft palate defects is support and retention of the surgical packing.

Some disadvantages are, Firstly, the drape of the intact soft palate precludes from obtaining an impression of the nasopharynx, where the normal velopharyngeal closure occurs and where the surgical obturator should be located. Secondly, functional movements of the velopharyngeal mechanism cannot be recorded either prior to or during surgery. Thirdly, the pharyngeal tissues which are peripheral to the defect will usually exhibit little movement during function in the immediate postoperative period. Fourthly, the extent of tumours in this region is more difficult to visualize; hence, it is more difficult to delineate the surgical margins presurgically

FABRICATION

Immediate surgical obturators are constructed presurgically. An extended impression of the soft palate is obtained. After the cast is retrieved, it is altered to correspond to the proposed defect. The superior-interior level of the obturator is determined by the plane of the hard palate. The cast is altered to extend the palatal plane within 2 to 3 mm of the estimated position of the posterior pharyngeal wall. The width of the obturator is determined by the width of the soft palate. Approximately 7 to 10 days post surgically, the prosthesis is removed along with the surgical packing and it is placed again after corrections are made.

Speech in the immediate postoperative period can be muffled, as lateral pharyngeal wall movements are necessary to control nasal emissions and to establish a proper resonance balance.

DELAYED SURGICAL OBTURATOR

In edentulous patients, or in patients with limited medial or lateral posterior border resections, a delayed obturation may be the treatment of choice. In edentulous or partially edentulous patients, consideration should be given to attachment of the delayed surgical obturator to the existing maxillary complete or partial denture

DEFINITIVE OBTURATION

Patients exhibiting considerable movement of the residual velopharyngeal complex during function have excellent prognosis for achieving normal speech with prosthesis. The obturator is attached to a conventional prosthesis. If the patient is dentulous, a removable partial denture framework retains the obturator.

The obturator should be rigid. Therefore, it does not attempt to duplicate the movements of the soft palate. It is a fixed platform of acrylic resin, which provides surface contact for the remaining musculature of the velopharyngeal mechanism during function.

If the lateral and posterior pharyngeal walls exhibit normal movement, a space will exist between these structures and the obturator when these tissues are at rest. This space permits breathing through the nasal cavity.

Subtelny et al., reported that a group of patients who could not speak successfully and had restorations with pharyngeal sections that extended below the palatal plane [6,7]. Contact between the palatal extension section and the dorsum of the tongue was observed [6-8].

Following guidelines should be considered for location of the obturator segment of the prosthesis:

- The obturator for an adult patient should be located in the nasopharynx, at the level of normal velopharyngeal closure.
- The inferior margin of the obturator should not extend beyond the lower level of muscular activity which is exhibited by the residual velopharyngeal complex
- The superior margin of the obturator should not extend above the level of muscular activity.
- The inferior extension of the obturator will usually be an extension of the palatal plane, and it will be extended to posterior pharyngeal wall.

Walter studied the pharyngeal activity in cleft palate subjects. He stated that [9]

- Patterns of attempted palatopharyngeal closure during speech in unrepaired cleft palate patients are complex and variable.
- The presence of the obturator has a marked effect on the pattern of activity.
- Obturators should be molded to speech function and not swallowing. Since the swallowing closure has more forceful pressure activity, the obturator which is molded to swallowing activity will be too small to give a palatopharyngeal seal during speech.

OBTURATION OF TOTAL SOFT PALATE DEFECTS

Construction of obturators for soft palate deficiencies begins with the fabrication of the conventional prosthesis.

METHODS OF FABRICATION

For obtaining impressions for diagnostic casts, the palatal portion of the stock tray should be extended with wax, so that the defect will be recorded. The cast will assist diagnostic procedures and tray preparation, and it will aid in establishing the appropriate

design for the obturator. Partial denture designs used for patients with defects or functional deficiencies of the soft palate are similar to partial denture designs used for non surgical patients.

A long lever arm is created by the extension of the obturator. The extension of the obturator increases the weight, length, the effect of gravitational force and the potential for rotation around the fulcrum line. For patients requiring class I or class II partial dentures, multiple indirect retainers are suggested. These will resist the downward displacement of the obturator and increase the stability of the prosthesis. Covering as much of the hard palate as feasible will also enhance stability and support.

In patients with an anterior edentulous area, consideration should be given to the placement of crowns on the adjacent abutment teeth with anterior tissue bar. The bar will act as an indirect retainer.

Jacob King described a definitive framework design for maxillofacial patients with complete maxillary dentitions and soft palate resections, which would require the use of direct and indirect retainers. This design would offer an aesthetic, retentive and functional restoration, while preserving existing structures. He suggested the use of anterior indirect retainer rests and bilateral posterior circumferential direct retainers [10].

Gardner et al., described a double swing lock design for class III (Aramany) defects which involved a midline defect of the hard palate, with a portion of soft palate as well. The design involved two unilateral S/L mechanisms, with hinges located posteriorly and the latches located anteriorly [11].

Gregory et al., described a obturator frame work design for class III (Aramany) defects. He suggested the use of bilateral anterior and posterior direct retainers with occlusal rests. He stated that an indirect retention was not required, as each terminus was supported by a direct retainer [12].

Tuma et al., in their report, have described treatment of patients with velopharyngeal insuffiencies and different oral conditions with different retention mechanisms [13].

If the defect was extensive, Tray resin would be added to the cast retention loops to approximate the area of the defect. There had to be no contact between the lateral and posterior walls when the patient said "ah". Modeling plastic would be added to the tray resin. Border molding would be started with the anterior margins of the defect. After the warm modeling, plastic would be placed in the mouth, the patient would be instructed to move the head in a circular manner from side to side, to extend the head as far forward and backward as possible, and to swallow.

These movements would activate the remaining velopharyngeal musculature and mold the modeling plastic.

Walter and Karnell suggested that swallowing should not be used to develop the obturator bulb physiologically, since the velopharyngeal musculature would contract more forcefully and as this contact would extend over a greater area during swallowing, as compared to speech [3].

Berry suggested that under extension of the prosthesis was initially preferred to overextension, as a compensatory function could develop [3].

Good lateral and posterior pharyngeal wall movements were essential for obtaining a proper oral-nasal airflow. Indentations are made by the anterior and posterior tonsillar pillars, tori tubari, Passavant's ridge (if present), and the anterior tubercle of the atlas. Shiny areas indicate the lack of tissue contact.

The excess modeling plastic which is displaced superiorly and inferior is trimmed. After the molding process is completed, the patient is asked to speak, swallow and breathe through the nostrils. If the position and the contours of the obturator are satisfactory, all the extensions are reduced by 1-2 mm.

A mouth temperature thermoplastic wax is added to the obturator, heated, tempered and the patient is instructed to repeat the head and the swallowing movements. The prosthesis is removed from the mouth and chilled in cold water. Over extended areas are identified where the wax is displaced, which exposes the modeling plastic

The altered cast impression is boxed and the master cast is completed. The obturator is processed in a customary manner with heat activated or auto polymerizing methyl methacrylate.

The superior surface should be convex and well polished, to facilitate deflection of nasal secretions into the oropharynx. The tongue side of the prosthesis should be slightly concave. If the obturator is bulky, it should be hollowed, with lid added, or an open top obturator can be fabricated.

A pressure indicator paste is helpful for identifying areas of extension.

SIZE AND POSITION OF THE OBTURATOR

The obturator should be placed at or just above the level of the palatal plane. If it is placed above the level of pharyngeal wall movement, it will occlude with the nasopharynx, resulting in difficulty in nasal breathing and hyponasal speech. If the obturator is placed too low into the oropharynx, tongue function will be disrupted and gagging may be precipitated.

Lateral dimensions are determined by the lateral and posterior pharyngeal wall movements. If the obturator is positioned correctly, a superior extension of approximately 10 mm is adequate. Pharynx is a conical tube with its widest dimension superiorly in the nasopharynx. The further superior extension of the obturator may add additional width and extra weight.

Nidiffer and Shipman wrote about using hollow obturator for acquired defects.

A hollow obturator offers certain advantages:

- The weight of the prosthesis is reduced, making it more comfortable and efficient.
- The lightness of the prosthesis changes one of the fundamental problems of retention and it increases physiologic function [14].

Alex Fox discussed a technique for preparing an obturator, which would place the 'bulb' in the pharynx in such a position, so as to provide excellent closure of the oronasal opening, for swallowing or talking and in which the bulb would not interfere with the dorsum of the tongue. This technique also provided a smooth, non-irritating surface of the 'bulb' or obturator [15].

Buckner, described a technique for fabricating a denture with a hollow obturator bulb and a soft acrylic lining, by investing, packing and curing it in one sequence [16].

Victor et al., described a simple procedure for the fabrication of a hollow obturator [17]. In this procedure, a layer of acrylic resin of 2 mm thickness was added inside the cavity, granulated sugar was filled, and then the mould was packed with acrylic resin. After polymerization, a hole was drilled with no. 8 bur and the sugar was poured out. The hole was sealed with self cured acrylic.

Schneider, described a technique for the fabrication of a hollow obturator. In this technique, the obturator cavity was filled with crushed ice. After acrylization was complete, two holes were drilled and the water was blown out of the cavity. The holes were then sealed with cold cure resin [18].

PALATAL LIFT PROSTHESIS [19,20]

Prosthetic treatment with a palatal lift prosthesis was first reported by Gibbons and Bloomer. This type of prosthesis is especially useful for patients with velopharyngeal incompetence. The objective is to displace the soft palate to the level of normal palatal elevation,

thus enabling closure by pharyngeal wall action. If the length of the wall is insufficient to effect closure after maximal displacement, the addition of an obturator behind the displaced soft palate may be necessary.

ADVANTAGES

- The gag response is minimized due to the superior position and the sustained pressure of the lift portion of the prosthesis against the soft palate.
- The physiology of the tongue is not compromised due to the superior position of the palatal extension.
- The access to the nasopharynx for the obturator (if necessary) is facilitated.
- The lift portion may be developed sequentially, to aid patient adaptation to the prosthesis.

CONTRAINDICATION

- If adequate retention is not available for basic prosthesis.
- If the palate is not displaceable.
- If the patient is uncooperative.

Gibbons Bloomer designed and evaluated a speech aid prosthesis. This was constructed for a patient with bulbospinal poliomyelitis which resulted in palatal paralysis. This appliance would elevate the palate to a position which approximated that of normal retraction, thereby narrowing the lumen of the palatopharyngeal valve [21].

Yuuji et al., described a palatal lift prosthesis technique for edentulous patients. They fabricated a movable palatopharyngeal section that elevated the soft palate by using force of orthodontic wires (Ni-Ti) [22].

Yuko et al., concluded in their study, that palatal lift prosthesis was useful for providing adequate velopharyngeal function in patients who showed poor velopharyngeal functions following palatoplasty, and that it should be considered as the first step in treating persistent velopharyngeal incompetence [23].

Jeffrey L Marsh mentioned some interventions for management of velopharnygeal dysfunction. He suggested an approach of differential management which was based on differential diagnosis, by which velopharnygeal dysfunction could be effectively treated in most of the patients [24].

Hema Raju et al., concluded in their study, that a palatal lift prosthesis, when it was used for a minimum duration of 3 months, caused a significant decrease in nasal resonance, thereby improving speech intelligibility in patients who failed to see improvement following pharyngeal flap surgeries done for velopharyngeal incompetence [25].

Shifman et al., suggested that nasopharyngeal obturation achieved by speech aid prostheses, in conjunction with speech-language therapy, was useful for the correction of velopharyngeal incompetence [26] [Table/Fig-1].

Sr. No	Year	Author	Events
1.	1957	Nidiffer and Shipman	Wrote about hollow obturator for acquired defects.
2.	1958	Alex Fox	Discussed a technique of preparing an obturator which places the 'bulb' in the pharynx.
3.	1958	Gibbons and Bloomer	Speech aid prosthesis.
4.	1959	Ali Aram	Studied the normal velopharyngeal function.
5.	1974	Buckner	Reported that the degree of velar movement from rest to closure was found to increase with increment in age.
6.	1976	Victor	Described a technique for fabricating a denture with hollow obturator bulb and a soft acrylic lining by investing, packing and curing in one sequence.
7.	1978	Schneider	Described a simple procedure for the fabrication of a hollow obturator using granulated sugar in the mould space of the obturator cavity.
8.	1987	Yuuji sato	Described a technique for the fabrication of hollow obturator, where the obturator cavity is filled with crushed ice.
9.	1990	Walter	The presence of the obturator has marked effect on the pattern of pharnygeal activity. Obturators should be molded to speech function and not swallowing.
10.	1990	Jacob and King	Described a definitive framework design for the maxillofacial patient with complete maxillary dentition and soft palate resection which require the use of direct and indirect retainers.
11.	1995	Gardner	Described a double swing lock design for class III (Aramany) defect.
12.	2000	Arie Shifman, Yehuda Finkelstein, Ariela Nachmani, Dov Ophir	Suggested the use of nasopharyngeal obturation by speech aid prostheses, in conjunction with speech-language therapy, was useful for the correction of velopharyngeal incompetence.
13.	2004	Jeffrey L. Marsh.	Suggested an approach of differential management based on differential diagnosis by which velopharnygeal dysfunction can be effectively treated in most patients.
14.	2005	Gregory	Described a obturator frame work design for class III (Aramany) defect. He suggested the use of bilateral anterior and posterior direct retainers with occlusal rests.
15.	2009	Yuko Ogata	concluded in their study that palatal lift prosthesis should be considered as the first step in treating persistent velopharyngeal incompetence.
16.	2010	S.H. Tuma, G. Pekkam, H.O. Gumus, A. Aktas	Described treatment of patients with velopharyngeal insuffiency and different oral conditions with different retention mechanism.
17.	2009	Hema Raju, T.t. Padmanabhan, Arvind Narayan.	Suggested the use of palatal lift prosthesis for a minimum duration of 3 months after pharyngeal flap surgery improves the speech intelligibility.

[Table/Fig-1]: Table of events

CONCLUSION

Sophistication in the surgical and prosthetic reconstructions of structural and functional defects in the cranio-maxillofacial region improves the final rehabilitation results. If it is carefully planned, unbiased rehabilitation regimens can be established. The primary objective in each case would be to construct a prosthesis which will restore the defect, improve aesthetics and thereby benefit the morale of patient. The improvements in aesthetics and function are not only essential for the patient's physical well being, but they also contribute to his/her mental attitude.

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