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CASE REPORT **OPEN ACCESS**

Velopharyngeal Obturator: An Innovative Approach for the Management of Soft Palate Defect

Pooja Kiran[1*], Bhanu Madan[2] , Amit Gupta[3] , Chetan Pathak[4], Manisha[5] , Harshita Narang[6]
[1-5]Department of Prosthodontics, Crown and Bridges, Sudha Rustagi College of Dental Sciences and Research, Haryana, India
[6]Clinical Practitioner, Prosthodontics and Implantology, New Delhi, India
*Email: kiranpooja161374@gmail.com
[4]Corresponding author's Email: chetanpathak84@gmail.com

ABSTRACT
Defects of the hard and soft palate may present as perplexing problems to the Prosthodontist. Soft palatal defects are more difficult to restore and rehabilitate. It is a condition in which there is difficulty in effective closure between the soft palate and pharyngeal walls during swallowing or speech. Abnormalities of the soft palate can occur in different ways with more complexity. The resultant palatopharyngeal deficiencies are usually grouped into congenital, acquired or developmental defects depending upon the etiology. Defects related to Velopharyngeal insufficiency has always been a critical and sensitive issue to manage as it requires rehabilitation of the palatal defect along with maintaining the integrity of speech, mastication and esthetics. The primary goal of a prosthodontist in each case is to construct a prosthesis, which will restore the patient's defect, improve speech, swallowing, mastication, esthetics and psychological well-being. The main concern in restoring a maxillary defect with a completely edentulous or partially dentate obturator is to provide adequate retention, increased stability and strong vertical support. This case reports addresses a novel approach with step-by-step fabrication of a maxillary metal obturator for patient suffering from Velopharyngeal insufficiency.
Keywords*: Velopharyngeal Obturator, palatopharyngeal deficiencies, maxillary metal obturator*

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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. [11] The Maxillofacial Prosthodontist contributes to all facets of patient care, from diagnosis and treatment planning to rehabilitation. [1] The primary objective in each case is to construct a prosthesis which will restore the defect, improve aesthetics and benefit the morale of the patient**.** [2]

A successful rehabilitation of a palatal defect by restoring the normal form and function along with aesthetics and providing a quality of life, is a difficult and a challenging task. Defects of the hard and soft palates may be divided into three categories: congenital, acquired, and developmental (Taylor, 2000). In a congenital cleft palate, embryologic development of the hard and soft palates is interrupted or incomplete. Surgical resection of a neoplastic disease results in an acquired defect that changes the soft palate's continuity. Inadequacies of soft palate function may be a result of developmental, muscular, or neurological diseases. In these cases, to obtain closure between the existing hard and soft palates and pharynx, an obturator, also called speech aid or speech bulb prosthesis, is fabricated. [3]Obturator is derived from the Latin verb '*obturate*' which means to close or to shut off. The obturator is helpful in improving the speech of individuals with partial or total velar defects i.e. cleft of soft palate. The speech-aid prosthesis has its origins in the prostheses first developed by Stearn in 1841 and then improved by Kingsley and Sversen. Originally developed for patients with cleft palate, these prostheses now are used almost exclusively for adult patients with cleft palate or those who have had a soft palatectomy for neoplastic disease. [4]

Soft palate cleft is one of the most common cause of velopharyngeal incompetence, which is the functional inability of the soft palate to effectively seal with the posterior and or lateral pharyngeal walls. Veau in

1922 classified congenital soft palate defect into four types. Class I cleft involves only soft palate and may include sub mucous cleft. Class II, III and IV involves bony structures unilaterally and bilaterally. [5, 6] The Acquired/ Congenital defects of soft palate may lead to Velopharyngeal insufficiency, which affects the functionality of the residual muscles and structures, leading to impairment of the closure with the pharynx. It induces nasal regurgitation of liquids, hyper-nasal speech, nasal escape, disarticulations and impaired speech intelligibility. [7, 8] Pharyngeal obturators used to close the residual palate and pharynx during speech and deglutition are a prosthetic solution for Velopharyngeal insufficiency. The prosthesis consists of a partial or complete denture base and a pharyngeal extension that will physically modify the pharyngeal airway and provide a seal between the oropharynx and the nasopharynx during function. Meatus obturator is indicated when entire soft palate has been lost in edentulous patients. [10] This clinical report describes the rehabilitation of a congenital soft palatal defect with palatal meatus obturator prosthesis and restoring the physical separation between the nasopharynx and oropharynx.

CASE REPORT

A 69 year old male patient aged reported with a chief complaint of difficulty in chewing food. On oral examination, a completely edentulous maxillary arch with cleft in the soft palate region extending from mid hard palate to the soft palate region and severely resorbed mandibular ridge was found. [Figure 1] On eliciting history, the patient was diagnosed with a congenital soft palatal defect where no surgical operation had been performed previously to repair the defect. Patient used an obturator with closed bulb for about a month 2 years back but discontinued the wearing, as it was heavy and uncomfortable for the patient. On observation, patient's speech showed hyper nasality of voice with no sign of nasal regurgitation of foods and fluids.

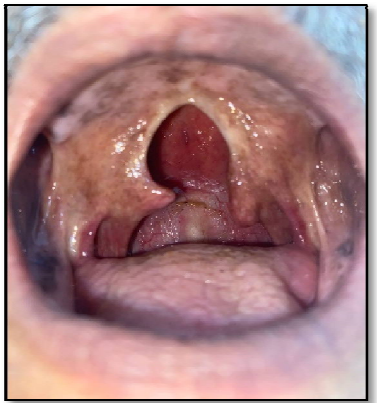


Fig 1: Soft Palate Defect in Maxilla

Diagnosis and Treatment Plan:

Veau's Class I cleft palate defect with completely edentulous maxillary and mandibular arches. The patient refused to undergo surgical reconstruction or any implant supported prosthesis due to economical reasons. Therefore, it was planned to fabricate definitive mandibular complete denture and maxillary complete denture prosthesis along with meatus obturator to close the velopharyngeal defect so as to improve retention, phonetics and enhance mastication. The retention, support and stability for the obturator prosthesis was planned to be obtained from favourable undercut present in the molar region of maxillary edentulous ridge and the denture bearing areas of edentulous maxilla. Patient was briefed about the procedure and the prognosis of the treatment plan and he willingly gave the consent for the same.

Prosthetic Approach: (Step by Step procedure)

1. Sectional Primary impression was made using condensation silicon putty (Dental World Official Zhermack Zetaplus Condensation Silicone Putty Only) impression material. Initially putty was mixed properly and gently inserted into the defect area to make the impression of soft palate defect region without causing any risk of trauma to the soft tissue. When the material was completely set, retrieved from the defect region cautiously. A thread was tied to the recorded impression which later on provided the stability and ease of retrieval of impression from defect region during *'pick-up'* impression.

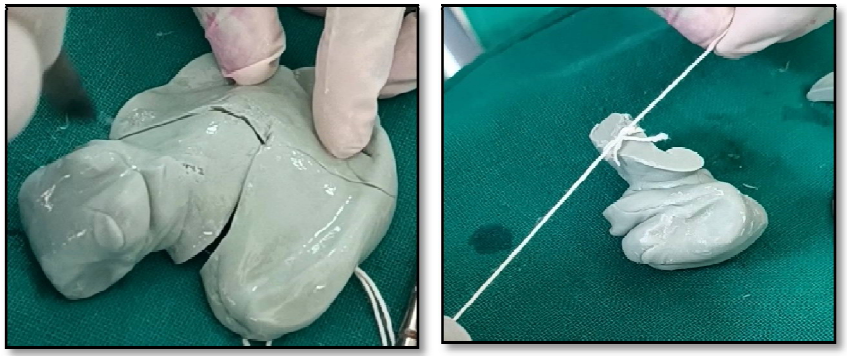


Fig 2: Impression of the Defect Region

After that, indexing was done on the recorded impression which provided the interlocking of the impression to the final *'Pick-Up'* impression. The initial recorded impression, was again seated inside the defect region carefully and the thread was placed outside of patient's mouth in order to avoid any mishap and ease retrieval of the impression from the soft palate defect region.

For the '*pick up*' impression, again condensation silicon putty (Dental World Official ZhermackZetaplus Condensation Silicone Putty Only) impression material was mixed properly, loaded over the selected tray and placed inside the mouth gently with required physiologic pressure and allows the material to follow inside the indexing to provide better mechanical interlocking between the initial impression and the *pick-up* impression. As the pick-up impression was completely set, retrieved from patient's mouth carefully and accessed properly to avoid any inadequacy in impression.

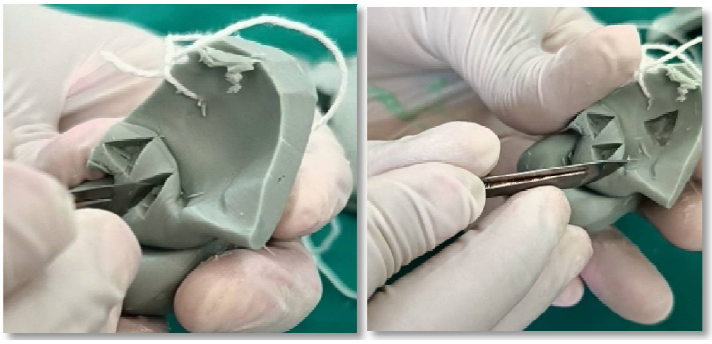


Fig 3: Indexing was done to provide mechanical interlocking of impression material

Fig 4: Place the initial impression inside the defect area

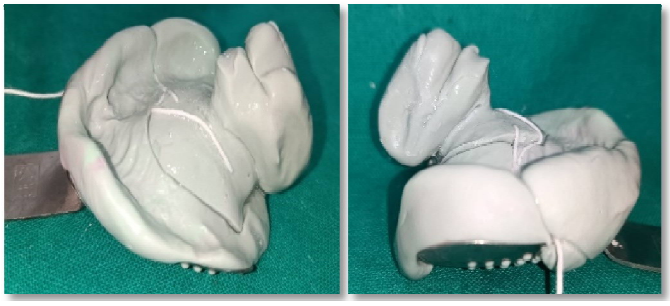


Fig 5: Primary impression of maxillary and mandibular arch

This technique allowed better impression making while recording the defect area with precision and without irritating or providing discomfort to the patient over irreversible hydrocolloid material. Mandibular impression was made using admixed technique to record the severely atrophied ridge. Conventional beading and boxing of both the impressions was done properly and impressions were poured to obtain the primary cast.

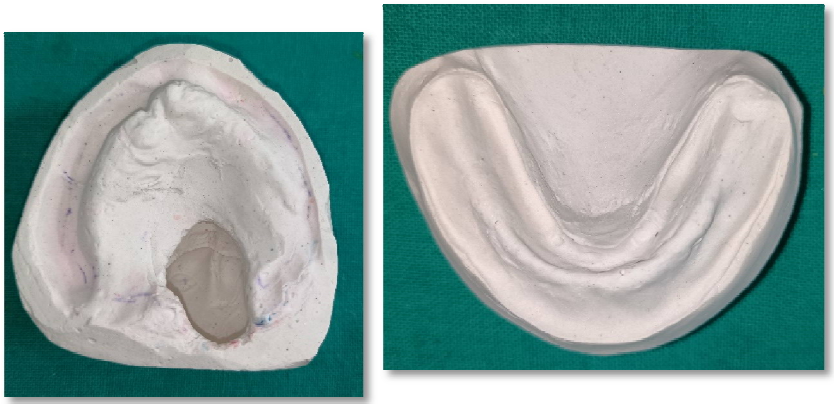


Fig 6: Primary maxillary and mandibular casts

2. The primary casts were duplicated using reversible hydrocolloid material in order to preserve the casts and poured in dental stone for better strength and detailing.
3. On the preliminary cast, wax spacer was adapted (4mm short to the sulcus) with tissue stops and the defect area was filled with the wax to make a concave surface on the upper surface. Custom tray was fabricated (2mm short to the sulcus) with auto polymerizing acrylic resin.

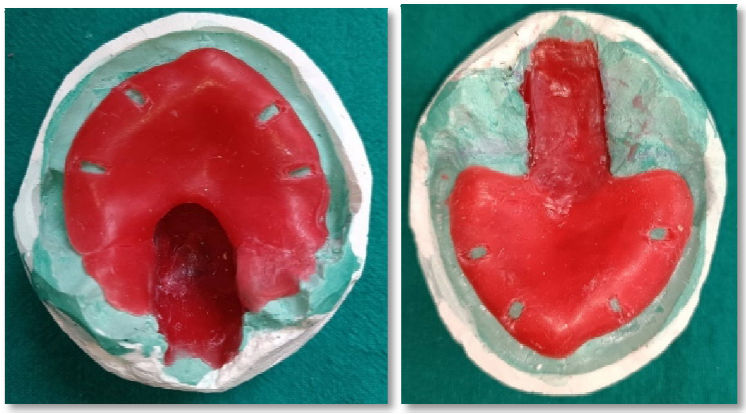


Fig 7: Spacer adaptation

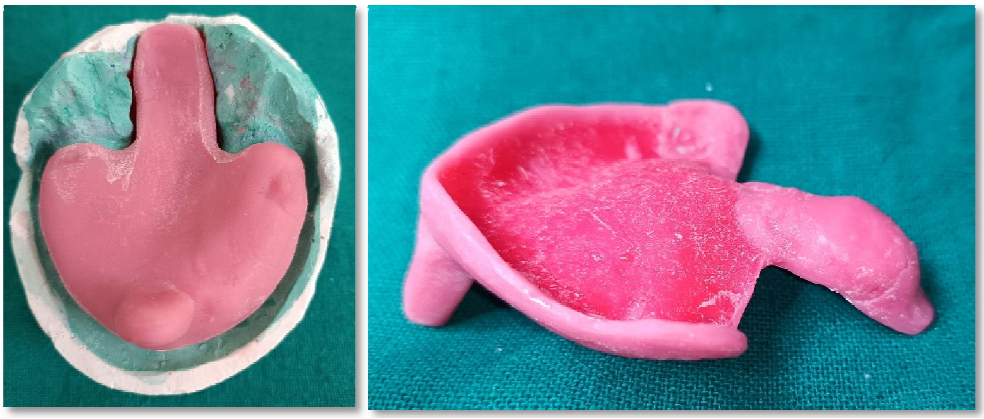


Fig 8: Fabrication of custom tray with auto-polymerizing resin

4. Fabricated custom tray was then placed inside patient's mouth to check for any trauma or any blanching of soft tissue due to tray insertion that may leads to muco-compressive impression making which later affects the stability of the prosthesis.

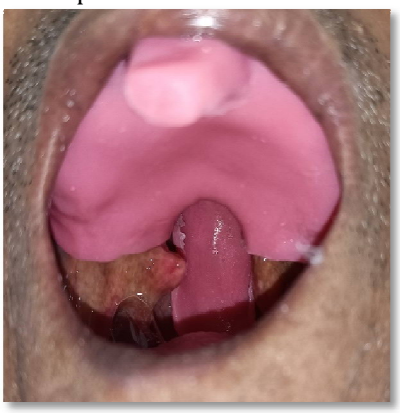


Fig 9: Custom tray placed inside patient's mouth

Conventional border molding using low fusing modelling compound (DPI PINNACLE tracing sticks, Mumbai, India) was done to record the borders in functional state within the physiological limits. Labial and Buccal freni was recorded properly and relieved accordingly to enhance the retention of the prosthesis.

To record the soft palate defect area functionally, low fusing modelling compound (DPI PINNACLE tracing sticks, Mumbai, India) was added on the posterior aspect of the custom tray, and patient was asked to perform various neck movements including:

1) Circular movements of neck from one side to another
2) Bending his head forward where chin should touches the chest and then backward movement.
3) Side to side neck movements where chin should touches the shoulders simultaneously
4) Speak words starting with *'k' and 'kh'*
5) Swallow gently to record the posterior nasal conchae as well as to record the physiologic activity of the pharyngeal muscles.

Patient was asked to sip warm water, swallow slowly and repeat the neck movements till maximum retention was achieved.

(a) Bending head backwards

(b) Bending head forward

(c)&(d) Side to Side neck Movements

(e) & (f) Simultaneous side to side movements to touch the shoulder with chin
Fig 10 (a-f) : Recording defect area with various neck movements

5. Final border molding was placed inside the patient's mouth to check any blanching of soft tissue or any interferences which needs to be relieved and the final retention achieved by the custom tray after border bolding. Similary conventional border molding was done in mandibular arch to record the border properly within their physiological limits to achieve the retention.

(a) (b)
Fig 11: (a) Final border molding inside Patient's mouth
(b) Final border molding

6. For the secondary impression, wax spacer was gently scrapped off from both maxillary and mandibular trays.
7. Using a frenum relieving bur, multiple relieving holes were drilled along the mid-palatal raphe region and over the alveolar ridge region.
8. For secondary impression in maxillary arch, vinylpolysiloxane (Reprosil regular body) elastomeric impression material was used whereas light body polyvinyl siloxane material was used for final impression in mandibular arch and final impressions were made.

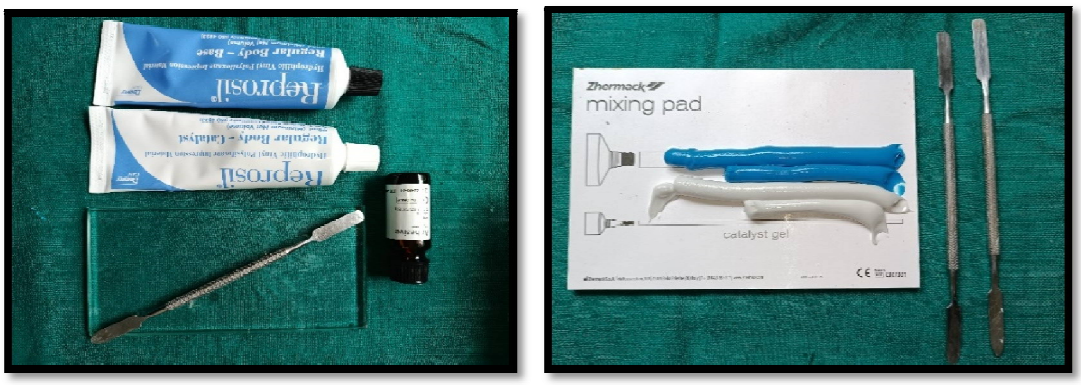


Fig 12: Medium body vinyl polysiloxane Impression material

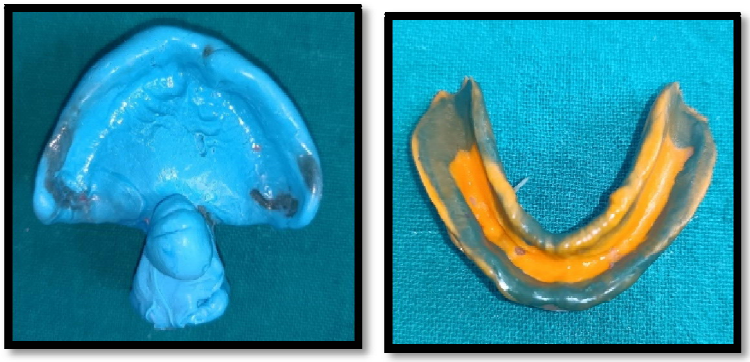
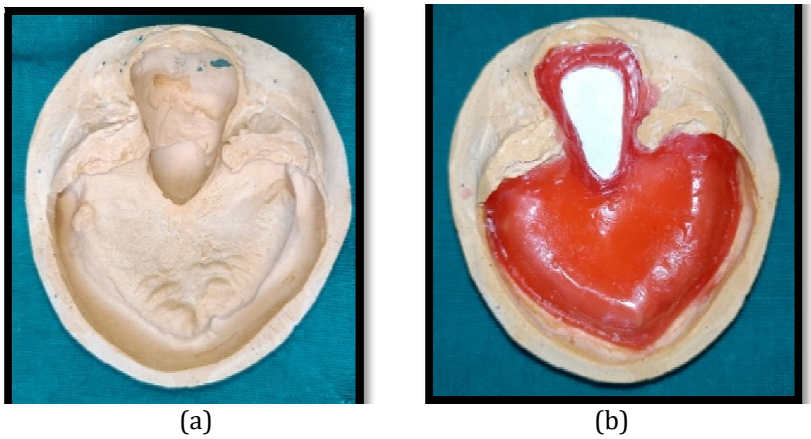


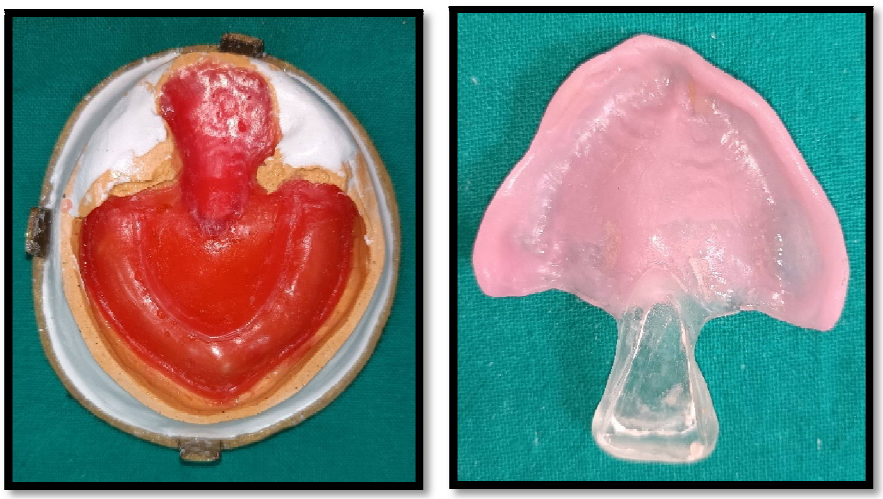
Fig 13: Final impressions in maxillary and mandibular arch

9. Conventional beading and boxing was done on both the impressions and poured to obtain the master cast. Master cast was again duplicated which reversible hydrocolloid material and poured again to be used if the master cast was destroyed during the acrylization.
10. Modelling wax of specific thickness was well adapted on maxillary cast over the alveolar ridge region and in the sulcus region. A 3-4 mm thick wax rim was adapted in the periphery of the defect region as shown in the figure. The defect area within the wax rim was filled with gypsum to block out the region. This was done to fabricate a hollow bulb prosthesis.
11. A permanent heat cured Denture base with a hollow bulb was fabricated on maxillary cast with pink heat cure acrylic resin and the defect area was packed with heat cure clear acrylic using 'compression molding' technique.



(a) (b)

Fig 14**:** (a) Master Cast
(b) Wax up done for fabrication of hollow bulb velopharyngeal obturator denturebase



(a) (b)

Fig 15: (a) Final wax up done
(b) Heat cure acrylized Denture base

Fig 16: Heat cure acrylic resin denture base for maxillary arch

12. After finishing and polishing of the permanent denture base, it was again verified inside patient's mouth for any blanching of soft tissue and for the retention of the denture base.

The posterior part of the obturator which provided the pharygeal seal was again recorded with low fusing modelling compound (DPI PINNACLE tracing sticks, Mumbai, India) to increase the height of the seal towards nasal cavity as the pharyngeal seal was present at the height of the maximum depth of hard palate.

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 The pharyngeal seal was achieved by increasing the height of meatal part of obturator in upwards direction because the Passavant ridge in present above the level of the hard palate. [1]

Hence height of the meatal part was again recorded and acrylized with heat cure acrylic resin.

Fig 17: Border molding of soft palat defect region to achieve pharyngeal seal

13. Occlusal wax rims were fabricated on the denture bases using the modelling wax. Facebow transfer using springbow facebow was done on hanau articulator. Vertical and Centric jaw relation was recorded using '*Nick and Notch'* method and finally mounted on the articulator.

Fig 18: Springbow Facebow record

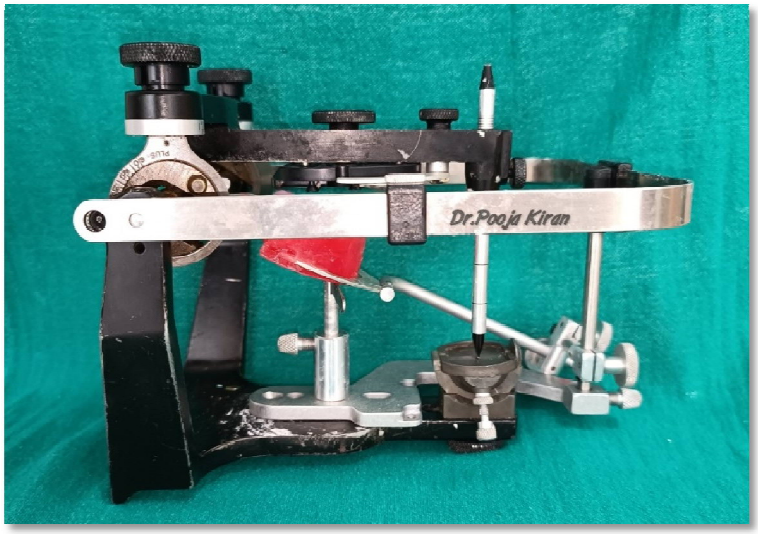


Fig 19: Facebow transfer on Hanau articulator

14. Teeth selection was done and arranged accordingly achieving the best occlusion for the patient.
15. Later '*try in*' was done inside the patient's mouth to verify centric relation, occlusion, phonetic and esthetics in a conventional manner. The fit of the velopharyngeal obturator and its function were checked during this stage to look for hypernasality of voice and regurgitation of fluid. The patient was seated in an upright position and asked to drink water with a glass to see if swallowing leads to any regurgitation. Functional seal was hence verified.

Fig 20: Try in done

16. Final 'wax up' was done, dual curing using the pink heat cure acrylic resin with compression moulding technique was done.
17. After curing the prosthesis, it was carefully removed from the cast, finished and polished. The prosthesis was placed in patient's mouth and evaluated for proper extension using a pressure indicating paste. Any pressure points if present were relieved.

Fig 21: Final prosthesis for both maxillary and mandibular arches

Fig 22: Maxillary velopharyngeal obturator with hollow bulb

Fig 23: Lateral view of molar relations

Fig 24: Frontal view of occlusion

18. The patient was trained for insertion and removal of the prosthesis. Post-insertion instructions were given and a regular follow-up was advised. The patient was satisfied with the prosthesis since there was marked improvement in swallowing and speech.

Fig 25: (a) Patient's frontal view before the prosthesis
(b) Patient's frontal view after the prosthesis

19. Definitive prostheses were delivered to the patient after making necessary adjustments done and patient recalled after 24 hours for final adjustments. Continuous recall visits every 1 month for 6 months was done and patient was kept under observation. Patient was recalled after 6 months and examined. He was happy and using the obturator very well without any discomfort and the hyper-nasality of his voice was marked decreased and the same was confirmed by his family members as well. Patient was highly satisfied with the prosthesis and his treatment.

DISCUSSION

Various degrees of deformity that involves all tissue layers are seen in cleft palate. With soft palate, deficiencies of the muscle and mucosal layers also are characteristics. Five muscle pairs contribute to the soft palate. Normally, the levatorveli palatine (LVP) muscle has a transverse orientation and occupies the midportion of the soft palate, thereby creating a muscular sling for the velum. [12] This muscular sling is the principal structural component in closure of the nasopharynx during speech and swallowing. Other muscles that contribute to the velopharyngeal sphincter include the palatopharyngeus, superior constrictor, and musculus uvulae. [13] In patients with cleft palate, the muscles of the soft palate may be hypoplastic in addition to exhibiting misdirection and abnormal insertion into the posterior hard palate. [14]

The velopharynx is a three dimensional muscular valve located between the nasal and oral cavities, consisting of the lateral and posterior pharyngeal walls and the soft palate, and controls the passage of air. Any problem of this valve either due to lack of tissue (velopharyngeal insufficiency) or even lack of proper movement (velopharyngeal incompetence) will result in velopharyngeal dysfunction. [15] Such patient will exhibit impaired speech intelligibility, seepage of nasal secretions into the oral cavity and vice versa. [16] Problems in deglutition and resonance, articulation disturbance, difficulty in swallowing and hyper nasality are also eminent. [8] The velopharyngeal dysfunction may be treated through surgery, prosthesis, speech therapy, or a combination of them all, depending on the case.

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

- Palatal insufficiency
- 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. [17]

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.

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. 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.
The ideal protocols for prosthetic treatment of patients with a palatal defect can be divided into three stages: immediate obturator, interim obturator, and definitive obturator. Each type of obturator can fulfil the patient's needs at different stages.

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.
Aim of obturation includes:

- 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

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: [29]

- 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.

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. [18]
Pharyngeal obturator prosthesis extends beyond the residual soft palate to create separation between the oropharynx and nasopharynx. It provides a fixed structure against which the pharyngeal muscles can function to effect velopharyngeal closure. [19-20] The level of contact of the prosthesis to the pharyngeal wall may differ in sex. In men, the typical relation of the soft palate to the posterior pharyngeal wall is at a point above the palatal plane. For women, contact is found to occur at or below the palatal plane. [21]
Meatus obturator is formed on the presumption that partial occlusion of the oropharynx from the nasopharynx, will result in marked diminution or complete elimination of the nasality that is

objectionable in the speech of cleft palate patients. [22-23]It is designed to close the posterior nasal conchae through a vertical extension, upwards from the distal aspect of the maxillary prosthesis to reach the roof of the nasopharynx. They are very efficient, require no muscle trimming and results can be ascertained immediately. Since the vertical extension is closer to the palatal portion of the prosthesis, less torque is placed on the palatal portion thus decreasing the tendency to dislodge. [1,19,24]

Various techniques may be used to evaluate the use of palatal lift prosthesis on velopharyngeal incompetence. Flexible fiberoptic video nasendoscopy and videofluoroscopy provide visual representation of velopharyngeal movement; however, such methods are invasive. Acoustic assessment samples the oral and nasal energy associated with speech by two unidirectional microphones. This would be of limited value in this patient's treatment, which was concerned more with airflow than with resonance. In addition, the relationship between hyper-nasality and the degree of velopharyngeal dysfunction is not considered linear when measured by this technique. There are a number of airflow measurement techniques, such as differential pressure, vortex shedding, impeller, ultrasound, and thermal sensors, of which some are very useful. [27, 28]

The case discussed here is the only soft palate defect where retention is achieved by the bilateral undercuts present in the maxillary arch and hollow bulb concept makes the prosthesis much lighter than the previous one which the patient was using. The only limitation was failure to construct a post-dam resulting in an unsatisfactory posterior palatal seal. However, upward extension of the obturator provided a certain degree of retention. The stability of the prosthesis is moreover achieved by the maxillo-mandibular occlusion. Esthetics and phonetics are very well accomplished in this case and appreciated by the family members of the patient.

CONCLUSION

The ultimate goal of the treatment in hard and soft palate defects is to obstruct liquid and food leakage between oral and nasal cavities, increase the understandability of speech, and facilitate chewing. Implants, teeth, or hard and soft tissue undercuts can be used for retention and stability of the prosthesis, which can be designed as a single component or as sections according to patient edentulism and maxillary defects but it is not economical and feasible in every patient.

In situations, with completely edentulous maxilla involving Velopharyngeal insufficiency, Meatus obturator imparts better retention and stability of the prosthesis, permits comfortable breathing, restores the functions of the mastication and prevents regurgitation of fluids through the nose. It can be considered as a valuable treatment alternative to the surgical option in cases with completely edentulous patients with cleft palate defect. Prosthetic treatment adjunct to speech therapy and counselling are necessary for complete rehabilitation of patients having soft palatal defects. For such patients who cannot be treated by surgical reconstruction alone, obturator prosthesis helps to improve the quality of life. With increased knowledge of craniofacial growth and development and improved surgical and orthodontic treatment, today's cleft palate/lip patients receive better care, and in less time. Thus, an interdisciplinary approach with proper care in the fabrication of the obturator and training of the patient demonstrate commendable results. Treatment of patient with soft palatal defects is among the most challenging in dentistry. Defects are highly individual, and require the clinician to call upon all knowledge and experience to fabricate a useable prosthesis. The basic principles and concepts described throughout will help to successfully rehabilitate such patients

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