Original Articles

ADEQUACY OF VELOPHARYNGEAL CLOSURE AND SPEECH COMPETENCY FOLLOWING PROSTHETIC MANAGEMENT OF SOFT PALATE RESECTION

M. El-Dakkak, BChD, HDD, MS*

تمت دراسة « ١٠ » مرضى أجريت لهم عمليّات استئصال قبة الحنك اللينة لإزالة أورام في منطقة قبة الحنك. وقد امتد التشوه الجراحي في كل من هؤلاء المرضى ليشمل الحافة الخلفيّة لقبة الحنك اللينة مما أدى إلى قصور وظيفي في المنطقة الحنكية البلعومية ولم يكن أي من هؤلاء المرضى يشكو من مشاكل في النطق أو السمع أو وظائف الأنف قبل العمل الجراحي . . . وقد صنع سداد لمساعدة عملية النطق لكل مريض وطلب منه استعماله لمدة شهر واحد قبل إجراء عملية تقييم هذا الجهاز.

جرت عملية تقييم الجهاز السني الصناعي لكل مريض عن طريق دراسة كفاية الإغلاق-الحنكي البلعومي ومقدرة المريض على عملية النطق. كذلك فقد تم ربط النواحي المختلفة للنطق بما في ذلك وضوحه وطريق إصدار الحروف وخروج الصوت عبر الأنف مع وجود بحة مع الإغلاق الحنكي البلعومي.

Ten patients who had undergone soft palate resection for the removal of palatal tumors were studied. In each patient, the surgical defect involved the posterior margin of the soft palate and lead to velopharyngeal insufficiency. None of the patients suffered any speech, hearing or nasal problems before surgery. For each patient, a speech aid obturator was constructed and was used at least one month before the evaluation. Prosthetic management of each subject was evaluated as reflected in adequacy of velopharyngeal closure and speech competency. Various aspects of speech including intelligibility, articulation, nasality, hoarseness and overall speech were correlated with the adequacy of velopharyngeal closure.

Introduction

The structural integrity of the hard and soft palates is vital for normal speech. Patients with palatal clefts usually have speech defects resulting from velopharyngeal incompetency[1"3] or interference with structural integrity of the soft and/or hard palates.[4,5]

Speech may be influenced by palatal defects via the inappropriate coupling of the nasal cavity and/or changes in the capability to impound, direct and constrict airflow.[5]

Repair of such defects may be accomplished by surgery, prosthetic replacement, or a combination of both,[6] but prosthetic restoration remains the desirable treatment in patients with large palatal defects.[7]

The prosthetic management of hard palatal defects is more successful than soft palatal defects due to inherent movements of the unresected portion of the soft paiate, which often interferes with prosthetic restoration.[4]

This study attempted to evaluate the efficacy of prosthetic management in resected soft palate patients as reflected in the adequacy of the velopharyngeal closure and speech *competency.* The velopharyngeal closure was measured by the assessment of pressure flow parameters and was correlated with the competency of the various aspects of speech including intelligibility, articulation, nasality, hoarseness and overall speech.

Materials and Methods

The study included ten subjects, each of whom had received surgical resection of soft palate due to palatal *tumor.* Their paiatal defects involved the posterior margin of the soft palate leading to velopharyngeal insufficiency [Fig. I],

All subjects had their surgical defect corrected with speech aid obturators. The obturators had

* Professor and Chairman, Department of Prosthodontic Dental Sciences, King Saud University College of Dentistry, P.O. Box 60169, Riyadh 11545, Saudi Arabia

been completed and placed for a minimum period of one month before the study so as to acquaint the patient with the prosthesis.

The speech aid obturators had been constructed to extend posteriorly into the pharyngeal region. In this manner, the action of both lateral and posterior pharyngeal walls could be utilized along with the action of the non-resected portion of soft palate. Such combined action achieves velopharyngeal closure during function. All of these resected soft palate patients still had an intact hard palate [Fig. 2].

The history of each subject revealed that none of them had had any speech, hearing or nasal problems before development of their tumors.

Methods of Evaluation of the Prosthetic Management

For each subject an evaluation of the prothesis, velopharyngeal closure, and speech competency were made.

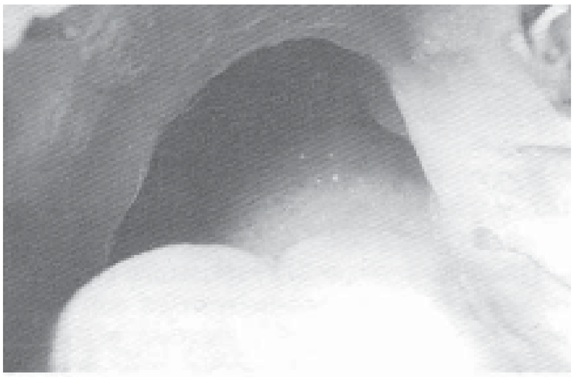

Figure 1. Resected soft palate. The resection involved the posterior margin of the soft palate.

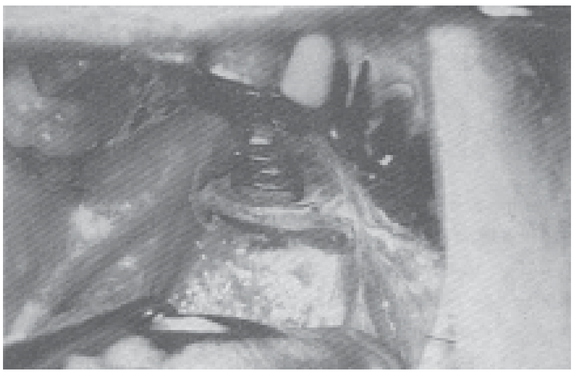

Figure 2. Speech aid prosthesis restoring resected soft palate.

Evaluation of the Prosthesis

Each prosthesis was examined for adequacy of retention and functional closure as follows:

- the patient's ability to swallow without fluid escape through the nose
- the patient's ability to speak
- visual examination of the functional closure along the pharyngeal section of the prosthesis during pronunciation of a strong "Ah" sound.

Assessment of the Velopharyngeal Orifice Size

The equipment used consisted of a pneumotachograph for measuring the rate of air flow, two differential pressure transducers, and two- channel dynographs for recording the data in a graphic form. Such equipment has been described previously by Warren et al[8] in an analysis of velopharyngeal function [Fig. 3].

The technique used for evaluation of the nasal airflow and velopharyngeal orifice area was based on the assumption that velopharyngeal orifice size can be calculated from simultaneous measurements of the pressure drop and airflow passing through the velopharyngeal orifice.[8]

The pressure drop across the orifice (oropharyngeal pressure minus naso-pharyngeal pressure) was measured by using a differential pressure transducer. One of the two pressure catheters (PE 200 tubing) was placed in the left nostril and the other in the oropharynx. The nasal catheter was secured using a cork which blocked the nostril, creating a stagnant column of air. The oral catheter was held in the oral cavity during the speech segment. The tips of both catheters were blocked with

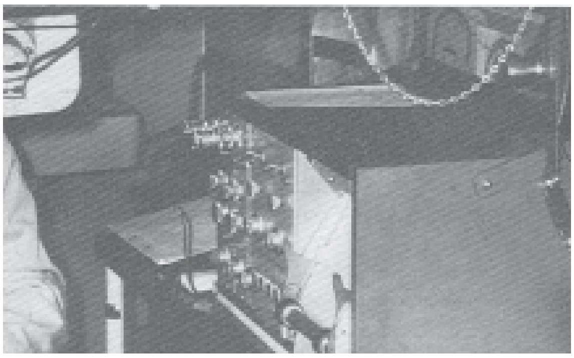

Figure 3. Pressure-flow apparatus used to measure the velopharyngeal orifice size.

dental wax with small holes made around the walls of the distal end of the tube so that static air pressure could be measured.

Nasal airflow was measured by means of a heated pneumotachograph connected by plastic tubing to the subject's nostril. The parameters of pressure and airflow were converted to electrical voltages, amplified and recorded on heat sensitive paper. Velopharyngeal orifice area was calculated using the parameters of pressure and airflow using the hydrokinetic equation utilized by Warren et al[8] for this purpose.

$$\text{Orifice Size} = \frac{\text{Rate of airflow through orifice}}{K\sqrt{2\,\dfrac{\text{Orifice differential pressure}}{\text{Density of air}}}}$$

K = Correction coefficient = 0.65
Density of air = 0.001 gram/cm^3

Each subject phonated a series of test syllables and sentences with the pressure flow apparatus in place. The speech sample was heavily loaded with the sound "P" which requires a high intra-oral pressure for adequate production [Fig. 4].

Speech Evaluation

The equipment used consisted *of ampex tape* recorder (AG - 600 B), speaker amplifier (AA - 620), shure microphone (Unidyne III Model 545, dynamic), and scotch recording tapes (low noise Dynamag magnetic tape 211) [Fig. 5].

The technique used for recordings was similar to that reported by Oral.[9] Each subject was seated in a sound proof room facing the microphone at a fixed distance and was asked to pronounce each word as carefully as possible (Fig. 6]. For each subject's recording, a certain speech recording schedule described by Oral was used.[9]

Three speech pathologists rated the recordings independently by listening to the master speech tapes of each of the ten patients. The sequence of the experimental conditions had been changed for each patient. Thus, the speech pathologists had no prior knowledge about which experimental condition was being evaluated at any point in time. Each recording was evaluated using a seven point scale (1-normal; 7-inadequate). The scores were applied to intelligibility, articulation, nasality, hoarseness, and overall speech.

Figure 4. The technique used of rmeasuring the velopharyngeal orifice size.

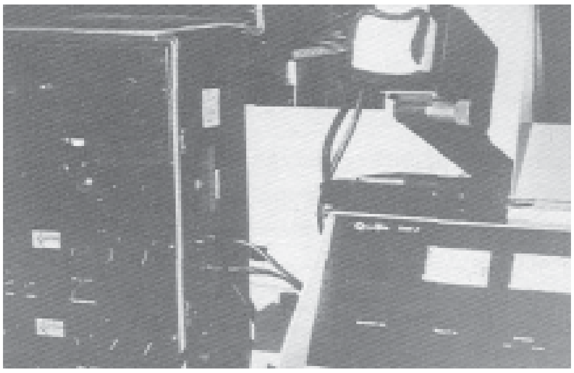

Figure 5. Ampex tape recorder AC-600 B and speaker amplifier.

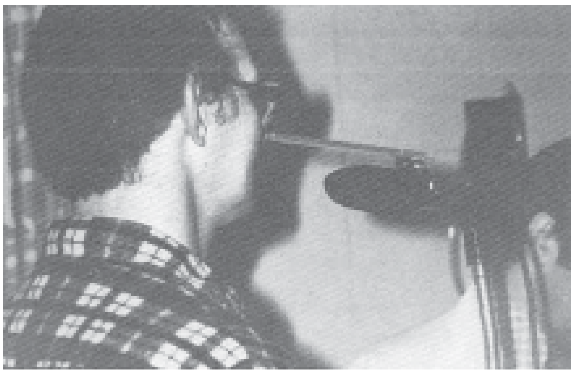

Figure 6. Speech recording in a sound proof room.

Results

The results demonstrated incomplete velopharyngeal closure in 80% of the subjects, i.e., orifice size was greater than zero, while 20%

showed complete closure, i.e., orifice size was zero. The linear correlation coefficient (r), was used to test the correlation between the adequacy of velopharyngeal closure and intelligibility, articulation, nasality, hoarseness and overall speech. Student "t" test was used to determine whether the greater than zero orifice sizes differed significantly from zero.[10] The results are shown in Table 1. The findings showed a statistically significant correlation between velopharyngeal orifice size and intelligibility (r=.749 and t=3.93). Increasing velopharyngeal orifice size adversely affected intelligibility in prosthetically managed patients.

Articulation was significantly and inversely related to orifice size (r =.665 and t = 2.52). Increasing orifice size reduced the adequacy of speech articulation. Additionally, there was a statistically significant correlation between nasality and velopharyngeal orifice size in prosthetically managed patients (r =.785 andt =3.59). increasing orifice size accompanied increasing nasality.

On the other hand, the results showed no statistically significant correlation between the velopharyngeal orifice size and hoarseness (r — .471 and t = 1.50) as well as overall speech (r = .609 and t = 2.17) (Table 1).

Table 1. Correlation between the rating scale of various aspects of speech and velophryngeal orifice size after prosthetic restoration.

	Intelligibility	Articulation	Nasality	Hoarseness	Overall SP
x of competency of various *aspects of* speech	2.38	2.73	2.54	1.65	2.93
x of velopharyngeal orifice *size*	12.2	12.2	12.2	12.2	12.2
x of adequacy of velopharyngeal closure	3.1	3.1	3.1	3.1	3.1
r	0.749	0.665	0.785	0.471	0.609
t	3.93	2.52	3.59	1.50	2.17

x = Mean

Discussion

The principal objective of this study was to evaluate the efficacy of prosthetic management in resected soft palate patients as reflected by the adequacy of velopharyngeal closure and speech competency.

Results demonstrated incomplete velopharyngeal closure in 80% of the prosthetically managed subjects during production of the sound elements that require high intra-oral pressure and maximum velopharyngeal closure, e.g. "P" sound. This is probably due to the lack of pharyngeal wall movements resulting from the surgical resection and scar tissue contraction. This observation is consistent with those in previous studies,[9,11] and may provide a basis for the clinical observation of hypernasality in prosthetically managed cleft palate speakers. It may simply arise from the condition that, in such speakers, the velopharyngeal space is too large to permit closure during pressure consonants.

The complete velopharyngeal closure which was achieved in the remaining 20% of the prosthetically managed subjects may be relevant to the increased ability of muscular adaptation against the speech prosthesis.[12]

The findings indicated an improvement in articulation and intelligibility following prosthetic management as a result of reduction in velopharyngeal port size and better sphincteric closure. However, the habits of dysarticulation are not corrected by obturators even when complete velopharyngeal closure is achieved. This has also been supported by Rosin and Bzoch.[13] The reason, probably, is that speech articulation is produced not only by the soft palate, but is also performed largely through the movements of the lower jaw, lips, tongue, and soft palate.[14] Thus, the use of training procedures in addition to adequate prosthetic management still is required to correct articulatory disorders. Correction of such conditions usually can best be accomplished by working with a skilled speech therapist.

Nasality became accentuated with an increase in velopharyngeal orifice size. It seemed reasonable to assume that the increased rate of airflow through the velopharyngeal port led to an excessive amount of overtone resonance occurring in the nasal chamber. This can be corrected by adequate prosthetic management which may also eliminate the distortion of certain pressure sound elements, such as "P" sound.[13]

Adaptation of the muscle action following prosthetic management could restore, within variable limits, the nasalized characteristics of speech to an acceptable level. However, the fact that control of hypernasality following prosthetic restoration was possible did not mean that it would be accomplished automatically during speech, and direct assistance was needed.

Hoarseness was not significantly related to the adequacy of velopharyngeal closure. While this observation appears not to have been discussed in any of the literature reviewed, it is possible to postulate that since hoarseness is originally produced in the larynx and does not depend mainly upon the movement of the soft palate, it should indeed be unrelated to velopharyngeal closure.

The results did not exhibit a direct correlation between overall speech and velopharyngeal orifice size following prosthetic management. The interpretation to this observation could not be definite, since speech competency is also related to the integrity of oral structures which affect speech (eg. upper and lower jaws, teeth, lips, and tongue).

Although more definitive conclusions must await substantiation of these data in the form of a larger sample, it is appropriate at this time to suggest that a greater cooperation in clinical management by the maxillofacial prosthodontist and speech pathologist would contribute to speech improvement.

Conclusions

The conclusions that can be made obtained from this study are :

1. Prosthetic management did not achieve complete velopharyngeal closure in 80% of the subjects. This is probably due to the relative lack of pharyngeal wall activity. The complete closure in the remaining 20% of the subjects is possibly related to the muscular adjustment to their prostheses.
2. Prosthetic management in resected soft palate patients enhances both articulation and intelligibility, but can not correct all habits of dysarticulation that the patient may possess.
3. Incompetent velopharyngeal closure following prosthetic intervention is probably accompanied by increased nasality. However, adjustment of muscle action may correct the nasalized characteristics to some degree.
4. Further investigations are recommended to determine the various factors that affect hoarseness of speech.
5. The integrity of the oral structures including upper and lower jaws, lips, and tongue are probably responsible for general speech competency.
6. Close cooperation between maxillofacial prosthodontists and speech pathologists is essential for speech improvement through the use of an adequate prosthesis and speech training.

References

1. Anam A, Subtelny JD. Velopharyngeal function and cleft prosthesis. J Prosthet Dent 1959;9:149.
2. Bjork L. Velopharyngeal function in connected speech. Acta Radiol 1961; 1 (Supplement 202).
3. Morris HL. An articulation test for assessing competency of velopharyngeal closure. J Speech Hear Res 1961 ;4:48,
4. Myers EN, Arniany MA. Rehabilitation of the oral cavity following resection of hard and soft palate. Transaction of American Academy of Opthalmology and Otology 1977;84:941.
5. Huryn JM, Piro JD. The maxillary immediate surgical obturator prosthesis. J Prosthet Dent 1989;61:343.
6. Minsley GE, Nelson DR, Rothenberger SL. An alternative method for fabrication of a closed hollow obturator. J Prosthet Dent 1936;55:485.
7. Armany MA, and Drave JB. Effect of nasal extension sections on the voice quality of acquired cleft palate patients. J Prosthet Dent 1974;27:194.
8. Warren DW. Effect of restorative procedures on the nasopharyngeal airway in cleft palate. J Am Cleft Palate Assoc 1964; 11:367.
9. Oral K, Armany MA, McWilliams BJ. Speech intelligibility with the buccal flange obturator. J Prosthet Dent 1979;41:323.
10. Sarhan A, Shabrawi M, El-Kashlan M. Introduction to statistical methods in medicine and public health. 3rd ed. Alexandria:University Book House, 1969.
11. Lubker JF, Schweiger JW, Morris HL. Nasal airflow characteristics during speech in prosthetically managed cleft palate speakers. J Speech Hear Res 1970;13:226.
12. Desjardin RP. Early rehabilitative management of maxillectomy patients.J Prosthet Dent 1977;38:311.
13. Rosin MS, Bzoch KR. The prosthetic speech appliance in rehabilitation of patients with cleft palate. J Am Dent Assoc 1958:57:203.
14. Kerman PC, Hagerty RF, Hoffmeister FS. Palatal lift and speech therapy for velopharyngeal incompetence. Arch Phy Med Rehabil 1973;54:271.