Velopharyngeal oclusion in people who were submitted to nasoendoscopy at The Center of Health Education (CEPS)

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ABSTRACT

The velopharyngeal sphincter corresponds anatomically to the area limited by the soft palate and lateral and posterior walls of the pharynx. Physiologically, there is a great variability in its mechanism of occlusion, which has been classified in general literature in four types: coronal, sagittal, circular and circular with Passavant's ridge.
This study analyzed and compared the different types of velopharyngeal closure to those described by the literature; establish the relationship between velopharyngeal occlusion, total or incomplete, with data obtained from the methodological procedures used: interview, resonance mirror and nasoendoscopy. The results pointed to a prevalence of velopharyngeal closure type coronal and allowed us to conclude that the soft palate had a more effective participation in most of individuals. This study also pointed to a presence of air leak by the nose and/or a minimum velopharyngeal gap in the most of subjects, mainly during the vowel /a/, without direct relationship with damage of velopharyngeal function. This shows that nose leaks and/or minimum velopharyngeal gap do not characterize necessarily velopharyngeal inadequacy.

Key words: velopharyngeal sphincter; velopharyngeal closure; patterns of velopharyngeal closure.

INTRODUCTION

The velopharyngeal sphincter (VFS) corresponds anatomically to the area limited by the soft palate, the lateral and posterior walls of the pharynx. This name comes from its function as a sphincter closure valvule during some functions.

From the physiological point of view there are three main mechanisms to attain velopharyngeal occlusion: upward and backward movement of the soft palate, medial drawn of pharynx's lateral wall and, less frequent, anteriorization of the posterior wall of the pharynx. The correct physiology of the VFS is responsible for activities such as: blowing, swallowing, suction, speaking and middle ear aeration (Altmann, 1994).

Videofluoroscopy and nasoendoscopy made possible a more detailed knowledge of the anatomy and physiology of the VFS. Among these technologies, nasoendoscopy is frequently mentioned in the literature as a procedure that allows the direct view of the VFS, which has been used as a subsidiary exam in the routine clinical evaluation (Hirschberg, 1986; Tabith, 1989; Shprintzen, 1994).

Shprintzen (1989) has mentioned some other advantages to the use of nasoendoscopy: patients are not exposed to radiation; the exam can be repeated; the procedure is relatively easy; it aids in the diagnosis and definition of conduct; and has therapeutic applications.

Hirschberg (1986) has also mentioned as an advantage the possibility of inspecting the mobility of VFS with little or no interference in its normal physiology. By this method, among others, it was possible to observe that velopharyngeal closure varies with the person (Shprintzen, 1994; Altmann, 1994; Finkelstein et al., 1995). However, Skolnick et al.(1973) (Croft et al., 1981; Shprintzen, 1994; Altmann, 1994; Finkelstein et al.,1995) have characterized four patterns of closure according to the more effective mobility of each of these structures:

- coronal – predominant participation of the soft palate
- sagittal – predominant participation of the lateral walls of the pharynx
- circular – predominant participation of the soft palate and of the lateral walls
- circular with Passavant´s pad – similar to the previous including the posterior wall with the Passavant´s pad.

Later on, Finkelstein et al., (1995), studying cephalometric measures, have identified an intermediate fifth pattern, classified as coronal with marked mobility of the lateral walls of the pharynx, being the main component the elevation of the soft palate and the movement being completed by the lateral walls of the pharynx between 50% and 0% of the transverse diameter.

Altmann (1994) referred that the variability of the closure depends also on the activity performed. In this way, in pneumatic activities (blowing, speaking, and whistling) the lateral walls do not move fully. Con-

versely, in non-pneumatic activities (swallowing, suction and vomiting reflex) the movement of the wall is quite clear since it occurs in its all course. Kuehn & Moon (1998) also mentioned the difference among activities that includes or not speech. They observed that maximum point of strength in the velopharyngeal closure during swallowing tends to be inferior than during speech. This is most probably due to the action of the constrictor muscles of swallowing.

According to Altmann (1994), the velopharyngeal closure may also vary quantitatively. It seems to follow some sort of hierarchy, being greater in swallowing and decreasing along blowing, emission of consonants and, finally, during emission of vowels.

According to Shprintzen (1994), when the VFS structures are not properly functioning there is a velopharyngeal insufficiency (VFI). As a consequence, it is possible to observe a gap between such structures.

Tabith (1989) states that VFI is, therefore, a communication between the oropharyngeal and nasopharyngeal cavities resulting in different symptoms in speech, feeding and auditive function. As a consequence there may appear hypernasality in the voice, compensatory articulator disturbs, gagging, nasal reflux of food and repetitive otitis.

Pinho & Joo (1995) reported respiratory and laryngeal compensation as result of alterations in the velopharyngeal closure. According to these authors, such compensations could be justified by the attempt of the individual of reducing the nasality by an extra effort of the vocal tract, which would be the main responsible for the voice disturbs.

Hirschberg (1986) mentioned that the voice produced in a hyperfunctional way could be considered as a compensatory mechanism leading to dysphonia and even to the development of nodules in the vocal pads. This author reports 12% of such nodules in his sample.

However, the velopharyngeal gap not always leads to the above-mentioned symptom. Warren (1986) reported that no repercussion in the velopharyngeal function in individuals with minimal velopharyngeal opening is also possible.

Causes for VFI may be of organic and functional origin or a combination of both. They could be acquired or congenital (Hirschberg, 1986). Among these, Shprintzen (1994) mentions the anomalies of the central and peripheral nervous system, neuromuscular disturbs and difficulties in the articulatory development. Cerebral palsy, craniofacial anomalies, surgeries in the adenoids and tonsils, their hypertrophy and trauma are also reported as possible causes of VFI according to Shprintzen & Golding-Kushner (1989).

Therefore, it is necessary a deeper knowledge of the VFS since in some pathological situations the first symptoms may appear in this region.

Based in the literature and in the practice, it is possible to ascertain that the velopharyngeal mechanism is complex and its physiological variability “seems to be the rule, not the exception” (Altmann, 1994). Researchers do no exclude any of the different possibilities for the velo-

pharyngeal closure due to the interference of multiple factors although the patterns described by Skolnick et al (1973) are the most frequently mentioned in the literature (Croft et al., 1981; Altmann, 1994; Finkelstein et al., 1995).

Taking the above in consideration the present study aims to:

- analyze and compare with the pattern described in the literature the obtained types of velopharyngeal closure;
- verify and describe the occurrence of other types of velopharyngeal closure in the case of observation of different types already reported in the literature.
- correlate the VFS closure, total or incomplete, as observed in the nasoendoscopy, to the data obtained in the anamnesis and in the evaluation with the resonance mirror.

MATERIALS AND METHODS

The individuals of the study were those scheduled weekly for nasoendoscopy in the ENT clinic at CEPS (Center for Health Education – University of the Sacred Heart).

Sixty-one evaluations were conducted in this study, being 13 excluded due to difficulties in the visualization of the VFS and other situations during the nasoendoscopic procedure.

The nasoendoscopy performed by a medical professional, constituted in a flexible optical fiber (MACHIDA) introduced in the larynx through the nasal cavity passing by the region of the VFS. The obtained images were magnified and monitored during the exam by a TV set connected to the nasoendoscopic equipment. The exam was registered in video tape making possible to the professional a later detailed analyzes. In this connection, it was reduced the period in which the optical fiber was in the patient.

Data collection followed the sequence below:

- Anamnesis was directed towards velopharyngeal function complaints and antecedents such as: reference to gags, nasal reflux, otitis and vocal and articulatory alterations (APPENDIX 1)
- Evaluation with resonance mirror aiming to verify the presence or absence of nasal escape, since this information is very important to complement diagnosis of VFI associated to the information obtained by nasoendoscopy (APPENDIX 2). The analyzes of the resonance mirror was considered positive (+) when escape of nasal air were observed by misting of the mirror and negative (-) when no nasal air escape was observed in any emission. However, the vowel /a/ was particularly analyzed due to the possibility of an isolated positive result.
- Nasoendoscopy, though which it was made the direct analyses of the VFS region (APPENDIX 2). This analyzes was considered po-

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sitive (+), with presence of gap when this characteristic was present in one or more emissions and negative (-) when there was no velopharyngeal gap. In this case, the vowel /a/ was also considered in a particular way.

The protocol used in these two procedures (APPENDIX 2) included blowing, prolonged emission of vowels and dump fricative phonemes, word and phrases with predominance of plosive and fricative phonemes, since they require a greater flow of intra-oral air.

All the nasoendoscopies were registered in tapes and weekly detailed analyzed being the data correlated to the ones obtained in the anamnesis and in the resonance mirror exam.

Age ranged from 6 to 76 years. The present study included Portuguese speaking individuals being 33 females and 15 males. To the analyzes of result, sex and age were not considered.

RESULTS AND DISCUSSION

It is possible to observe that in 48 patients the pattern of velopharyngeal closure was similar to those proposed by Skolnick et al. (1973): coronal, sagittal, circular and circular with Passavant´s pad. Among these, the coronal type was more frequent (TABLE 1).

TABLE 1 – Patterns of velopharyngeal closure observed in the study

Patterns	Cases (48)
Coronal	54.1% (26)
Sagittal	4.2 % (02)
Circular	31.2% (15)
Circular with Passavant´s pad	4.2 % (02)
Coronal and Circular	4.2% (02)
Coronal and Sagittal	2.1% (01)

Croft et al. (1981) performed a study that includes cases with normal and pathologic velopharyngeal function (TABLE 2).

TABLE 2 – Patterns of velopharyngeal closure according to Croft et al.

Patterns	Normal cases (80)	Pathological cases (500)
Coronal	55% (44)	45% (225)
Sagittal	16% (13)	11% (55)
Circular	10% (8)	20% (100)
Circular with Passavant's pad	19% (15)	24% (120)

Altmann et al. (1994), have also conducted a similar study to verify the incidence of these patterns but only with individuals supposed to be normal (TABLE 3).

TABLE 3 – Patterns of velopharyngeal closure according to Altmann et al. (1994)

Patterns	Cases (30)
Coronal	60.0% (18)
Sagittal	6.7% (02)
Circular	23.3% (07)
Circular with Passavant's pad	10.0% (03)

The results of the mentioned studies, as well as in the present study, indicate a predominance of velopharyngeal closure of the coronal type. These findings may indicate that, despite the tridimentional movement of the VFS, the soft palate seems to have a more effective participation in the majority of individuals.

As for the remaining patterns, it is possible to verify a closer similarity of our result to those of Altmann et al., (1994). The sample size and the inclusion of pathological cases in the study by Croft et al., (1981) may have interfered in the difference found in regards to the hierarchy of the remaining patterns, despite some subjectivity that involves the analyze of these cases.

In the present study it was also considered the individuals that, during emission, showed two types of velopharyngeal closure, as displayed in TALBE 1: coronal + circular and coronal + sagittal. This is possible to occur since there is a strong physiological variety of VFS, which is due to the influence of different factors such as: speed of speech; type of emission (formed sounds); type of performed, activity including those that requires or not phonation (blowing, swallowing, speech) (Altmann, 1994; Hirschberg, 1986).

TABLE 4 – Comparison of action between the mirror test and the results of nasoendoscopy.

Test	Cases	Percentage
Mirror (-) /nasoendoscopy (-)	16	33.3%
Mirror (-) in all emissions / nasoendoscopy (+) with /a/	06	12.5%
Mirror (-)/ nasoendoscopy (+) in more than one emission	01	2.1%
Mirror (+) with /a/ / nasoendoscopy (+) with /a/	03	6.2%
Mirror (+) with /a/ / nasoendoscopy (-) in all emissions	04	8.3%
Mirror (+) in more than one emission/ nasoendoscopy (+) with /a/	08	16.7%
Mirror (+) in more than one emission/ nasoendoscopy (+) in more than one emission	02 (*)	4.2%
Mirror (+) in more than one emission / nasoendoscopy (-)	08 (**)	16.7%

(*) one of the cases presented mirror (-) during the emission of the vowel /a/.
(**) three cases presented mirror (-) during the emission of the vowel /a/.

These data confirm the great diversity that exists in the velopharyngeal mechanism, varying according to the individual. There are plenty of references in the literature concerning the variability of the velophayngeal function (Moll, 1962; Altmann, 1994; Shprintzen, 1994; Finkelstein et al., 1995; Kuehn & Moon, 1998). Many factors may explain this versatility. Among them, Kuehn & Moon (1998) mention the action of various muscles associated to the *levator veli palatini* (palatoglossus, palatopharyngeal, superior constrictor of the pharynx); mechanical factor, mainly the position of the tongue in the oral cavity; specific phonological rules of each linguistic system.

According to the findings of the present study (TABLE 4), it is possible to verify that the negative mirror test and nasoendoscopy were more prevalent, that is, there was no nasal air escape and no velopharyngeal gap was observed. This result seems to be compatible to the studied sample since the majority of individuals were considered as asymptomatic regarding the specific symptomatology of alterations in the velopharyngeal function.

These facts could be observed through the analysis of data obtained from the anamnesis, showing the majority (37 cases / 77.08%) complaints related to vocal disturbs mainly associated to laryngeal alterations.

Results of the present study also indicate a great percentage of cases that presented nasal air escape and/or velopharyngeal gap during the emission of the vowel /a/ (TABLE 4).

Mool (1962) studied the velopharyngeal closure in isolated vowels and in connected speech with different consonantal phonemes. This author concluded that the velopharyngeal closure is greater with high vowels than with low vowels, which includes the vowel /a/. It is important to note that this study was conducted with English speaking individuals. The author correlates this difference among high and low vowels to the position of the tongue in the oral cavity during the emission of such vowels. In its turn, the elevation of the tongue seems to be related to the palatoglossus muscle, which connects this structure to the soft palate.

The palatoglossus muscle aids in the elevation and retraction of the tongue being, thus, very active during the production of high vowels where the tongue is considerable elevated (Altmann, 1994).

Kuehn & Moon (1998) studied the forces of the velopharyngeal closure and observed a direct relation to the findings of Mool (1962). Thus, as Moll observed, that in the high vowels the height of the soft palate is greater, Kuehn & Moon (1998) have found a greater force in the velopharyngeal closure during the emission of these vowels.

Mool (1962) has also found differences in the velopharyngeal closure among vowels emitted in a sustained and isolated basis, with vowels produced during connected speech (vowels associated to different consonants). In this case, there was less velopharyngeal closure during the isolated vowels.

Therefore, these studies support the results of the present study in regard to the presence of nasal escape and/or velopharyngeal gap, inclusi-

ve in normal individuals, during the isolated production of the phoneme /a/, which is regarded as low vowel.

TABLE 4 also indicates individuals with positive result for nasal escape (resonance mirror), although negative to the presence of velopharyngeal gap (nasoendoscopy). In these situations the mirror might have registered nasal escape from minimal velopharyngeal gaps, which were not properly seen during the nasoendoscopic analyzes.

This fact is possible taking into consideration the finding of Warren (1986) that, in other studies (1975 and 1979), has defined the velopharyngeal function in physiological terms. According to this author this function is competent till a gap of 0.2 cm^2. Above this limit the individual will not produce and adequate speech since he/she could not afford sufficient intra-oral air pressure, resulting in a hypernasal resonance.

The same author indicates other velopharyngeal opening and the connected repercussions. In this regard, openings below 0.05cm^2 should not cause speech disturbs. Openings between 0.05 and 0.10 cm^2 should not interfere in the ability to speak, but could bring some audible nasal emissions. Openings between 0.10 and 0.20cm^2 are regarded as borderline and, in many cases, the individual will show a moderate nasal emission and hypernasality.

However, Warren (1986) do not exclude the possibility of the exceptions for each of the sub-groups above mentioned, that is, contrary to the expected, there are situations in which the gap is minimum but there is some interference in the voice of the individual. On the other hand, it may appear individuals with a borderline gap without consequences to his/her voice. This confirms, again, the great variability of the velopharyngeal mechanism.

Therefore, these explanation support the positive results of the resonance mirror and negative for nasoendoscopy since the gap with such minimal measures are not all ways perceptible to the examiner.

Finally, it is possible to observe in TABLE 4 the individuals that presented negative results regarding the nasal escape although positive to the presence of velopharyngeal gap (nasoendoscopy). It was not possible to find an explanation to these findings in the literature. However, a possible explanation could be the occurrence of velopharyngeal closure at a lower level of the VFS, which was not possible to be viewed and given the wrong impression of a minimal velopharyngeal gap.

The fact that a velopharyngeal occur in many emissions, but mainly with the vowel /a/, did not seem to be related to nasality in the speech of the studied individuals. This aspect is supported by Pontes & Behlau (1994) that states that – " it is fundamental to stress that nasality in speech, although based in the grade of opening of the velopharyngeal space, depends also on other factors. Therefore, the interpretation of what we observe in nasoendoscopy should be inserted in the global context of each case".

Amid other factors, that may or may not carry out increased nasality, Warren (1986) indicates the importance of the articulatory accuracy with what phonemes are produced. This author mention that there is individuals with minimal velopharyngeal opening (0.05 and 0.10cm^2) but with quite close articulation, which can induce a moderate hypernasal vocal production.

CONCLUSION

Data obtained through evaluation with resonance mirror and nasoendoscopy should be analyzed in the particular context of the individual, including his/her present and past history regarding symptomatology that involves the velopharyngeal function, since air escape observed in the mirror, as well as velopharyngeal gap observed in the nasoendoscopy, do not necessarily characterize a VFI.

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APPENDIX 1

TAPE Nº_____ Date ___/___/___

ANAMNESIS

1 - IDENTIFICATION

Name:_____ Age:_____

Date of birth ___/___/___ Phone: _____

Address:_____

2 - REASON FOR NASOENDOSCOPY:

Request by the phonoaudiologist ( ) Request of ENT ( ) Other( )

Reason:_____

3 - GENERAL INFORMATION

3.1 - Pregnancy: intercurrences ( ) yes ( ) no

Explain?_____

3.2 - Childbirth: intercurrences ( ) yes ( ) no

Which?_____

3.3 – Motor development: retard ( ) yes ( ) no

Describe:_____

4 – ORAL COMMUNICATION:

4.1 Articulatory alterations: ( ) yes ( ) no

Period: _____

Describe:_____

4.2 Voice alterations: ( ) yes ( ) no

Nasal voice ( ) yes ( ) no

Hoarse voice ( ) yes ( ) no

others: ( ) yes ( ) no

Period: _____

5 - NUTRITION:

5.1 Nasal reflux ( ) yes ( ) no

with aliments ( ) liquids ( ) pasty ( ) solids

Period: _____

5.2 Gags ( ) yes ( ) no

with food ( ) liquids ( ) pasty ( ) solid

Period: _____

6 - HEARING

6.1 Otitis ( ) yes ( ) no

Frequent ( ) yes ( ) no

Period: _____

Symptoms:_____

6.2 Can hear well?: ( ) yes ( ) no

7 – FAMILY HISTORY:

Is there anyone in family with: nasal voice ( ) yes ( ) no

cleft ( ) yes ( ) no

progressive or degenerative disease ( ) yes ( ) no

8 – PAST SURGERIES

( ) tonsillectomy ( ) adenoidectomy ( ) other

APPENDIX 2

PROTOCOL
RESONANCE MIRROR

1 – Nasal flux: ( ) symmetric ( ) asymmetric ( ) right ( ) left
sufficient: ( ) yes ( ) no

2 - Blowing:_____ Blowing with tongue out of the mouth

3 - Emissions:

/a/	/i/	/u/
/f/	/s/	
pipa	Kiko	chuva
sítio	fubá	

papai pediu pipoca_____
caqui caiu_____
a fita é da fada_____
Chico chegou_____
saci assobiou_____
a babá beijou o bebê_____
Obs: _____

4 – Observations of the examiner:
Articulatory alterations: ( ) yes ( ) no ( ) compensatory ( ) other
Associated nasal movements: ( ) yes ( ) no
Vocal alterations: ( ) yes ( ) no
nasal ( ) yes ( ) no
hoarse ( ) yes ( ) no
Describe if necessary:_____
Other:_____

NASOFIBROSCOPY

2 – Blowing: _____ Blowing with tongue out of the mounth

3 - Emissions:

/a/	/i/	/u/
/f/	/s/	
pipa	Kiko	chuva
sítio	fubá	

papai pediu pipoca_____
caqui caiu_____
a fita é da fada_____
Chico chegou_____
saci assobiou_____
a babá beijou o bebê_____
Obs: _____
_____
_____
_____

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