PERCEPTUAL AND NASOMETRIC ASSESSMENT OF HYPERNASALITY AFTER INTRAVELAR VELOPLASTY FOR SURGICAL MANAGEMENT OF VELOPHARYNGEAL INSUFFICIENCY: LONG-TERM EFFECTS

Análise perceptiva e nasométrica da hipernasalidade após a veloplastia intravelar para correção da insuficiência velofaríngea: efeitos a longo prazo

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ABSTRACT

Purpose: to investigate the long-term effect of intravelar veloplasty for surgical management of velopharyngeal insufficiency (VPI) on hypernasality of individuals with repaired cleft palate. **Methods:** sixty patients with repaired cleft palate±lip and residual VPI, of both genders, aged 4 to 52 years were analyzed. The patients underwent secondary palatoplasty with intravelar veloplasty. A perceptual speech assessment was used to rate hypernasality using a 6 point-scale, where 1=absent and 6=severe hypernasality. Nasometry was performed for determining nasalance, the acoustic correlate of nasality, during the reading of a set of five Brazilian Portuguese sentences containing only oral sounds, using a cutoff score of 27%. The assessments were done 4 days before and 16 months after surgery, on average, and the surgical success was analyzed based on reduction and elimination/normalization of hypernasality and nasalance. **Results:** postoperative decreases of hypernasality and nasalance scores were observed in 75% and 52% of the patients, respectively. Lower percentages were observed when the criterion of analysis was elimination/normalization (32% of hypernasality elimination and 38% of nasalance normalization, respectively). **Conclusion:** intravelar veloplasty was shown to be an effective procedure in reducing the most important symptom of VPI in the long-term, and should be seen at as a first approach for VPI management.

KEYWORDS: Cleft Palate; Velopharyngeal Insufficiency; Palate; Speech; Surgical Procedures, Operative

INTRODUCTION

The speech disorders associated with cleft palate are caused by anatomical alterations of velopharyngeal structures, in which the insertion of palatal muscles, especially the levator palatini muscle, is anteriorly displaced presenting a sagittal position, inserted on the posterior edge of the hard

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palate, thus impairing the integrity of the muscle sling required for velopharyngeal closure[1-3].

The primary surgeryaims to repair the palate both anatomically and functionally, thus allowing adequate velopharyngeal closure, fundamental for the normal speech production[4,5]. However, in many cases, even after primary palatoplasty, the characteristic speech symptoms of velopharyngeal insufficiency (VPI) such as hypernasality, nasal air emission, weak intraoral pressure and compensatory articulation, may persist[6-8]. This occurs because, even though the palate may be completely closed and present long extent, the insertion of levator palatini muscles remains anteriorly displaced. In these cases, secondary surgical managementof the palate is necessary[9].

Among the different surgeriesfor VPI correction, the procedure known as *intravelar veloplasty* is based on total release of the palatal musculature and posterior displacement of the muscle bundle, so that the fibers may reach a more transverse position and favor the velum mobility, consequently promoting the velopharyngeal closure[10-12]. The technique was initially described by Braithwaite and Maurice[13] and later by Kriens[14]as an anatomic-functional surgical procedure used for primary closure of the soft palate cleft[15]. Since then, the procedure became popular and was incorporated to several surgical techniques, both for primary palatal repair and for correction of residual VPI.

The main criterion for indication of intravelar veloplastyis the anterior insertion of the palatal musculature. The intravelar veloplastyis mainly indicated in cases presenting good extent and mobility of the palate and small failure in velopharyngeal closure[8,16-18].

Since surgery aims to restore the normal anatomy or modify the existing anatomy to improve the velopharyngeal function[1], it is expected that the use of this procedure, also in individuals presenting medium to large failures in velopharyngeal closure, may improve the speech symptoms.

A recent study conducted at our laboratory[19] revealed that intravelar veloplasty favored the speech improvement in a considerable part of individuals presenting small failures in velopharyngeal closure. Conversely, individuals presenting severe VPI were also benefited from surgery, though to a lesser extent. This is probably due to the fact that, in that study, postoperative evaluations were performed in a period shorter than one year after surgery, which is considered relatively short from a clinical standpoint to assess the definitive outcome of surgery on speech. Therefore, this study investigated the long-term effect of intravelar veloplasty performed for surgical management of residual velopharyngeal insufficiency (VPI), on the hypernasality of individuals with repaired cleft palate.

METHODS

This study was conducted at the Laboratory of Physiology at the Hospital for Rehabilitation of Craniofacial Anomalies, University of São Paulo (HRAC-USP), and was approved by the Institutional Review Board (n. 295/2009).

The study was conducted on 60 individuals with repaired cleft palate, with or without cleft lip, aged 4to 52 years (mean 17 years). The individuals were selected among those with indication for surgical management of VPI, routinely assisted at the hospital, in a two-year period. All individuals presented residual VPI and had indication for secondary palatoplasty with intravelar veloplasty, according to the perceptual and nasopharyngoscopic analysis performed by the speech-language pathologist and plastic surgeon. Individuals with syndromes and/or evident neurological disorders, residual palatal fistulas and acute allergic respiratory symptoms that might cause nasal congestion during the examination were excluded.

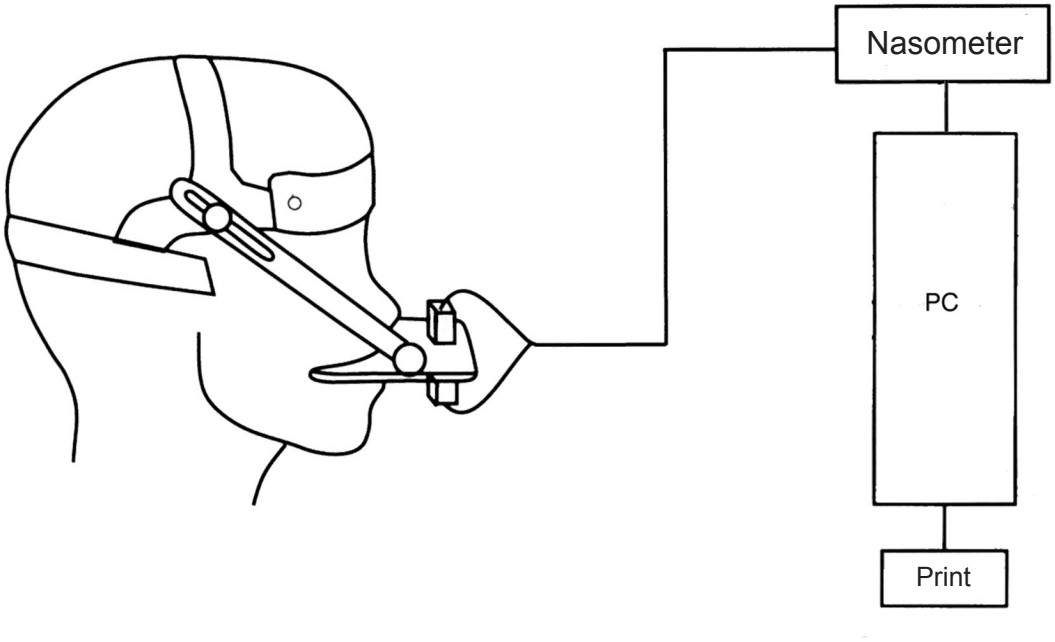
All individuals or legal responsible parties signed an informed consent form. In the average, the individuals were submitted to perceptual and nasometric analysis of speech four days before surgery (preoperative evaluation – PRE) and 16 months after surgery (postoperative evaluation – POST). Intravelarveloplasty was performed by the Furlow technique, von Langenbeck technique or secondary posterior palatoplasty with Braithwaite procedure.

The individuals were submitted to perceptual speech assessment, which is routinely performed at the Laboratory of Physiology of HRAC-USP, and this study employed the hypernasality outcomes. The pre- and postoperative perceptual speech assessments were performed face to face, as described in the literature[20],by a single examiner with more than 20 years of experience with cleft lip and palate.

Hypernasality was classified during spontaneous conversation and repetition of a list of vocables and sentences containing exclusively oral phones, using a six-point scale, as follows: 1=absent, 2=mild, 3=mild to moderate, 4=moderate, 5=moderate to severe and 6=severe. Only individuals presenting at least mild hypernasality (score=2) were included in the study.

The individuals were also submitted to nasometry for nasalance assessment. Nasalance was determined using a Nasometer (model 6200-3 IBM, software version 30-02-3.22, Kay Elemetrics, Lincoln Park, NJ)[21]during reading of a set of five

Brazilian Portuguese sentences containing only oral sounds[22].The cutoff score adopted was 27%, i.e. values higher than 27% were considered suggestive of hypernasality[23]. Individual changes were considered clinically significant when greater than eight percent points, compared to a previous observation, in which 95% of serial nasalance measurements did not vary more than 8%in healthy individuals, tested and retested on the same day at intervals of 1,6 and 12 months (I.T., personal communication, 2010). Figure 1 schematically displays the system configuration.



Source: Trindade IEK, Yamashita RP, Bento-Gonçalves CGA. Diagnóstico instrumental da disfunção velofaríngea. In: Trindade IEK, Silva Filho OG, coordenadores. Fissuras labiopalatinas.

Figure 1 –Schematic representing the instrumentation for nasalance assessment (Nasometer 6200-3 IBM, Kay Elemetrics Corp. Lincoln Park, NJ, USA)

The surgical success was analyzed according to the following postoperative observations[24].

Hypernasality: 1) *reduction*, defined as a reduction of one or more points in the hypernasality score compared to the preoperative assessment, including cases of elimination; 2) *elimination*, defined as a reduction of hypernasality up to score 1 (absence of hypernasality).

Nasalance: 1) *reduction*, defined as a reduction of at least eight percent points in the nasalance score compared to the preoperative evaluation, including cases of normalization; 2)*normalization*, defined as a reduction of nasalance score up to the normal value (nasalance ≤27%).

The statistical significance of pre- and postoperative differences was investigated by the Student t test for paired samples. Perceptual differences were analyzed by the Wilcoxon test. All tests considered a significance level of $p<0.05$.

RESULTS

The 60 individuals analyzed present hypernasality scores equal to or greater than 2 before surgery. Table 1 demonstrates that, according to the perceptual speech assessment, there was reduction in the degree of hypernasality in 75% (45/60) of cases; in 20% (12/60) there was no change, and in 5% (3/60) there was increase. The statistical analysis revealed statistically significant prevalence of score reduction. Table 2 demonstrates that complete elimination of hypernasality was observed in 32% (19/60) of individuals.

All individuals presented mean nasalance scores greater than 27% before surgery. After surgery, the mean nasalance score was significantly reduced from 41±8% to 33±15% (Table 3).

Table 1 – Result of intravelar veloplasty according to the perceptual speech assessment (hypernasality) and instrumental evaluation (nasalance). The values represent the percentage (number) of individuals with positive result (reduction/improvement), negative result (increase/worsening) and without alteration in the postoperative evaluation (POST)

VARIABLES	Postoperative outcome	% (n) Patients POST
HYPERNASALITY (n=60)	Reduction	75 (45)*
	Worsening	5 (3)
	No alteration	20 (12)
NASALANCE (n=60)	Reduction	52 (31)*
	Worsening	10 (6)
	No alteration	38 (23)

*p < 0.05 statistically significant difference –Wilcoxon test

Table 2 –Results of resolution of intravelar veloplasty according to the perceptual speech assessment of speech (hypernasality) and instrumental evaluation (nasalance). The values represent the percentage (number) of individuals with positive results (elimination/normalization) in the postoperative evaluation (POST)

VARIABLES	% (n) Patients POST
HYPERNASALITY (n=60)	32 (19)
NASALANCE (n=60)	38 (23)

Table 3 –Mean and standard deviation of nasalance values obtained on the nasometric evaluation, performed before (PRE) and after (POST) intravelar veloplasty

	PRE	PÓS
NASALANCE (n=60)	41±8	33±15*

*p < 0.05 statistically significant difference (PRE X POST) –Student t test

The individual analysis of data demonstrated that, after surgery, there was reduction of nasalance in 52% of individuals (31/60), suggesting improvement; in 38% (23/60) there was no significant alteration, and in 10% (6/60) there was increase of nasalance, suggesting worsening. The statistical analysis demonstrated that the reduction observed was statistically significant. Among all individuals analyzed, 38% (23/60) presented normal nasalance values after surgery.

DISCUSSION

Intravelar veloplasty has been increasingly used for correction of residual VPI, because it provides a more favorable condition for velopharyngeal mobility with lower risk of morbidity compared to other secondary surgeries, such as pharyngeal flap and sphincteroplasty[25]. During the years, intravelar veloplasty has undergone changes and adaptations and has been incorporated to different surgical techniques, such as the von Langenbeck and Furlow, used in this study. Selection of the surgical technique depends on the velopharyngeal conditions identified on the preoperative evaluation and the plastic surgeon's preferences[10,17]. In fact, there is considerable variation in interpretation of the term intravelar veloplasty, which has been used to describe any degree of muscle dissection, from partial release of muscles up to the most radical forms of dissection and posterior displacement of the velar musculature[10,12,26]. The surgical procedure also varies between surgeons and, to some extent, between surgeries performed by the same surgeon.

In fact, the literature unanimously agrees that intravelar veloplasty is the procedure of choice in cases with small velopharyngeal gap. However, studies have suggested that this procedure is also effective in the presence of severe VPI[8,19]. This study was conducted on 60 individuals with gaps of variable extents, eligible for intravelar veloplasty. In general, it was observed that surgery improved the hypernasality (reduction of scores) in the long term, in a significant part of individuals analyzed (75%). These results were similar to reports in the literature, which ranged between 75% and 85%[9,10,18,26]. Recently, better long-term results were also reported in an individual with repaired cleft lip and palate with severe VPI, who obtained significant improvement of hypernasality after intravelar veloplasty, leading to complete elimination of the symptom 18 months after surgery[27].

Concerning the resolution of symptoms, the present results were less expressive, with 32% of individuals presenting balanced resonance after surgery. Better outcomes, with 85% of cases of elimination of hypernasality were reported in the literature[25]. Conversely, other authors[11]observed 39% of elimination of hypernasality, similar proportion to the present study, nearly 14 months after surgery in a study that, similar to this study, also included individuals with large gaps in the sample. It should be considered that perceptual speech assessment in this study was performed face to face and by a single examiner with more than 20 years of experience in the treatment of individuals with cleft lip and palate. This may be a limitation of this study, since notwithstanding the large examiner's experience, such studies increasingly require the participation of more than one examiner for classification of speech symptoms. Currently, other studies are being conducted at the Laboratory of Physiology, using recorded speech samples and perceptual analysis by at least three examiners for speech assessment.

The effect of intravelar veloplasty on the speech of individuals was also analyzed using an instrumental methodology. The results demonstrated that, even though the nasalance score did not reach the cutoff point after surgery in the average, the observed reduction was statistically significant. Individually, it was observed that surgeryled to reduction of nasalance in 52% of cases and normalization in 38%. Higher percentages, of 87% of reduction and 58% of normalization of nasalance, have been reported in the literature[9].However, the differences between these results may be related to the speech sample used by the investigators, which comprised isolated emission of high vowel and syllable containing high vowel. It should be mentioned that the proportion of normalization observed by the instrumental examination confirmed the findings of perceptual assessment, even though the latter was conducted by a single examiner.

Since nasoendoscopy is part of the preoperative evaluation routinely performed for these individuals, separate analysis of individuals in this study presenting small velopharyngeal gap(29/60) revealed greater proportion of surgical success. In these cases, hypernasality improved in 83% of individuals and the symptom was eliminated in 55% of cases. Nasometry demonstrated 66% of reduction and 52% of normalization of nasalance in these individuals. However, in individuals with large gaps, there was 67% of improvement of hypernasality and only 10% of elimination of symptoms, while the nasometry revealed 40% of reduction and 23% of normalization of nasalance scores. These findings confirm the greater effectiveness of intravelar veloplasty in individuals with small velopharyngeal gaps, as observed in the short term in other studies[16,19].

Conversely, intravelar veloplasty was less effective in reduction of nasalance than the pharyngeal flap surgery performed for the surgical management of VPI[7,24,28,29]. However, some studies also observed that the pharyngeal flap led to the appearance of hyponasality and subnormal nasalance scores in the production of nasal sounds as a consequence of hypercorrection[7], and this effect was not expected in individuals submitted to intravelar veloplasty, due to the characteristics of this technique. Recently, a comparative study between the two techniques conducted at our laboratory confirmed the superior results of pharyngeal flap for VPI correction, concerning the elimination of hypernasality[30].

In summary, the present results demonstrated that, in the long term, intravelar veloplasty was successful in improving the speech resonance of a considerable part of individuals. Even individuals without complete resolution of speech symptoms were benefited from surgery. These findings reinforce the statement that repositioning of the palatal musculature favors the velar movement, reducing the symptoms and enhancing the speech intelligibility, even without achieving complete velopharyngeal closure[11,26]. Even though the isolated analysis of individuals based on the size of velopharyngeal gap revealed better results in the presence of small gaps, the results obtained in individuals with large gaps should not be considered as surgical failure, since there was a high proportion of improvement in hypernasality. It is believed that these individuals may be submitted to less aggressive subsequent interventions, e.g. avoiding the indication of very large flaps and their undesirable effects[8,16]. It should be emphasized that the indication of intravelar veloplasty in these cases is based on the preoperative velopharyngeal conditions, especially anterior insertion of the velar musculature and the presence of diastasis of the palatal musculature. Under different conditions, other surgical procedures as pharyngeal flap, sphincteroplasty or adaptation of palatal prosthesis may be indicated following the criteria defined in the literature. However, factors as age, severity of preoperative symptoms, size of velopharyngeal gap, failure in preoperative diagnosis, surgical technique, surgeon's skills or even tissue repair problems may negatively influence these results[24].

CONCLUSION

Based on the present study, the perceptual and instrumental evaluation of speech demonstrated that intravelar veloplasty had a positive long-term effect in improving the main speech symptom caused by VPI, which lead us to agree with reports in the literature that advocate the accomplishment of intravelar veloplasty as a first attempt for VPI correction.

RESUMO

Objetivo: investigar o efeito, a longo prazo, da veloplastia intravelar realizada para a correção cirúrgica da insuficiência velofaríngea (IVF) residual, sobre a hipernasalidade de indivíduos com fissura de palato reparada. **Métodos:** foram avaliados 60 pacientes com fissura de palato±lábio operada e IVF residual, de ambos os sexos, com idade entre 4 e 52 anos, os quais foram submetidos à palatoplastia secundária com veloplastia intravelar. A avaliação perceptivo-auditiva da fala foi realizada para classificação da hipernasalidade, durante a conversação espontânea e a repetição de vocábulos e frases, utilizando-se escala de 6 pontos, onde 1=ausência e 6=hipernasalidade grave. A nasometria foi utilizada para determinação do escore de nasalância (correlato acústico da nasalidade), durante a leitura de 5 sentenças contendo sons exclusivamente orais, utilizando-se como limite de normalidade o escore de 27%. As avaliações foram realizadas 4 dias antes e 16 meses, em média, após a cirurgia e o sucesso cirúrgico foi analisado com base na proporção de redução e eliminação/normalização da hipernasalidade e da nasalância. **Resultados:** verificou-se, após a cirurgia, redução da hipernasalidade e da nasalância em 75% e 52% dos pacientes, respectivamente. Proporções menores foram identificadas quando utilizado o critério mais rigoroso de análise (eliminação/normalização), ou seja, 32% de eliminação da hipernasalidade e 38% de normalização da nasalância, respectivamente. **Conclusão:** aveloplastia intravelarmostrou ser um procedimento efetivo, a longo prazo, na redução do sintoma mais significante da IVF residual e deve ser considerada como uma primeira opção no tratamento cirúrgico da IVF residual.

DESCRITORES: Fissura Palatina; Insuficiência Velofaríngea; Palato; Fala; Procedimentos Cirúrgicos Operatórios

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