

Comparative Study between Superiorly Based Pharyngeal Flap and Sphincteroplasty in Treatment of Velopharyngeal Insufficiency after Cleft Palate Repair

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ABSTRACT

Background: Despite technical advances in cleft palate repairs, the post-surgical development of palatal fistulas and VPI is not uncommon. Approximately 20-38% of children who undergo cleft palate repair develop velopharyngeal insufficiency (VPI). Surgical alteration of the VP sphincter is directed at decreasing the horizontal cross-sectional surface area of the sphincter's tissue boundaries. This can be achieved by the interposition of pedicled pharyngeal flaps (splitting one large port into two smaller one) or repositioning the posterior and lateral borders of the sphincter by the introduction of musculomucosal tissue flaps (Sphincteroplasty).

The Aim of this Work: Is to compare results of pharyngoplasty and superiorly based pharyngeal flap in the treatment of velopharyngeal insufficiency after cleft palate repair.

Patients and Methods: A random group of twenty-two patients with VPI after cleft palate repair was studied. Patients were prone to three diagnostic procedures at phoniatic clinic, preoperatively: 1- Flexible fiber optic nasopharyngoscopy. 2- Nasometric evaluation. 3- Tape recording. Patients were classified into two random groups; for 11 patients pharyngoplasty was done. Superiorly based pharyngeal flap was done for the rest of the patients. Nasometric evaluation and tape recording were repeated after phonotherapy (3-4 months postoperatively) and percentage drop in nasometer for nasal and oral sentences were calculated. Flexible fiber optic nasopharyngoscopy was repeated after 3-6 months postoperatively.

Results: In group I, 3 patients had persistence of nasal tone postoperatively (two patients had marked improvement and one patient had minimal improvement), giving incidence of complications 27.3%. According to results of postoperative tape recording of this group, 8 patients were categorized as good results, two as moderate and one as poor result. In group II, one patient had partial dehiscence and persistence of nasal tone postoperatively. Two patients had hypo nasality, one of them developed sleep apnea. Incidence of complications in this group was 27.3%. According to results of postoperative tape recording in this group, 9 patients were categorized as good results, one as moderate and one as poor result. Percentage drop in nasometer in nasal sentence in group I & II was 35.55% and 42.61% respectively. Percentage drop in nasometer in oral sentence in group I & II was 51.95% and 49.11% respectively.

Conclusion: Both sphincter pharyngoplasty and superiorly based pharyngeal flap proved to be effective in treatment of velopharyngeal insufficiency with accepted incidence of complications. Sphincter pharyngoplasty had better results in patients with good palatal and lateral pharyngeal wall movements on preoperative videoendoscopy. Superiorly based pharyngeal flap had better results in patients with poor palatal and lateral pharyngeal wall movements on preoperative videoendoscopy.

INTRODUCTION

Velopharyngeal insufficiency (VPI) includes any structural and/or neuromuscular disorder of the velum and/or pharyngeal walls at the level of nasopharynx in which interference with normal sphincteric closure occurs. VP insufficiency (VPI) may result from anatomic, myoneural, behavioral, or a combination of disorders. It is diagnosed clinically by a constellation of symptoms that includes pathologically incurred nasal resonance (hypernasality), misarticulation, escape of air through the nose (nasal emissions) and aberrant facial movements (grimacing) [1].

The source of VPI may be palate that is structurally deficient (e.g., too short or lacking muscle bulk), a VP mechanism that is neurologically impaired (e.g. cerebral palsy, myasthenia gravis, head injuries and cerebrovascular accidents), or the result of faulty learning (e.g. phoneme-specific nasal emission). Most commonly, however, the plastic surgeon will encounter VPI in the post-palatoplasty [2].

Despite technical advances in cleft palate repairs, the post-surgical development of palatal fistulas and VPI is not uncommon. Approximately 20-38% of children who undergo cleft palate repair develop VPI [3].

In 1865, after a detailed study of VP physiology, Passavant was the first to tether the uvula to the pharynx in an attempt to restore a competent valvular mechanism during speech. Since that time the use of removable devices designed correct the VPI, also a number of surgical procedures have been devised to restore the physiologic closure of this sphincter-like mechanism [4].

Surgical alteration of the VP sphincter is directed at decreasing the horizontal cross-sectional surface area of the sphincter's tissue boundaries. This can be achieved by the interposition of pedicled pharyngeal flaps (splitting one large port into two smaller one) or repositioning the posterior and lateral borders of the sphincter by the introduction of musculomucosal tissue flaps (Sphincteroplasty) [5].

The pharyngeal flap has probable been the single most popular method of treating individuals with VPI over the past two decades. The procedure was initially described in the 19th century and later refined by surgeons such as Rosenthal, Padgett, Sanvanero-Rosselli and Conway [6].

Hynes initially described sphincteroplasty in 1950, but its use in VPI management has only recently become popular as a result of modifications by Orticochea and Jackson [7].

The aim of this work is to compare results of pharyngoplasty and superiorly based pharyngeal flap in the treatment of velopharyngeal insufficiency after cleft palate repair.

PATIENTS AND METHODS

A random group of twenty-two patients with VPI after cleft palate repair was studied in the Department of Pediatric Surgery, Cairo University and in Hearing and Speech Institute.

The study was conducted during the period from July 2000 to March 2002.

Full history was obtained from each patient with physical examination stressing on absence of fistula, hypernasality, nasal emission or regurgitation, compensatory misarticulation and facial grimacing. Type of palatal repair was excluded as in most cases it was difficult to be sure of it.

Patients were Prone to Three Diagnostic Procedures at Phoniatic Clinic, Preoperatively:

1- *Flexible fiber optic nasopharyngoscopy:* Following Groft et al. [8] patients were classified into four categories.

- a- Short palate, good palatal movement, poor or limited lateral pharyngeal wall movement, $\pm$ posterior pharyngeal wall movement.
 - b- Good lateral pharyngeal wall movement, poor palatal elevation, $\pm$ posterior pharyngeal wall movement.
 - c- Short palate, large VP gap, and good palatal and lateral pharyngeal wall movement, $\pm$ posterior pharyngeal wall movement.
 - d- Limited or poor movement of the palate and lateral and posterior pharyngeal walls.
- 2- *Nasometric Evaluation:* Nasometer is a device for calculating the ratio between the nasal and oral output (percent nasalance). It consists of three major subunits:
- 1- Nasal and oral microphones.
 - 2- Electronic circuits for processing the microphone signals.
 - 3- A personal computer for calculating nasalance values.

A short simple arabic nasal sentence and oral sentence were used.

$$\text{Percent nasalance} = \frac{N}{N + O} \times 100$$

- 3- *Tape recording:* According to results of postoperative tape recording, patients were categorized as good, moderate and poor results.

Patients were classified into two random groups; for 11 patients pharyngoplasty was done. Technique used was that described by Jackson and Silverton [7]. Superiorly based pharyngeal flap was done for the rest of the patients. Michael Sadove et al. [9]. Both techniques are shown in illustrations (Figs. 4,5).

Oral feeding was allowed 24 hours postoperatively and patients were discharged 48 hours postoperatively.

Phonotherapy started one month postoperatively for all patients and continued for six sessions.

Nasometric evaluation and tape recording were repeated after phonotherapy (3-4 months postoperatively) and percentage drop in nasometer for nasal and oral sentences were calculated.

Flexible fiber optic nasopharyngoscopy was repeated after 3-6 months postoperatively.

All patients were followed regularly every 2 weeks. The least period of follow-up was 5 months with mean period of 10.4 months.

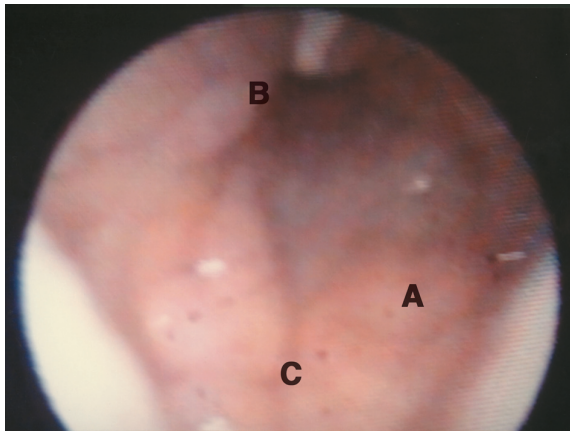


Fig. (1): Flexible fiber optic nasopharyngoscopy VPI: Category (B) with good posterior pharyngeal wall movement.
A: Lateral pharyngeal wall.
B: Palate.
C: Posterior pharyngeal wall.

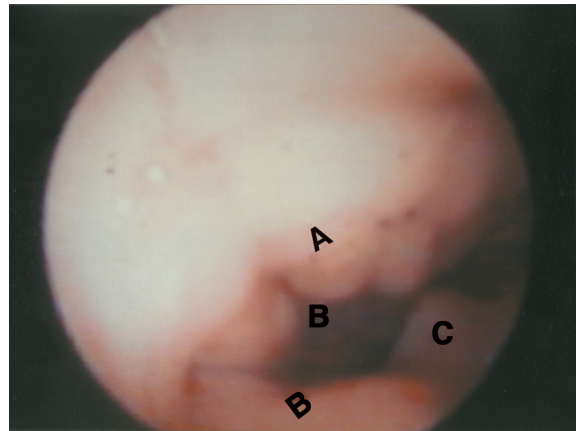


Fig. (2): Flexible fiber optic nasopharyngoscopy showing VPI (category C) with poor posterior pharyngeal wall movement.
A: Lateral pharyngeal wall.
B: Palate.
C: Posterior pharyngeal wall.

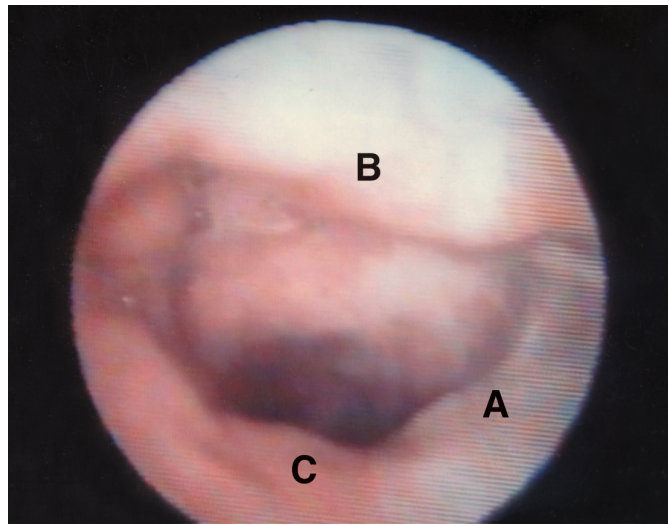


Fig. (3): Flexible fiber optic nasopharyngoscopy showing VPI (category D).
A: Lateral pharyngeal wall.
B: Palate.
C: Posterior pharyngeal wall.

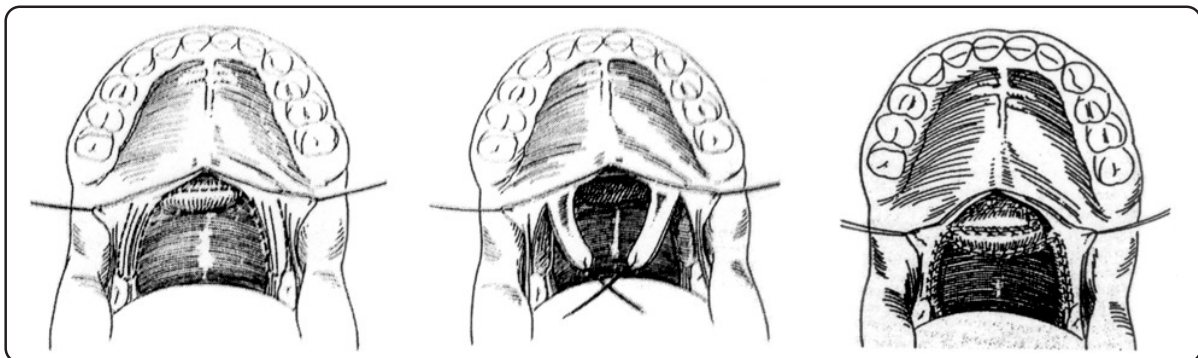
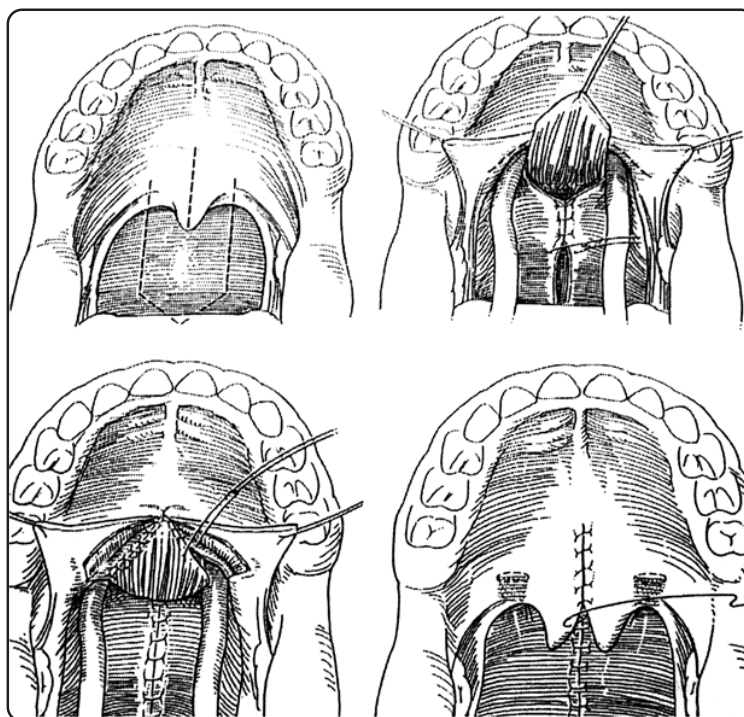


Fig. (4): Sphincter pharyngoplasty. (Soft palate is artificially split for diagrammatic purposes and is not performed as part of the procedure). A- Superiorly based musculomucosal flap design. B- Flap elevation and reorientation posteriorly. C- A horizontal posterior pharyngeal wall bulge is created by flap interdigitation and closure of the donor defects narrows the horizontal dimension. (Quoted from: Michael Sadove et al., 1999) [9].

Fig. (5): Superiorly based pharyngeal flap. A- Division of soft palate and pharyngeal flap design. B- Full-thickness musculomucosal flap elevation off the prevertebral fascia. The posterior wall mucosa is reapproximated and catheters are passed nasally for the fashioning of lateral ports. C- Mucosal flaps are elevated from the nasal sides of the split soft palate and sutured to create a nasal closure around the catheters. D- The raw muscular surface of the flap is lined with soft palatal mucosa to complete the closure. (Quoted from: Michael Sadove et al., 1999) [9].



RESULTS

A random group of twenty-two patients with VPI was studied all of them were subjected to cleft palate repair with no fistula. All of them on perceptual evaluation had nasal resonance. Second operation was done at least 6 months after cleft palate repair with mean period of 11.3 months.

They were Classified Into Two Random Groups:

Group I: Patients for whom pharyngoplasty was done.

Group II: Patients for whom superiorly based pharyngeal flap was done.

In this study the postoperative evaluation was based on tape recording, statistical analysis for nasometric data and findings of flexible fiber optic nasopharyngoscopy.

Tape recording was categorized into three degrees; good, moderate and poor results.

Concerning group I, they were seven girls and four boys. Age of patients ranged between 7.5 years to 2.3 years with a mean age of 3 years and 9 months.

Preoperative findings according to videoendoscopy are shown in Table (1).

Table (1): Preoperative findings of videoendoscopy of group (I).

Category	No. of patients	Preoperative findings	Closure pattern
A	6	Short palate, good palatal movement, poor or limited lateral pharyngeal wall movement, $\pm$ posterior pharyngeal wall movement	Coronal
B	3	Good lateral pharyngeal wall movement, poor palatal elevation, $\pm$ posterior pharyngeal wall movement	Sagittal
C	1	Short palate, large VP gap, good palatal and lateral pharyngeal wall movement, $\pm$ posterior pharyngeal wall movement	Circular
D	1	Limited or poor movement of the palate and lateral and posterior pharyngeal walls	Circular

In this group, 3 patients had persistence of nasal tone postoperatively (two patients had marked improvement and one patient had minimal improvement), giving incidence of complications 27.3% (three patients out of 11). It is important to mention that; the three patients had poor palatal and lateral

pharyngeal wall movement on preoperative videoendoscopy. According to results of postoperative tape recording of this group, 8 patients were categorized as good results, two as moderate and one as poor result.

Concerning group II, they were 6 girls and 5 boys. Age of patients ranged between 6.7 years to 2.8 years with a mean age of 3 years and 5 months.

Preoperative findings according to videoendoscopy are shown in Table (2).

Table (2): Preoperative findings of videoendoscopy of group (II).

Category	No. of patients	Preoperative findings	Closure pattern
A	5	Short palate, good palatal movement, poor or limited lateral pharyngeal wall movement, $\pm$ posterior pharyngeal wall movement	Coronal
B	3	Good lateral pharyngeal wall movement, poor palatal elevation, $\pm$ posterior pharyngeal wall movement	Sagittal
C	1	Short palate, large VP gap, good palatal and lateral pharyngeal wall movement, $\pm$ posterior pharyngeal wall movement	Circular
D	2	Limited or poor movement of the palate and lateral and posterior pharyngeal walls	Circular

In this group, one patient was complicated by partial dehiscence and persistence of nasal tone postoperatively. Two patients had hyponasality, one of them developed sleep apnea. Incidence of complications in this group is 27.3% (three patients out of 11). It is important to mention that; the two patients who developed hyponasality had good palatal and lateral pharyngeal wall movement on preoperative videoendoscopy. According to results of postoperative tape recording in this group, 9 patients were categorized as good results, one as moderate and one as poor result.

Statistical analysis for nasometric data and postoperative percentage drop in nasometer both for oral and nasal sentences for groups I & II is shown in Table (3) and Figs. (6-9).

Table (3): Nasometric data and postoperative percentage drop in nasometer both for oral and nasal sentences for groups I & II.

	Group I	Group II
<i>Main differences:</i>		
Nasal	-27.47	-31.58
Oral	-30.92	-28.64
<i>Percentage drop:</i>		
Nasal	35.55%	42.61%
Oral	51.95%	49.11%

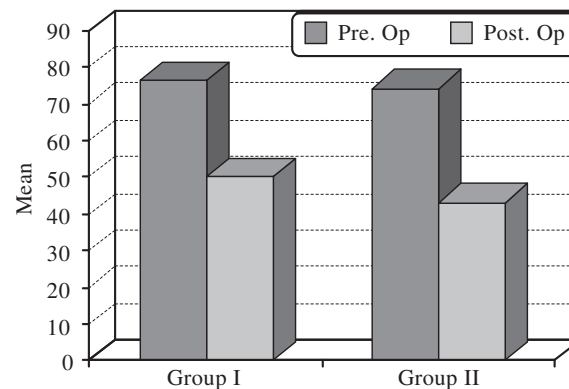


Fig. (6): Pre and postoperative nasometric data for nasal sentence for groups I & II.

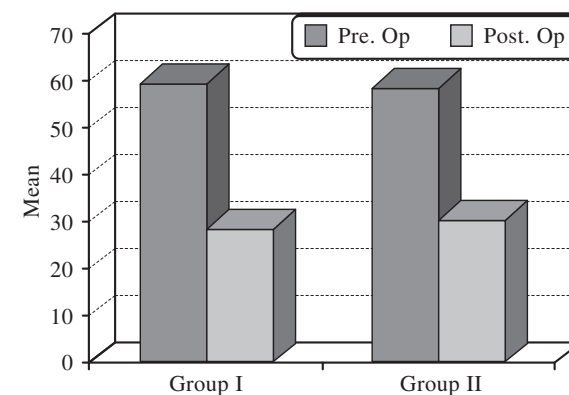


Fig. (7): Pre and postoperative nasometric data for oral sentence for groups I & II.

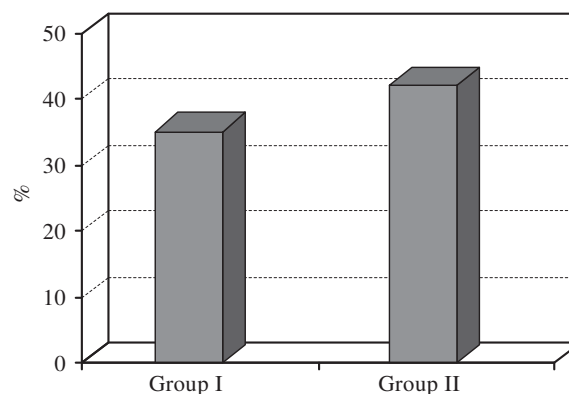


Fig. (8): Percentage drop in nasometer for nasal sentence for groups I & II.

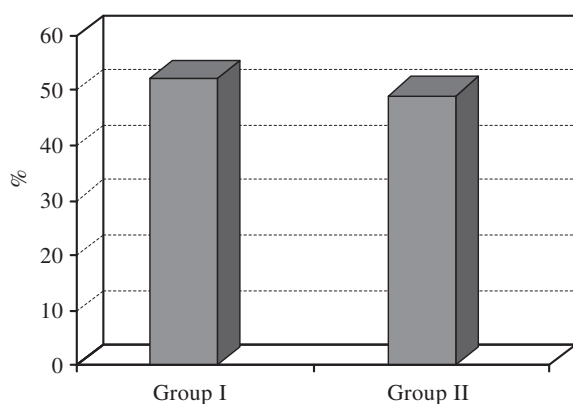


Fig. (9): Percentage drop in nasometer for oral sentence for groups I & II.

No major post-operative complications were encountered in both groups. There were no recorded cases of postoperative bleeding or pulmonary complications. Patients were discharged in the same night of operation (early in the study they were discharged 24 hours postoperatively).



Fig. (10): Postoperative videoendoscopy after sphincter pharyngoplasty showing complete closure of the VP sphincter.

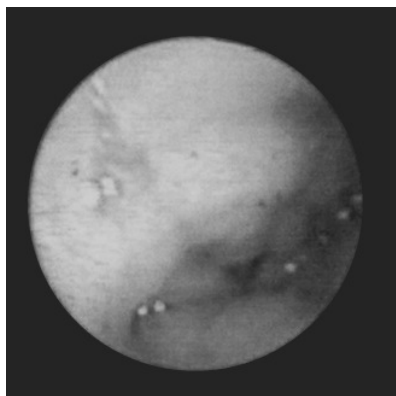


Fig. (11): Postoperative videoendoscopy after sphincter pharyngoplasty showing incomplete closure of the VP sphincter (Persistence of nasal tone with marked improvement).

DISCUSSION

Even in this modern era of palatal procedures that incorporate palatal lengthening and intravelar muscular repair, the incidence of VPI has been reported as high as 38% in some series [10].

A comprehensive assessment of velopharyngeal function involves both a perceptual speech and an instrumental evaluation. Treatment strategies based on only one of these assessments are prone to failure [11].

In this study assessment of velopharyngeal function was based on pre and postoperative findings of flexible fiber optic nasopharyngoscopy, nasometric evaluation and tap recording.

It is difficult to judge the degree of nasality by listening to speech. For this, nasometer is a useful device to comment upon the degree of velopharyngeal insufficiency and to compare between pre and postoperative nasalance to judge upon the improvement of the patients.

In ideal circumstances, the goal of surgical management is to eliminate the symptoms of hypernasality and audible nasal emission. The extent to which this goal is realized depends on an appreciation of the preoperative VP anatomy, physiology, and kinematics and the appropriateness of the pharyngoplasty that is performed [12].

Utilizing the superior constrictor muscle and mucosa from the posterior pharyngeal wall, a pedicled flap is created that inserts into the soft palate. This results in a permanent midline connection between the nasopharynx and oropharynx, which bisects the VP port into two lateral ports [13].

The intraoperative use of rubber catheters with known diameters and a wide pharyngeal flap is commonly used to create lateral ports that aim to maintain the delicate balance between naso-oropharyngeal patency and adequate VP function. Intraoperative "over tightening" of the port combined with scar contracture, however, runs the risk of nasal airway obstruction and sleep apnea. There is currently greater interest in individualizing flap width to the amount of lateral pharyngeal wall motion present rather than to a predetermined port size.

Studies have shown success rates for pharyngeal flap surgery of 80-90%. The classification success depends on the investigator. Certain studies classify patients with hypo nasality as success. Other studies classify post surgical hypo nasality as a failure. In

these studies, the success rate is somewhat lower [9]. In this study the success rate of superiorly based pharyngeal flap is 72.7%. In this study, if cases with post surgical hypo nasality were classified as success, the success rate of superiorly based pharyngeal flap will be 90.9%. This may explain the wide range of success rate in different series.

Pharyngeal flaps can be dangerous if performed in patients with unusually narrow upper airways. Patients requiring surgical VP management who have risk factors for upper airway obstruction are preferentially recommended for sphincter pharyngoplasty based on reports of its minimal effect on the airway [14,15].

Unlike the pharyngeal flap, the sphincter pharyngoplasty is a partial circumferential narrowing that occludes the lateral and posterior aspects of the velopharyngeal port but maintains the centric opening [16].

Sphincter pharyngoplasty has been associated with lower success rates of 40-60%. Jackson stated that the success rate can reach approximately 80% with appropriate patient selection [7].

In this study sphincter pharyngoplasty was performed for 11 patients, three patients out of 11 had persistence of nasal tone giving incidence of complications 27.3% and success rate 72.7%. It is important to mention that: the three patients had poor palatal and lateral pharyngeal wall movements on preoperative videoendoscopy.

In group II (patients for whom superiorly based pharyngeal flap) the two patients who developed hypo nasality had good palatal and lateral pharyngeal wall movements on preoperative videoendoscopy.

Taking in consideration the relatively small number of patients in this study, sphincter pharyngoplasty had better results in patients with good palatal and lateral pharyngeal wall movements on preoperative videoendoscopy. Also, superiorly based pharyngeal flap had better results in patients with poor palatal and lateral pharyngeal wall movements on preoperative videoendoscopy.

Conclusion:

Velopharyngeal insufficiency is a correctable condition in most instances if it has been carefully evaluated preoperatively and the appropriate surgical correction is performed successfully followed by speech therapy and follows up.

Both sphincter pharyngoplasty and superiorly based pharyngeal flap proved effective in treatment of velopharyngeal insufficiency with accepted incidence of complications.

Taking in consideration the relatively small number of patients in this study, sphincter pharyngoplasty had better results in patients with good palatal and lateral pharyngeal wall movements on preoperative videoendoscopy. Superiorly based pharyngeal flap had better results in patients with poor palatal and lateral pharyngeal wall movements on preoperative videoendoscopy.

The success rate of repair of VPI can be improved by selecting the most appropriate procedure based on the anatomy and movement of the VP port.

The greatest future challenge, therefore, is to develop and coordinate multicenter randomized controlled studies to evaluate treatment outcomes. This would aid greatly in producing a better match between differential diagnosis and differential management.

Additionally and Lastly: The comprehensive team approach gives the child cleft palate the greatest opportunity for best outcomes.

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