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Original article

The Effect of Pharyngeal Flap in Treatment of Post Adenoidectomy Velopharyngeal Insufficiency due to Submucous Cleft Palate

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Abstract:

Background: Validity of pharyngeal flap in the treatment of velopharyngeal insufficiency (VPI) due to submucous cleft palate. **Patient and methods:** This research has been performed on 18 children (12 males and 6 females, age range from 5-15 years old), who attended the otorhinolaryngology outpatient clinic, Benha University hospitals during the period from January 2023 to January 2024, after obtaining informed consent from their parents. The study has been permitted by the institutional research ethics committee Patients have been chosen from children who developed hypernasality after adenotonsillectomy due to the presence of submucous cleft. All patients underwent complete phoniatric assessment and treated them with posterior pharyngeal flap. **Results:** Males constituted 66.7% and the females constituted 33.3% and the mean age of adenoidectomy was 3.17 years. All patients complained of nasal tone of speech due to submucous cleft following adenoidectomy. There was significant improvement in the degree of closure of lateral pharyngeal wall and posterior pharyngeal walls of the velopharyngeal valve postoperatively, 2 weeks and 3 months following speech therapy. There was significant improvement in the results of all CSL measurements except for Fftr and DUV postoperatively, 2 weeks and 3 months following speech therapy. There was significant improvement in the results of all nasometry measurements postoperatively, 2 weeks and 3 months following speech therapy. **Conclusion:** pharyngeal flap has a significant effect in the management of hypernasal speech after adenotosillectomy due to submucous cleft and this effect is better when the surgery is followed by speech therapy for at least three months.

Key Words: Pharyngeal flap; submucus cleft; velopharyngeal insufficiency; nasometry; CSL.

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Introduction

Adenoidectomy is one of the most conducted surgeries in children. Nasal blockage, sleep-disordered breathing, and craniofacial/dental development anomalies are all common indications for adenoidectomy. VPI is a well-known side effect of adenoidectomy. The real incidence is difficult to a certain, however estimates range from one in 1500 to one in 10,000 [1].

Velopharyngeal dysfunction happens when there is insufficient closure of the velopharyngeal area while speaking or swallowing. This could lead to hypernasal speech, noticeable nasal air release, and/or the backflow of food or drink throughout swallowing. Velopharyngeal dysfunction might be categorized into three types: 1) velopharyngeal insufficiency (VPI) resulting from structural issues in the velopharyngeal valve (pharyngeal walls and soft palate), 2) velopharyngeal incompetence induced by neurological conditions, and 3) velopharyngeal mislearning resulting from improper component positioning during speech [2].

Proper velopharyngeal function is essential for effective speech progress. As a result, VPI has the potential to significantly impair a child's QOL **[3].** VPI patients have altered nasal resonance, resulting in a hypernasal voice tone. The production of pressure consonants is particularly affected. VPI mostly affects oral pressure consonants (p, b, t, d, k, g), fricatives (f, v, th, s, z, sh, zh), and affricates (ch, j). High intraoral pressure is necessary to pronounce oral consonants like "p" and "b" clearly. To make these sounds, close the velopharynx and avoid nasal air emissions [4].

The adenoid pad may naturally enhance the posterior pharyngeal wall. The adenoid pad reduces the distance required for velopharyngeal closure. The absence of adenoids might result in incomplete closure in the anterior-posterior dimension.

Adenoidectomy may cause or unveil underlying velopharyngeal insufficiency in at-risk cases, including those with a submucous cleft palate which is formed of the triad bifid uvula, zona pellucida, and notched hard palate **[5].** Adenoidectomy and other oropharyngeal surgeries can modify the pharyngeal muscles, resulting in velopharyngeal insufficiency or incompetence [6].

The pharyngeal flap serves as the main surgical solution for individuals who possess sufficient lateral pharyngeal wall motion nevertheless exhibit weak palatal motion, leading to a velopharyngeal gap. In 1876, Schoenborn 1st detailed the pharyngeal flap. He initially outlined an inferiorly based flap but subsequently modified the method to a superiorly based flap upon realizing that the inferiorly based flap is short and gradually causes the soft palate to be pulled downwards over time **[7]**. In 1930, Padgett popularized the posterior pharyngeal flap in the United States [8]. Also, 1979 pushed for a customized pharyngeal flap. The flap width has been adjusted by measuring the lateral pharyngeal wall movement before surgery using video fluoroscopy and nasopharyngoscopy [9]. In 2012 published a modification of the posterior pharyngeal flap to make the flap insect easier so incidence of complications in terms of OSA and disturbance in the physiology of the palate had been decreased [10].

For a century, the posterior pharyngeal flap was the preferred method for definitive VPI repair. However, issues and difficulties have arisen despite its success. Obstructive sleep apnea (OSA) is one of the most serious complications associated with posterior pharyngeal flap operation. Following posterior pharyngeal flap surgery, between 2% to 10% of patients may have OSA. Achieving a correct posterior pharyngeal flap might be challenging due to factors such as flap dehiscence, width, superior or inferior base, inset in transverse or longitudinal palatal incisions, and flap lining [11].

Patient and methods

This observational case series study was conducted on eighteen children (12 males and 6 females, aged between 5 and 15 years) who attended the Otorhinolaryngology Outpatient Clinic at Benha University Hospitals during the period from January 2023 to January 2024. Informed consent was obtained from the parents of all participants. The study was approved by the Institutional Research Ethics Committee (Approval code: R.C.44.11.2023). Patients were selected among children who developed hypernasality following adenotonsillectomy due to the presence of a submucous cleft. The exclusion criteria included children older than 15 years or those who did not have submucous cleft as a cause of hypernasality after adenotonsillectomy.

All patients under the study have been subjected to all the following: interview and history taking starting from personal history including (name, gender, age, residence, schooling, parent consanguinity and presence of similar conditions in the family). Developmental history and milestones of development. The onset, course and duration of the complaint Operative history includes the age, place of procedure and the effect of adenotonsillectomy.

Speech assessment:

Auditory perceptual analysis (APA of speech) commenting on the type and degree of nasality, how consonants were affected and the presence pf compensatory articulatory mechanisms, facial grimace, audible air.

Visual examination of the vocal tract by simple clinical tests for giving data on the condition of lips (intact or clefted and the type of cleft), dentition, Bite, Tongue, Hard and Soft palate, Uvula, signs of submucous cleft.

Nasopharyngoscopy: the cases have been examined utilizing the flexible nasopharyngeal video-fiberscope Storz 11101RPK2 connected to Storz video camera and digital recorder.

The velopharyngeal valve motion has been recorded whereas the case is repeating different speech sounds (consonants, vowels, phrases, oral and nasal sentences). Movements of the velum, posterior and lateral pharyngeal walls are tracked on the monitor [12]. Then patients VPI are classified into:

- Velopharyngeal insufficiency (VPI) grade I: Mild Velopharyngeal gap is seen during sustained phonation with active movement of velum and lateral walls give up to 75% valve closure is considered mild degree of VPI.
- Velopharyngeal insufficiency (VPI) grade II: Moderate gap is seen during sustained phonation with moderately active movement of velum and lateral walls gives up to 50% valve closure is considered moderate degree of VPI.
- Velopharyngeal insufficiency (VPI) grade III: Wide gap is seen during sustained phonation with sluggish movement of velum and lateral walls gives up to 25% 77 Subjects and Methods
- Valve closure is considered moderately severe degree of VPI.
- Velopharyngeal insufficiency (VPI) grade IV: during sustained phonation, velopharyngeal valve is at resting position, widely opened and no active movement of velum and lateral walls detected is considered severe degree of VPI.

Nasometry to measure the nasalance score which is the ratio of nasal/total energy. Scores were compared to normative data.

Acoustic analysis: Utilizing the Multi-dimensional Voice Program (MDVP) (KAY PENTAX Model 5105) of the Computerized Speech Lab (CSL) system, (Kay Elemetrics). The acoustic signals were recorded from each subject while sitting on an examination chair within a quiet room. A dynamic microphone (Shure Incorporated Evanston) model DM-510 AIWA IMP.600 was positioned 10 cm from the patient's lips. The distance

between the microphone and the lips in the recordings was short and the voice signals were clearly stronger compared to the background noise. The subject was instructed to elicit a sustained /a/ vowel and was recorded at a comfortable pitch and loudness with no vibrato (steady) for the longest possible period. The mid-vowel voicing sample was captured. The initial and final seconds of voice production were not involved in the information analysis to control for the potential voice onset-offset influences. Common acoustic measures were jitter, fundamental frequency, shimmer, and Harmonic to noise Ratio.

Two experienced phoniatricians performed all the measurements in a double-blind manner. The findings are approved if they are agreed by the two observers.

All these assessments were done preoperatively, 2 weeks after surgery and 3 months after surgery and speech therapy.

Operative technique:

All patients treated with superiorly based pharyngeal flaps following Emara modification [(10)].

The surgical field has been prepared and draped with intraoral povidone-iodine preparation. The soft palate and posterior pharyngeal wall were injected with 1:200,000 epinephrine and 0.25 percent Marcaine. A superiorly based posterior pharyngeal flap lifted off the buccopharyngeal fascia was used for flap harvest in the second phase after flap design **(Fig. 1).** The flap's breadth was adjusted to match the lateral pharyngeal walls' degree of mobility, which was previously shown via nasoendoscopy, by comparing the flap's length to the velum's anteroposterior diameter, the appropriate flap length was established. The flap was intended to be 1.5 times as long as the velum's anteroposterior diameter. This accomplishes the tension-free notion following flap inset. The third phase involved setting the flap through a full-thickness soft palate incision positioned one centimeter from the hard-soft palate junction. To reduce needless flap manipulation, a 3-0 Vicryl suture was inserted into the flap's free caudal end and guided through the palatal incision **(Fig.2).** To avoid mucosal trapping throughout flap inset into the palate, the distal mucosa was excised, leaving the flap's end free of any mucous membrane covering. To secure the flap to the palate, several sutures were taken **(Fig. 3).** A 4-0 Vicryl suture has been inserted through each corner of the palatal incision, subsequently through the flap's edge to secure its width and to modify the size and shape of the lateral ports. Sutures were then positioned at the cephalic edge of the palatal incision, passing through the palatal musculature and mucous membrane, subsequently through the flap and its covering mucous membrane. Care has been taken to avoid any of the covering mucous membrane of the flap to be entrapped inside the palate to avoid a mucosal-lined sinus, finally sutures have been situated at the caudal edge of the palatal incision going through its mucous membrane and palatal musculature then through the flap. The edges of the donor site of the posterior pharyngeal wall were left to heal with 2ry intention after adequate hemostasis.it is also advised not to make unnecessary cauterization to decrease postoperative pain and neck rigidity, at the end of the procedure, nasal endoscope was introduced to make sure the flap in place with sufficient nasopharyngeal lateral ports to prevent postoperative OSA**.**

In an intermediate care facility, patients were observed all night. For the first 24 hours, oral feeding was not allowed to reduce flap strain. Once oral intake was sufficient and nasal breathing was normal, cases have been released at the end of the first following operation day. One week, one month, and six months following surgery, following operation follow-up was conducted. Nasoendoscopy was used to assess flap integrity.

Statistical analysis of the data

Information has been fed to the computer and examined utilizing IBM SPSS software package version 20.0. **(**Armonk, NY: IBM Corp**)**. Categorical information has been represented as numbers and percentages. They were evaluated for normality by the Shapiro-Wilk test. Quantitative information has been expressed as range (minimum and maximum), mean, standard deviation and median - Friedman test for abnormally distributed quantitative parameters, to compare among above 2 periods or stages and Post Hoc Test (Dunn's) for pairwise comparisons. Significance of the gained outcomes has been judged at the five percent level.

Fig.1: Posterior pharyngeal wall flap elevation

Fig .2: Delivery of the flap through full thickness palatal incision

Fig.3: Flap inset and suturing to the soft palate.

Results:

The current research has been performed on 18 Egyptian children after informed consent taken from their parents. The men constituted 66.7 percent, and the women constituted 33.3 percent. The mean age of cases was 8.42 years, and the mean age of adenoidectomy was 3.17 years. All patients complained about the nasal tone of speech due to submucous cleft following adenoidectomy **(table 1).**

Comparison between the results of flexible nasopharyngolaryngoscopy in the three periods of examination: during swallowing the velopharyngeal valve (VPV) was competent in all patients (n=18). Regarding posterior pharyngeal wall closure, 50% of patients (n=9) were grade 1 and 50% were grade 2 (n=9) in the preoperative assessment while in the two weeks postoperative examination 33.3% (n=6) were grade 2 and 66.7% (n=12) were grade 3. All patients showed competent VPV (n-18) in the 3 months following surgery and speech therapy assessment. These results indicate significant improvement of the severity of closure of posterior pharyngeal wall in the three periods of examination. In the preoperative assessment of lateral pharyngeal wall closure 77.8 percent (number =14) were grade 1 while 22.2% (number =4) were grade 2. 2 weeks after surgery 33.3% (number =6) were grade 1 and 66.7% (number =12) were grade 2. In the 3 months after surgery and speech therapy assessment 66.7% (number =12) were grade 3 and 33.3% (number =6) were grade 4 with competent VPV. So, there was significant improvement in lateral pharyngeal wall closure between the preoperative assessment and the assessment after speech therapy along with significant improvement in the examination results in the two weeks and three months following surgery. All patients showed coronal closure of VPV **(table 2).**

Table (1): Distribution of the examined cases regarding demographic data (number = 18).

	No. (%)
Sex	
Male	12 (66.7%)
Female	6 (33.3%)
Age (years)	
Mean ± SD.	8.42 ± 1.32
Median (Min. – Max.)	8.75 (6 – 10)
Date of adenoidectomy (years)	
Mean ± SD.	3.17 ± 0.24
Median (Min. – Max.)	3 (3 – 3.50)
Complaint (Nasal tone**)**	18 (100.0%)
Oral Examination	
Sub mucous cleft	18 (100.0%)

SD: Standard deviation

Table (2): Comparison between the three periods regarding flexible fiberoptic nasoendoscopy (number = 18)

		Preoperative	2 weeks Postoperative	After speech therapy	Fr	P
Swallowing	1	0 (0.0%)	0 (0.0%)	0 (0.0%)	–	–
	2	0 (0.0%)	0 (0.0%)	0 (0.0%)		
	3	0 (0.0%)	0 (0.0%)	0 (0.0%)		
	4	18 (100.0%)	18 (100.0%)	18 (100.0%)		
Posterior pharyngeal wall	1	9 (50.0%)	0 (0.0%)	0 (0.0%)	35.086*	>0.001*
	2	9 (50.0%)	6 (33.3%)	0 (0.0%)		
	3	0 (0.0%)	12 (66.7%)	0 (0.0%)		
	4	0 (0.0%)	0 (0.0%)	18 (100.0%)		
Sig.bet. periods			p_1=0.008*, p_2>0.001*, p_3=0.002*			
lateral pharyngeal wall	1	14 (77.8%)	6 (33.3%)	0 (0.0%)	32.375*	>0.001*
	2	4 (22.2%)	12 (66.7%)	0 (0.0%)		
	3	0 (0.0%)	0 (0.0%)	12 (66.7%)	12.00*	0.002*
	4	0 (0.0%)	0 (0.0%)	6 (33.3%)		
Sig.bet. periods			p_1=0.182, p_2>0.001*, p_3>0.001*			
Pattern of closure (Coronal)		18 (100.0%)	18 (100.0%)	18 (100.0%)	–	–

Fr: **Friedman test**, Sig. bet. periods were done using **Post Hoc Test** (**Dunn's)** p: p value for comparing between the three periods.

p_1: p value for comparing between **Preoperative** and **2 weeks Postoperative.**

p_2: p value for comparing between **Preoperative** and **after speech therapy.**

p_3: p value for comparing between **2 weeks Postoperative** and **after speech therapy.**

*: Statistically significant at $p \leq 0.05$

Comparison between the results of acoustic analysis between the three periods of examination: The mean of fundamental frequency (F0) preoperatively was 294.1 with SD 26.1 while the mean F0 two weeks after surgery was 264.7 with SD 39.5.

The mean Fo three weeks following surgery was 227.4 with SD 45.2. The mean of mean fundamental frequency (MF0) were 293 with SD 26, 264.5 with SD 39.6 AND 227.4 SD 45.2 in preoperative, two weeks and three months postoperative, respectively. The average pitch period (AV pitch P) was 3.43 SD 0.29 preoperatively, 3.86 SD 0.53 2 weeks postoperative and 5 SD 1.38 three months after surgery. The mean of highest fundamental frequency (FHI) was 324.8 SD 35.7, 293.8 SD 35.5 and 232.4 SD 44.9 in the three periods assessment respectively while the lowest fundamental frequency (FLO) showed a mean of 271.2 SD 12.8, 233.7 SD 41.2 and 217 SD 41.8 during the assessment in the three periods respectively. The mean of slandered deviation of acoustic analysis (STD) preoperatively was 6.78 SD 2.4,

7.88 SD 0.88 two weeks postoperative and 3.29 SD 0.92 three months after surgery. The Peak Frequency ratio (PFR) was 4.33 SD 1.28, 5 SD 1.46 and 2.63 SD 0.29 in the three-period assessment, respectively. The means of Fast Fourier Transform (Fftr) in the preoperative assessment was 3.59 SD 1.4 while two weeks and three months postoperative were 3.15 SD 0.48 and 3.54 SD 0.33 correspondingly. The mean frequency of timbre space analyzer and mapper (TSAM) in the preoperative assessment was 3.75, 3.75 for the two weeks postoperative period and three weeks after surgery. The mean of Absolute jitter (Abs jitter) were 58.1 SD 32.9, 105.2 SD 26.8 and 49.9 SD 20 for the three periods respectively and the mean of jitter were 1.72 SD 0.96 for the first period and 2.86 SD 0.38 and 1.01 SD 0.09 for the second and third periods, respectively. The mean relative average perturbation (Rap) was 1.03 SD 0.58 in the preoperative assessment, 1.61 SD 0.22 in the assessment two weeks postoperative and 0.59 SD 0.01 for three months following surgery and speech therapy. The mean Period Perturbation Quotient (PPQ) in the first assessment was 1 SD 0.57 and it was 1.61 SD 0.25 for the second assessment and 0.49 SD 0.01 for the third assessment. The mean of smoothed pitch perturbation quotient (sPPQ) was 1.14 SD 0.46, 1.83 SD 0.43 and 0.68 SD 0.05 for the three assessments correspondingly. The means of Fundamental Frequency Variation (VF0) in the first period was 2.26 SD 0.6, in the second period was 3.05 SD 0.62 and for the third period was 1.73 SD 0.12. The mean for Shimmer was 2.96 SD 0.84, 4.25 SD 1.84 and 2.45 SD 0.59 for the three assessments, respectively. The means for amplitude of the perturbation quotient (APQ) and Smoothed amplitude of the perturbation quotient (SAPQ) were 2.05 SD 0.62, 3.14 ±SD1.50 and 1.88 SD 0.51 for APQ and 3.93 SD 1.71, 7.01 SD4.26 and 3.73 SD 0.46 for the three periods, respectively. The mean of Vibro- Acoustic Modulation (VAM) for preoperative assessment was 16.3 ± 6.62 and two weeks postoperative was 25.3 ± 6.13 while after three months was 12.3 ± 2.01. The mean harmonic to noise ratio (HNR) was 0.12 SD 0.01, 0.13 SD 0.01 and 0.11 for the three assessments, respectively. The mean of Voice Turbulence Index (VTI) was 0.05 SD 0.01 for preoperative assessment, 0.05 – 0.01 for two weeks after surgery and 0.51 SD 0.09 for three months after surgery. The mean for Soft Phonation Index (SPI) was 20.9 ±SD 2.45, 16.0 SD 5.78 and 9.99 SD 1.91 for the three assessments, respectively. The mean for frequency tremor intensity index (FTRI) for the first assessment was 0.44 SD 0.20 and 0.68 SD 0.35 and 0.42 SD 0.07 for the second and third assessments, respectively. The meaning of Degree of Voiceless (DUV) was 9.14 SD 13.3, 0.81 SD 1.17 and 0.29 SD 0.05 for the three assessments, respectively. From the above mentioned results we find that there was significant enhancement in the measurements of acoustics of voice except for Fftr and DUV between the preoperative assessment and the assessment after speech therapy along with significant improvement in the examination results in the two weeks and three months following surgery **(tables 3 & 4).**

Table (3): Comparison between the three periods as regards CSL (number = 18)

		Preoperative	2 weeks Postoperative	After speech therapy	Fr	P
CSL-F0	Mean ± SD.	294.1 ± 26.1	264.7 ± 39.5	227.4 ± 45.2	28.00*	>0.001*
	Median (Min – Max)	279.6(272.9 – 329.7)	244.7(231.0 – 318.4)	245.1(166.9 – 270.0)		
	Sig.bet. periods		p_1>0.001*, p_2>0.001*, p_3=0.317			
CSL-MF0	Mean ± SD.	293.9 ± 26	264.5 ± 39.6	227.4 ± 45.2	28.00*	>0.001*
	Median (Min – Max)	279.5(272.8 – 329.4)	244.5(230.6 – 318.3)	245.1(166.9 – 270.0)		
	Sig.bet. periods		p_1>0.001*, p_2>0.001*, p_3=0.317			
AV pitch p	Mean ± SD.	3.43 ± 0.29	3.86 ± 0.53	5 ± 1.38	36.00*	>0.001*
	Median (Min – Max)	3.58 (3.04 – 3.67)	4.09 (3.14 – 4.34)	4.09 (4 – 6.90)		
	Sig.bet. periods		p_1=0.003*, p_2>0.001*, p_3=0.003*			
FHI	Mean ± SD.	324.8 ± 35.7	293.8 ± 35.5	232.4 ± 44.9	36.00*	>0.001*
	Median (Min – Max)	306.3(294.8 – 373.5)	272.8(266.1 – 342.4)	254.7(171.4 – 271.0)		
	Sig.bet. periods		p_1=0.003*, p_2>0.001*, p_3=0.003*			
FLO	Mean ± SD.	271.2 ± 12.8	233.7 ± 41.2	217.2 ± 41.8	16.00*	>0.001*
	Median (Min – Max)	271.0(256.0 – 286.5)	222 (191.5 – 287.4)	230.6(162.1 – 258.9)		
	Sig.bet. periods		p_1=0.046*, p_2>0.001*, p_3=0.046*			
STD	Mean ± SD.	6.78 ± 2.40	7.88 ± 0.88	3.29 ± 0.92	28.00*	>0.001*
	Median (Min – Max)	5.84 (4.51 – 9.99)	7.80 (6.87 – 8.96)	3.65(2.05–4.17)		
	Sig.bet. periods		p_1=0.317p_2>0.001*, p_3>0.001*			
PFR	Mean ± SD.	4.33 ± 1.28	5 ± 1.46	2.63 ± 0.29	22.800*	>0.001*
	Median (Min – Max)	4 (3 – 6)	4 (4 – 7)	2.55 (2.33 – 3)		
	Sig.bet. periods		p_1=0.617, p_2>0.001*, p_3>0.001*			
Ff	Mean ± SD.	3.59 ± 1.40	3.15 ± 0.48	3.54 ± 0.33	4.00	0.135
	Median (Min – Max)	2.94 (2.35 – 5.48)	2.88 (2.76 – 3.81)	3.76 (3.09 – 3.78)		
Ts	Mean ± SD.	3.75 ± 0.0	3.75 ± 0.0	3 ± 0.0	36.00*	>0.001*
	Median (Min – Max)	3.75 (3.75 – 3.75)	3.75 (3.75 – 3.75)	3 (3 – 3)		
	Sig.bet. periods		p_1=1.000, p_2>0.001*, p_3>0.001*			
Abs Jitter	Mean ± SD.	58.1 ± 32.9	105.2 ± 26.8	49.9 ± 20.0		
	Median (Min – Max)	70.0 (14.4 – 90)	122.9 (68.4 – 124.4)	42.0 (30.9 – 76.6)	16.00*	>0.001*
	Sig.bet. periods		p_1=0.046*, p_2=0.046*, p_3>0.001*			
Jitter P	Mean ± SD.	1.72 ± 0.96	2.68 ± 0.38	1.01 ± 0.09	16.00*	>0.001*
	Median (Min – Max)	2.30 (0.40 –2.46)	2.83 (2.18 – 3.04)	1 (0.90 – 1.12)		
	Sig.bet. periods		p_1=0.046*, p_2=0.046*, p_3>0.001*			
RAP	Mean ± SD.	1.03 ± 0.58	1.61 ± 0.22	0.59 ± 0.01	16.00*	>0.001*
	Median (Min – Max)	1.41 (0.24 – 1.45)	1.69 (1.32 – 1.82)	0.59 (0.57 – 0.59)		
	Sig.bet. periods		p_1=0.046*, p_2=0.046*, p_3>0.001*			
PPQ	Mean ± SD.	1 – 0.57	1.61 ± 0.25	0.49 ± 0.01	16.00*	>0.001*
	Median (Min – Max)	1.32 (0.22 – 1.45)	1.77 (1.27 – 1.80)	0.48 (0.48 – 0.50)		
	Sig.bet. periods		p_1=0.046*, p_2=0.046*, p_3>0.001*			

Table (4): Comparison between the three periods as regards CSL (number = 18) "continue"

		Preoperative	2 weeks Postoperative	After speech therapy	Fr	P
SPPQ	Mean ± SD.	1.14 ± 0.46	1.83 ± 0.43	0.68 ± 0.05	16.00*	>0.001*
	Median (Min – Max)	1.41 (0.52 – 1.50)	1.93 (1.28 – 2.29)	0.69 (0.62 – 0.74)		
Sig.bet. periods			p_1=0.046*, p_2=0.046*, p_3>0.001*			
VF0	Mean ± SD.	2.26 ± 0.60	3.05 ± 0.62	1.73 ± 0.12	16.00*	>0.001*
	Median (Min – Max)	2.14 (1.61 – 3.03)	2.81 (2.45 – 3.88)	1.70 (1.60 – 1.89)		
Sig.bet. periods			p_1=0.046*, p_2=0.046*, p_3>0.001*			
SHdB	Mean ± SD.	0.26 ± 0.08	0.40 ± 0.17	0.24 – 0.06	16.00*	>0.001*
	Median (Min – Max)	0.24 (0.18 – 0.37)	0.38 (0.22 – 0.62)	0.20 (0.19 – 0.32)		
Sig.bet. periods			p_1=0.046*, p_2=0.046*, p_3>0.001*			
Shim	Mean ± SD.	2.96 ± 0.84	4.25 ± 1.84	2.45 ± 0.59	16.00*	>0.001*
	Median (Min – Max)	2.86 (2.01 – 4.01)	4.48 (1.96 – 6.32)	2.50 (1.71 – 3.13)		
Sig.bet. periods			p_1=0.046*, p_2=0.046*, p_3>0.001*			
APQ	Mean ± SD.	2.05 ± 0.62	3.14 ± 1.50	1.88 ± 0.51	16.00*	>0.001*
	Median (Min – Max)	1.87 (1.41 – 2.86)	3.17 (1.35 – 4.92)	1.77 (1.34 – 2.54)		
Sig.bet. periods			p1=0.046*, p2=0.046*, p3>0.001			
SAPQ	Mean ± SD.	3.93 ± 1.71	7.01 ± 4.26	3.73 ± 0.46	12.00*	0.002*
	Median (Min – Max)	3.10 (2.43 – 6.24)	5.10 (3.18 – 12.8)	3.96 (3.10 – 4.12)		
Sig.bet. periods			p1=0.003*, p2=1.000, p3=0.003*			
vAm	Mean ± SD.	16.3 ± 6.62	25.3 ± 6.13	12.3 ± 2.01	36.00*	>0.001*
	Median (Min – Max)	13.6 (10.1 – 25.1)	29.2 (16.9 – 29.8)	11.9 (10.1 – 14.8)		
Sig.bet. periods			p1=0.003*, p2=0.003*, p3>0.001*			
NHR	Mean ± SD.	0.12 ± 0.01	0.13 ± 0.01	0.11 – 0.0	9.818*	0.007*
	Median (Min – Max)	0.12 (0.10 – 0.13)	0.14 (0.11 – 0.14)	0.11 (0.11 – 0.12)		
Sig.bet. periods			p_1=0.134, p_2=0.134, p_3=0.003*			
VTI	Mean ± SD.	0.05 ± 0.01	0.05 – 0.01	0.51 ± 0.09	36.00*	>0.001*
	Median (Min – Max)	0.04 (0.03 – 0.07)	0.06 (0.04 – 0.07)	0.53 (0.39 – 0.61)		
Sig.bet. periods			p_1=0.003*, p_2>0.001*, p_3=0.003*			
SPI	Mean ± SD.	20.9 ± 2.45	16.0 ± 5.78	9.99 ± 1.91	28.00*	>0.001*
	Median (Min – Max)	22.4 (17.5 – 22.6)	19.1 (8.15 – 20.8)	10.7 (7.44 – 11.8)		
Sig.bet. periods			p_1=0.317p_2>0.001*, p_3>0.001*			
FTRI	Mean ± SD.	0.44 ± 0.20	0.68 ± 0.35	0.42 ± 0.07	16.00*	>0.001*
	Median (Min – Max)	0.34 (0.26 – 0.71)	0.46 (0.43 – 1.15)	0.44 (0.33 – 0.50)		
Sig.bet. periods			p_1=0.046*, p_2=0.046*p_3>0.001*			
DUV	Mean ± SD.	9.14 ± 13.3	0.81 ± 1.17	0.29 ± 0.05	4.800	0.091
	Median (Min – Max)	0.0 (0.0 – 27.4)	0.0 (0.0 – 2.42)	0.29 (0.22 – 0.35)		

Comparison between the results of nasometry between the three periods of assessments: As regard nasal sentence (nasal s) the mean nasalance score was 66.3 SD 10 for the preoperative assessment and 48.7 SD 8.5 and 44.7 SD 5.59 for the assessment two weeks and three months post operative respectively while the mean nasalance score for the oral sentence were 38.3 SD 33.9, 28 SD 14.2 and 11.3 SD 0.51 for the three assessments respectively showing significant improvement for the results between the preoperative assessment and

three months following surgery and speech surgery as well as the two weeks and three months postoperative. For the (T) sound the mean nasalance score was 48.3 SD 21.3, 34.7 SD 21.1 and 0.07 SD 0.1 for the three periods of assessments, respectively. As for the (D) sound the mean nasalance score was 47.7 SD 22.3 for preoperative assessment, 38.7 SD 16.7 two weeks after surgery and 0.02 SD 0.03 three weeks following surgery and speech surgery. The mean nasalance score for the (N) sound was 53 SD 19.1 preoperatively, 54.3 SD 6.79 two weeks postoperative and 86.3 SD 1.28 three months after surgery. As for the (M) sound the mean nasalance score was 55 SD 15.3, 63 SD 11.9 and 86 SD1.68. So, for the consonants sounds the nasalance score showed significant improvement for the results between the preoperative assessment and three months following surgery and speech surgery as well as the two weeks and three months postoperative. The mean nasalance score for (I) sound was 55.3 SD 17.8, 51 SD 7.7 and 17.3 SD 1.28 for the three assessments, respectively. The mean nasalance score for the (A) sound was 54.7 SD 19.5 for the preoperative assessment, 40.7 SD 24.1 two weeks after surgery and 8.33 SD 0.49 three months after surgery and speech therapy. Meanwhile the mean nasalance score for (U) was 53.3 SD 20.7, 41 SD 21 and 13 for the three assessments, respectively. So, for the vowels the nasalance score showed significant improvement for the results between the preoperative assessment and three months following surgery and speech surgery as well as the two weeks and three months postoperative**. (Table 5).**

Table (5): Comparison between the three periods according to nasometry (n = 18)

		Preoperative	**2 weeks Postoperative**	**After speech therapy**	**Fr**	**P**
Nasal.S	Mean ± SD.	66.3 ± 10.0	48.7 ± 8.50	44.7 ± 5.59	16.00*	>0.001*
	Median (Min – Max)	70 (53 – 76)	54 (37 – 55)	48 (37 – 49)		
	Sig.bet. periods		p_1=0.134, p_2>0.001*, p_3=0.003*			
Oral.S	Mean ± SD.	38.3 ± 22.9	28.3 ± 14.2	11.3 ± 0.51	12.00*	0.002*
	Median (Min – Max)	51 (7 – 57)	24 (14 – 47)	11 (10.9 – 12)		
	Sig.bet. periods		p_1=1.000, p_2=0.00*, pp_3=0.003*			
B	Mean ± SD.	49.3 ± 19.9	38 ± 17.4	0.03 ± 0.05	36.00*	>0.001*
	Median (Min – Max)	62 (22 – 64)	41 (16 – 57)	0 (0 – 0.10)		
	Sig.bet. periods		p_1=0.003*, p_2>0.001*, p_3=0.003*			
T	Mean ± SD.	48.3 ± 21.3	34.7 ± 21.1	0.07 ± 0.10	36.00*	>0.001*
	Median (Min – Max)	63 (19 – 63)	41 (7 – 56)	0 (0 – 0.20)		
	Sig.bet. periods		p_1=0.003*, p_2>0.001*, p_3=0.003*			
D	Mean ± SD.	47.7 ± 22.3	38.7 ± 16.7	0.02 ± 0.03	33.818*	>0.001*
	Median (Min – Max)	63 (17 – 63)	43 (17 – 56)	0 (0 – 0.06)		
	Sig.bet. periods		p_1=0.046*, p>0.001*, p_3>0.001*			
N	Mean ± SD.	53 ± 19.1	54.3 ± 6.79	86.3 ± 1.28	28.00*	>0.001*
	Median (Min – Max)	63 (27 – 69)	53 (47 – 63)	86 (85 – 88)		
	Sig.bet. periods		p_1=0.317, p_2>0.001*, p_3>0.001*			
M	Mean ± SD.	55 ± 15.3	63 ± 11.9	86 ± 1.68	28.00*	>0.001*
	Median (Min – Max)	64 (34 – 67)	61 (50 – 78)	86 (84 – 88)		
	Sig.bet. periods		p_1=0.317, p_2>0.001*, p_3>0.001*			
I	Mean ± SD.	55.3 ± 17.8	51 ± 7.70	17.3 ± 1.28	28.00*	>0.001*
	Median (Min – Max)	65 (31 – 70)	49 (43 – 61)	17 (16 – 19)		
	Sig.bet. periods		p_1=0.317, p_2>0.001*, p_3>0.001*			
A	Mean ± SD.	54.7 ± 19.5	40.7 ± 24.1	8.33 ± 0.49	33.818*	>0.001*
	Median (Min – Max)	66 (28 – 70)	52 (8 – 62)	8 (8 – 9)		
	Sig.bet. periods		p1>0.001*, p>0.001*, p3=0.046*			
U	Mean ± SD.	53.3 ± 20.7	41 ± 21.0	13 ± 0.0	33.818*	>0.001*
	Median (Min – Max)	66 (25 – 69)	49 (13 – 61)	13 (13 – 13)		
	Sig.bet. periods		p_1>0.001*, p>0.001*, p_3=0.046*			

Discussion:

Submucous cleft is one of the commonest etiologies of hypernasality following adenotonsillectomy. The effect of submucous cleft most probably obscured by the hypertrophied adenoid which aids in closure of the velopharyngeal valve. Pharyngeal flaps are one of the most popular operations in the treatment of velopharyngeal incompetence. This investigation aimed to use pharyngeal flaps in the management of hypernasal speech after adenotonsillectomy due to submucous cleft.

The objective of VPI operation is to reduce hypernasality symptoms and audible nasal emission without completely obstructing the velopharynx, permitting nasal breathing and resonance. For the past 30 years, the pharyngeal flap was the most prevalent procedure for secondary repair of velopharyngeal dysfunction. Despite the posterior pharyngeal flap's high success rate, various difficulties have emerged, and numerous changes were proposed to address these issues. Numerous factors correlated with the posterior pharyngeal flap have caused a lot of discussion, involving inferior or superior flap design, flap lining, breadth of the flap, and inset of the flap either through a transverse or longitudinal palate incision **(13)**.

This study aims to use pharyngeal flaps in the management of hypernasal speech after adenotonsillectomy due to submucous cleft and study the effect of speech therapy following the pharyngeal flap operation to enhance the QOL of those cases. Up to our knowledge this research is among the first to emphasize the role of pharyngeal flap operation in the treatment of submucous cleft following adenotonsillectomy and the necessity to follow the surgery by speech therapy sessions to reach the best outcome for the case quality of life.

In our study there is significant improvement in the closure of velopharyngeal valve regarding posterior pharyngeal wall and lateral pharyngeal walls after pharyngeal flap and this can be explained by the contribution of the flap in the approximation of velopharyngeal port walls helping in its closure. This closure was noticed to be more efficient after speech therapy because all patients learned how to direct the airflow through the mouth during speech.

It was found in this study that there is improvement in the acoustic analysis of the voice signal of the patients following the pharyngeal flap and this improvement was more significant following speech therapy and this could be clarified by the role of speech therapy in correction of the airflow direction in various consonants and vowels thus approximating their voice signal to normal range.

This study showed reduction (improvement) of nasal airflow for various consonants, vowels, oral and nasal sentence following the operation and the improvement was more significant following speech therapy because the aim of speech treatment was to teach the case how to redirect the airflow through the mouth during oral consonants and vowels so the nasal cavity didn’t contribute in the pronunciations.

There are few studies that managed the effect of pharyngeal flaps in the treatment of hypernasality after adenotosillectomy due to submucous cleft but there were studies that showed the efficacy of pharyngeal flaps in the management of hypernasal speech, and their results were like our study. Some of these studies are Emara et al, 2012 [(10)], Amer et al, 2022 [(40)], Sullivan et al, 2010 [(15)] and Abdel-Aziz, et al 2009 [(16)].

OSA is one of the most commonly reported complication in this technique which we didn’t meet such complication in our study because harvest of the flap is tailored preoperatively by using flexible fiberoptic naso endoscopy and also checked intraoperative to make sure every lateral port around the flap is sufficient for

air flow and inset of the flap is central neither of our cases developed flap dehiscence [17- 19].

Shorter period of the study and fewer number of cases are considered the main limitations in this study.

In conclusion, pharyngeal flaps have a profound effect in the management of hypernasal speech after adenotosillectomy due to submucous cleft and this effect is better when the surgery is followed by speech therapy for at least three months. This technique allows every child to avoid any embarrassment due to hypernasality so it will be reflected on the social health of the child and psychological state, but we must confess that bigger sample size and longer monitoring period is required for better outcome assessment.

Every procedure used in research involving human subjects complied with the Benha Research Committee's ethical guidelines, the 1964 Helsinki Declaration and its subsequent revisions, or similar ethical guidelines. Every individual participant in the study gave their informed consent.

In this research, the authors declare that they have no conflicts of interest.

Conclusion

Pharyngeal flaps have a pronounced effect in the management of hypernasal speech after adenotosillectomy due to submucous cleft and this effect is better when the surgery is followed by speech therapy for at least three months.

Conflict of interest

None declared any conflict of interest.

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