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Effect of Adenotonsillectomy on Velopharyngeal Closure Patterns

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ABSTRACT

Background: For a long time, the hypertrophied tonsils impact on velopharyngeal closure has been a point of concern.

Objectives: To identify the alterations in the velopharyngeal valve (VPV) closure patterns following adenotonsillectomy in Arabic-speaking children, to predict the incidence of complications as nasal regurgitation or open nasality.

Patients and methods: This observational prospective research was performed on 100 patients, with hypertrophied adenoid and tonsils, who were collected from outpatient clinic of Benha University Hospitals. All cases underwent preoperative laboratory investigations, otorhinolaryngology examination and video-nasoendoscopy and speech assessment before and after adenotonsillectomy.

Results: The VP closure pattern was insignificantly different between both groups. However, the Nasality was significantly different among the 3 studied periods (P<0.001). There was no relation between gender and VP closure pattern preoperatively and 1 month after surgery. Regarding the postoperative nasality (hypernasality), the most prevalent observed VP closure patterns were both coronal and circular ones.

Conclusions: The coronal pattern of closure of the VPV is the most prevalent type, which remains even postoperatively, also the type of closure has no significant value in predicting outcoming hypernasality.

Keywords: Adenotonsillectomy, Tonsillar hypertrophy, Velopharyngeal valve, Velopharyngeal closure patterns**.**

INTRODUCTION

A muscular valve known as the velopharyngeal valve (VPV) isolates the oropharynx from the nasopharynx. It is anteriorly composed of the soft palate (velum), posteriorly situated to the posterior pharyngeal wall, and bounded by the lateral pharyngeal walls on both sides. By maintaining a tight barrier between the pharyngeal walls and velum, the VPV primarily separates the oral cavity from the nasal cavity for pneumatic aims during speech and non-pneumatic reasons such as swallowing [1].

Appropriate speech articulation requires an intact dynamic contact between the palatal and pharyngeal wall muscles; the neural pathway regulates this interaction and the VPV. Under varying pressures, the VPV is primarily responsible for regulation of the acoustic energy and airflow via the oral and nasal canals. During nasal sounds (m, n, ng) production, air transmission is permitted through the VPV. However, when oral sounds (all vowels and remaining consonants) are produced, the VPV becomes closed, allowing air to exclusively pass through the mouth cavity [2].

In normal cases, among the various VPV closure patterns, 3 fundamental forms had been identified including coronal, sagittal and circular (with or without Passavant's ridge) [3]. Although, whether coronal or circular VPV closures are more prevalent, continues to be a contentious issue [4].

Tonsils or adenoids' hypertrophy may cause hyponasal resonance; therefore, adenotonsillectomy is appropriate when this condition impairs speech intelligibility [5].

On the contrary, it has been documented that adenotonsillectomy can result in velopharyngeal insufficiency (VPI) and hypernasality [6].

Speech intelligibility is typically impaired when the velopharynx is obstructed by the superior pole of hypertrophied tonsils. This condition is typically ameliorated through tonsillectomy, although there are few cases where speech therapy is necessary to resolve VPI, as documented in numerous studies [7].

Key Messages:

Due to the significant importance of the velopharyngeal valve, the velopharyngeal closure patterns reman a point of interest for long time. The coronal pattern of closure of the VPV is the most prevalent type, however type of closure has no significant value in predicting outcoming hypernasality.

We aimed to identify the alterations in the VPV closure patterns following adenotonsillectomy in Arabic-speaking children, therefore, prediction of individuals who were at risk for incidence of complications as nasal regurgitation or open nasality.

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SUBJECTS AND METHODS

This observational prospective research was performed on 100 patients, with hypertrophied adenoid and tonsils and were scheduled for adenotonsillectomy, who were collected from outpatient clinic of Benha University Hospitals for one year (August 2022 till August 2023).

The inclusion criteria were patients aged between 4-15 years old, of both sexes, and with adenoid and/or hypertrophied tonsils.

The exclusion criteria was cases with craniofacial anomalies, submucous cleft palate, cleft palate, with history of nasal and/or oropharyngeal surgery and history of palatal or pharyngeal injury.

All patients underwent complete history taking, preoperative laboratory investigations including complete blood count (CBC), serum creatinine, aspartate transferase (AST), alanine transferase (ALT), prothrombin time, activated partial thromboplastin time, and erythrocyte sedimentation rate (ESR) and general and otorhinolaryngology investigations. Phoniatric examination and speech sample recording to assess the presence or absence of nasality and its grade and then video nasoendoscopy was performed using Flexible Fiberoptic Nasopharyngoscope (Storz Medical, 11101RPK2, Germany) the pattern of closure of VPV was recorded during swallowing and then during repeating different speech samples. The assessment was performed prior to and after adenotonsillectomy.

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

All patients underwent adenotonsillectomy. The procedure started with adenoidectomy using adenoid curette then adenoid pack for 10 minutes, followed by bilateral tonsillectomy using cold dissection technique.

Ethical approval:

This protocol was granted approved by Benha University's Medical Ethical Committee. The procedure was performed to patients after taking written informed consent from their caregivers who were informed of the surgical outcome and were afforded the autonomy to decide whether or not to partake in the study or to discontinue at any time, without incurring any consequences for the treatment of the patients or affecting the relationship with their healthcare providers. They were informed about every step of our procedure. The Helsinki Declaration was followed throughout the study's conduct.

Statistical analysis

The IBM SPSS software package version 20.0 (New York: IBM Corp., Armonk) was utilized to analyze the data. Mean ± standard deviation (SD), range or median and interquartile range (IQR) were utilized for representing the quantitative data. Frequency (%) was used for representing the categorical data, that was analysed and compared using chi-square test, whereas, when over 20% of cells have an anticipated count below 5, Monte Carlo adjustment was used.

To determine the relative significance of each step, the marginal homogeneity test was utilized. One way ANOVA test was employed to compare quantitative variables that followed a normal distribution across more than two time periods. On the other hand, variables exhibiting an aberrant distribution were identified using the Friedman test. P value <0.05 was considered significant.

RESULTS

There was a male predominance in our study, with mean age of 7.19 ± 2.17 years (Table 1).

Table (1): Distribution of the studied cases according to demographic data (n = 100)

	No.	%
Gender		
Male	57	57.0
Female	43	43.0
Age		
Min. – Max.	4.0 – 15.0	
Mean ± SD.	7.19 ± 2.17	
Median (IQR)	7.0 (6.0 – 8.0)	

IQR: Inter quartile range, SD: Standard deviation.

The two studied periods exhibited comparable VP closure pattern (Table 2).

Table (2): Comparison between the two studied periods according to VP closure pattern

VP closure pattern	Preoperative		1 month		MH	p
	No.	%	No.	%		
Coronal	52	52.0	65	65.0		
Circular	43	43.0	23	23.0		
Sagittal	3	3.0	5	5.0	39.50	0.866
Pass. Ridge	2	2.0	7	7.0		

MH: Marginal Homogeneity Test

There was a significant difference among the 3 studied periods regarding the nasality (Table 3).

Table (3): Comparison between the three studied periods according to Nasality

Nasality	Preoperative		1 month		3 months		Fr	p
	No.	%	No.	%	No.	%		
Hypo-nasality	84	84.0	0	0.0	0	0.0		
Normal	16	16.0	69	69.0	95	95.0	160.643	<0.001*
Hyper-nasality	0	0.0	31	31.0	5	5.0		

Fr: Friedman test, *: Statistically significant.

There was no relation between gender and VP closure pattern preoperative and 1 month after surgery (Table 4).

Table (4): Relation between Gender and VP closure pattern

VP closure pattern	Gender				χ^2	^{MC}p
	Male (n = 57)		Female (n = 43)			
	No.	%	No.	%		
Preoperative						
Coronal	27	47.4	25	58.1	1.636	0.720
Circular	27	47.4	16	37.2		
Sagittal	2	3.5	1	2.3		
Pass. Ridge	1	1.8	1	2.3		
1 month						
Coronal	35	61.4	30	69.8	1.048	0.854
Circular	14	24.6	9	20.9		
Sagittal	3	5.3	2	4.7		
Pass. Ridge	5	8.8	2	4.7		

χ^2: Chi square test, MC: Monte Carlo.

There was no relation between age and VP closure pattern preoperatively and 1 month after surgery (Table 5).

Table (5): Relation between VP closure pattern and age (n = 100)

	N	Age			F	p
		Min. – Max.	Mean ± SD.	Median		
Preoperative						
Coronal	**52**	5.0 – 14.0	7.21 ± 2.31	6.50	1.682	0.176
Circular	**43**	4.0 – 15.0	7.02 ± 1.99	7.0		
Sagittal	**3**	6.0 – 8.0	7.0 ± 1.0	7.0		
Pass. Ridge	**2**	10.0 – 11.0	10.50 ± 0.71	10.50		
1 month						
Coronal	**65**	5.0 – 14.0	7.28 ± 2.18	7.0	1.633	0.187
Circular	**23**	5.0 – 15.0	6.70 ± 2.10	6.0		
Sagittal	**5**	5.0 – 8.0	6.40 ± 1.14	6.0		
Pass. Ridge	**7**	4.0 – 11.0	8.57 ± 2.51	9.0		

F: One way ANOVA test.

Coronal and circular VP closure patterns were the most commonly observed pattern in postoperative Nasality (Hypernasality) (Table 6).

Table (6): Distribution of the studied cases according to preoperative VP closure pattern and postoperative nasality (Hypernasality)

Preoperative VP closure pattern		Nasality (Hypernasality)			
		1 month		3 months	
	No.	No.	%	No.	%
Coronal	52	15	48.4	2	40.0
Circular	43	15	48.4	3	60.0
Sagittal	3	0	0.0	0	0.0
Pass. Ridge	2	1	3.2	0	0.0
Total	**100**	**31**	**100.0**	**5**	**100.0**

DISCUSSION

Children frequently develop chronic hypertrophic tonsillitis; hence, tonsillectomy is a commonly performed surgical operation among young children [7].

There are certain consequences for the hypertrophied tonsils including hyponasal resonance, cul-de-sac resonance and sometimes or less commonly they cause hypernasality due to VPV closure impairment. As well as affecting the degree of VPV closure, hypertrophied tonsils may also alter the pattern of closure, according to previous reports [8].

We aimed to identify the alterations in the VPV closure patterns in Arabic-speaking children following adenotonsillectomy, therefore, prediction of individuals who were at risk for incidence of complications as nasal regurgitation or open nasality. In the current study, 52% of children had preoperative coronal closure pattern, this finding increased to 65% postoperatively.

The preoperative circular closure pattern was reported in 43% but decreased to 23% postoperatively. The preoperative circular with Passavant's ridge closure pattern was reported in 2 % then increased up to 7% postoperatively and the preoperative sagittal closure pattern was reported in 3% then increased to 5% postoperatively. The postoperative stability of the coronal pattern of closure stands as the most significant finding of this research, in contrast to other closure patterns which were changed in some cases after adenotonsillectomy.

This was in accordance with a study by **Witzel *et al.*** [9] who demonstrated that the most common pattern seen was coronal closure, which accounted for 68% of cases, followed by circular closure in 23% of cases, circular with a Passavant's ridge in 5% of cases, and sagittal closure at last in 4 %.

Also a study by **El-Anwar *et al.*** [10] revealed that coronal closure was observed in 50.5% of children, and circular pattern was observed in 49.5% of children. The remaining two types of closure (circular with Passavant's ridge and sagittal closure) were not reported in their study. On the contrary, circular closure was the most prevalent type reported by **Manochiopinig *et al.*** [4]. As regard nasality in this study, hyponasality was found in 84% of children with hypertrophied adenoid and tonsils, one month postoperatively there was 69% of the children with normal nasality and 31% with hypernasality which reduced to 5% after 3 months follow up. This means that temporary hypernasality is a well-known complication following adenotonsillectomy which improves gradually.

In a study included 137 cases presented with persistent hypernasality following adenoidectomy, **Witzel *et al.*** [9] found that more than 30% of the cases possessed preoperative risk factors, involving clefting, family history of VPI, fluid regurgitation through the nose or submucous cleft palate. To correct hypernasality, 37% of their cases needed speech therapy alone, 50% needed pharyngoplasty, while 13% improved without treatment.

Fernandes *et al.* [11] included 15 cases that developed post-adenoidectomy VPI in their research, and revealed that around 50% of the cases responded favorably to conservative management, while the remaining cases required surgical intervention.

Additionally, **Donnelly** [12] demonstrated that surgical approach may be required in as little as 50% of cases, although through 1-year follow-up, spontaneous improvement is anticipated, and speech therapy may be beneficial. In a study by **Saunders *et al.*** [13] normal or near-normal speech was achieved in 13 out of 15 patients who underwent post-adenoidectomy VPI, and a combination of speech therapy and surgery were recommended. In their study of 42 patients with persistent post adenoidectomy hypernasality, **Stewart *et al.*** [14] determined that in 6 cases, no treatment was necessary, 13 cases responded to speech therapy, and 23 cases necessitated surgical approach.

An expanded follow-up period and a larger sample size are necessary for evaluation of the impact of adenotonsillectomy on the pattern of VPV closure and its subsequent effects on nasality.

CONCLUSION

The coronal pattern of closure of the VPV is the most prevalent type, which remains even postoperatively after adenotonsillectomy, also the type of closure has no significant value in predicting outcoming hypernasality.

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REFERENCES

1. **Perry J (2011):** Anatomy and physiology of the velopharyngeal mechanism. Semin Speech Lang., 32: 83-92.
2. **Johns D, Rohrich R, Awada M (2003):** Velopharyngeal incompetence: a guide for clinical evaluation. Plast Reconstr Surg., 112:1890-7.
3. **Karnell M, Linville R, Edwards B (1988):** Variations in velar position over time: a nasal videoendoscopic study. J Speech Hear Res., 31:417-24.
4. **Manochiopinig S, Chuangsuwanich A, Taweepraditpol S (2005):** The nasoendoscopy study of velopharyngeal closure patterns in normal Thai volunteers. Siriraj Med J., 57:118-21.
5. **Mora R, Jankowska B, Mora F *et al.* (2009):** Effects of tonsillectomy on speech and voice. J Voice, 23:614-18.
6. **Kummer A, Billmire D, Myer C (1993):** Hypertrophic tonsils: the effect on resonance and velopharyngeal closure. Plast Reconstr Surg., 91:608-12.
7. **Mitchell R, Archer S, Ishman S *et al.* (2019):** Clinical practice guideline: Tonsillectomy in children. Otolaryngol Head Neck Surg., 160:1-42.
8. **Abdel-Aziz M, El-Fouly M, Nassar A *et al.* (2019):** The effect of hypertrophied tonsils on the velopharyngeal function in children with normal palate. Int J Pediatr Otorhinolaryngol., 119: 59-62.
9. **Witzel M, Rich R, Margar-Bacal F *et al.* (1986):** Velopharyngeal insufficiency after adenoidectomy: an 8-year review. Int J Pediatr Otorhinolaryngol., 11: 15-20.
10. **El-Anwar M, El-Sheikh E, El-Nakeb N (2018):** Patterns and grade of velopharyngeal closure in candidates for adenotonsillectomy. Iran J Otorhinolaryngol., 30:27-34.
11. **Fernandes D, Grobbelaar A, Hudson D *et al.* (1996):** Velopharyngeal incompetence after adenotonsillectomy in non-cleft patients. Br J Oral Maxillofac Surg., 34:364-7.
12. **Donnelly M (1994):** Hypernasality following adenoid removal. Ir J Med Sci., 163: 225-7.
13. **Saunders N, Hartley B, Sell D *et al.* (2004):** Velopharyngeal insufficiency following adenoidectomy 1. Clin Otolaryngol Allied Sci., 29: 686-8.
14. **Stewart K, Ahmad T, Watson A *et al.* (2002):** Altered speech following adenoidectomy: a 20 year experience. Br J Plast Surg., 55:469-73.