

## Original Article

## Effect of tonsillar hypertrophy on velopharyngeal closure and resonance of speech

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### ABSTRACT

**Background:** The effect of hypertrophied tonsils on velopharyngeal closure and resonance of speech has been a matter of controversy for a long time.

**Objective:** The aim of this work is to investigate the effect of tonsillar hypertrophy on the pattern and degree of closure of the velopharyngeal valve and resonance of speech.

**Methodology:** A hundred child, in the age range of 4 to 10 years, with tonsillar hypertrophy (grade 3 or 4), with average intelligence, normal hearing, and intact structure of the velopharyngeal valve have been assessed by nasoendoscopy and nasometry. All patients have been reevaluated 3 months after tonsillectomy.

**Results:** Seventy-two patients (72%) showed coronal pattern of closure and twenty-eight (28%) showed circular pattern of closure. The degree of closure was II/IV in 7 patients (7%) and III/IV in 93 patients (93%). The mean nasalance score of the nasal sentence and oral sentence was 57.48% and 16.17% respectively. In the postoperative evaluation 83 children exhibited a coronal pattern and 17 children showed a circular pattern. The closure was competent in 96 children and was III/IV in 4 children, with significant reduction of the nasalance score postoperatively.

**Conclusion:** Hypertrophied tonsils may affect the pattern and degree of velopharyngeal closure and subsequently resonance of speech even in children with normal palate.

*JRAM 2020; 1(2): 90-95*

**Keywords:** Nasalance scores, speech resonance, tonsillar hypertrophy, velopharyngeal valve

**Submission Date:** 23 January 2020

**Acceptance Date:** 21 March 2020

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**Please cite this article as:** Mostafa SY, Ibrahim HA, and Sallam YA. Effect of tonsillar hypertrophy on velopharyngeal closure and resonance of speech. *JRAM 2020; 1(2): 90-95*. DOI: 10.21608/jram.2020.22154.1032

### INTRODUCTION

Chronic hypertrophic tonsillitis is common among children, and therefore tonsillectomy is one of the most common surgical procedures in young children<sup>[1]</sup>. Palatine tonsils are immunologically active lymphoid tissue situated between the palatoglossal and palatopharyngeal arches<sup>[2]</sup>. The palatopharyngeal arches form the lateral boundaries of the pharyngeal isthmus (velopharyngeal valve), which is bounded anteriorly by the velum and posteriorly the posterior pharyngeal wall<sup>[3]</sup>. The dynamic interaction between these structures serves to seal the velopharyngeal valve either during speech or non-speech activities<sup>[4]</sup>. The primary laryngeal sound, once emitted at the level of the vocal folds, receives its resonance characters in the supralaryngeal

part of the vocal tract during its articulation to form the speech sounds<sup>[5]</sup>. The velopharyngeal valve controls the nasal resonance. It closes to build an intra-oral pressure for the production of oral sound and opens to allow the passage of air through the nose during the production of nasal sounds<sup>[6]</sup>. Closure of the velopharyngeal valve may take one of four patterns; coronal, sagittal, circular, or circular closure with Passavant's ridge. The degrees of closure of velopharyngeal valve range from I/IV to IV/IV, were I-II/IV mean that the valve is incompetent, III/IV means that the valve is approximately competent, whereas IV/IV means complete closure of the velopharyngeal valve<sup>[7,8]</sup>. Passavant's ridge is a mucosal

bulge located in the posterior pharyngeal wall opposite to the velum [9].

Hypertrophied tonsils may impair the closure of the velopharyngeal valve causing hypernasality [10] or less commonly, cul-de-sac resonance [11]. Hypertrophied tonsils do not only affect the degree of closure of the velopharyngeal valve, it has been reported that the pattern of closure may be affected as well [3]. The aim of this work is to investigate the effect of hypertrophied tonsils on the velopharyngeal valve, regarding its pattern and degree of closure, and on the resonance of speech in children with structurally intact velopharyngeal valve.

**SUBJECTS AND METHODS**

This observational prospective study has been conducted on 100 children in the age range of 4-10 years, suffering from chronic hypertrophic tonsillitis.

Inclusion criteria: Children with grade 3-4 chronic hypertrophic tonsillitis according to Ng et al. [12] grading scale of tonsillar hypertrophy, normal hearing, average or below average intelligence, and intact structure of the velopharyngeal valve were included in the study.

Exclusion criteria: All patients with acute tonsillitis, structural or functional velopharyngeal insufficiency (due to hearing impairment or mental retardation), or patients with adenoid enlargement more than grade II were excluded from the study. Adenoid assessment was done according to Yaseen et al. [13].

All patients have been subjected to otolaryngological examination and phoniatric evaluation followed by audiological evaluation, psychometry, plain X ray lateral view nasopharynx, nasoendoscopy, and nasometry. Nasometric evaluation included analysis of both oral sentence (ʕæli raħ jelʕæb korah) and nasal sentence (mama betnajim mænæ).

All patients have underwent tonsillectomy by dissection without adenoidectomy, and have been reevaluated 3 months later, using nasoendoscopy and nasometry. Statistical analysis was done using the Statistical Package of Social Science version 20.

The study was approved by ethical committee of faculty of medicine for girls, Al-Azhar University Cairo, Egypt.

**RESULTS**

This study has been conducted on 100 children in the age range of 4-10 years, mean age 7±2.5 years. Fifty-seven (57%) were males and 43 (43%) were females, with normal hearing, average intelligence, and adenoid enlargement less than grade II.

Nasoendoscopic evaluation of the velopharyngeal valve showed that 72 (72%) children had coronal pattern of closure and 28 (28%) children showed circular pattern of closure, in the preoperative evaluation. The degree of closure of the velopharyngeal valve was II/IV in 7 (7%) children (3 with coronal pattern of closure and 4 with circular pattern) and III/IV in 93 (93%) children (69 children with coronal closure and 24 children with circular closure). Three months after tonsillectomy, 83 (83%) children showed coronal pattern and 17 (17%) children showed circular pattern. Closure was competent (IV/IV) in 96 (96%) children and was III/IV in 4 (4%) children only (3 with coronal pattern of closure and 1 with circular pattern of closure) (table 1) (figures 1&2). Nasometric evaluation revealed mild hypernasalnce; the mean nasalance score of the nasal sentence was 57.48 (table 2) and the mean nasalance of the oral sentence was 16.17 (table 3). In the post-operative evaluation, the mean nasalance of the nasal sentence was 55.11 (table 2) and the mean nasalance of the oral sentence was 12.76 (table3). P value was 0.013 and 0.003 for the nasal and oral sentences respectively (tables 2&3).

**Table (1): Nasoendoscopic evaluation**

Closure pattern	Preoperative			Postoperative		
	Frequency	Closure degree		Frequency	Closure degree	
Coronal	72	II/IV	3	83	III/IV	3
		III/IV	69		IV/IV	80
Circular	28	II/IV	4	17	III/IV	1
		III/IV	24		IV/IV	16
<b>Total</b>	<b>100</b>		<b>100</b>	<b>100</b>		<b>100</b>

**Table (2): Nasalance score of the nasal sentence**

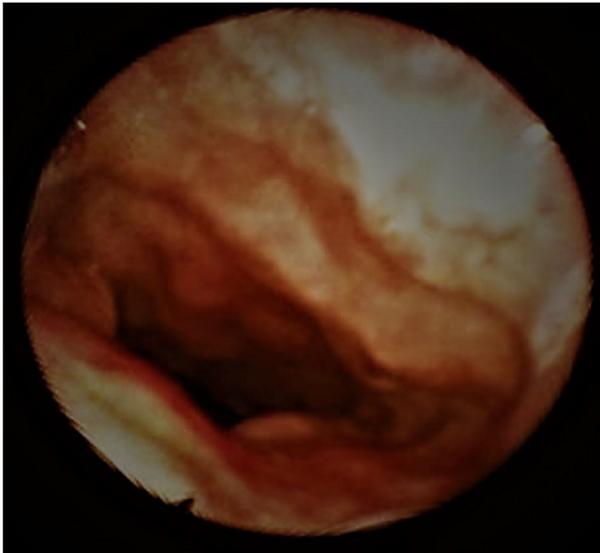
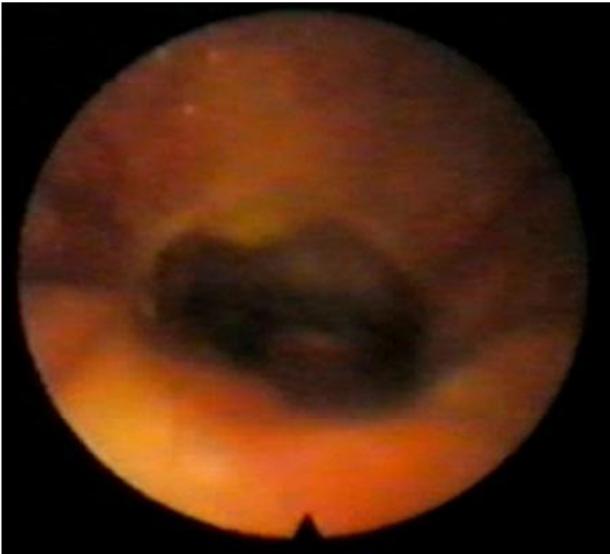
Items	N	Mean	SD	correlation	p- value
Nasal sentence pre-operative	100	57.48	13.79	0.544	0.013*
Nasal sentence post-operative		55.11			

\*Significant p-value < 0.05

**Table (3): Nasalance score of the oral sentence**

Items	N	Mean	SD	Correlation	p -value
Oral sentence pre-operative	100	16.17	4.19	0.627	0.003*
Oral sentence post-operative		12.76			

\*Significant p-value &lt; 0.05

**Figure (1): Nasoendoscopic evaluation of the velopharyngeal valve before tonsillectomy.** It shows Type of closure, Coronal, Degree of closure: II/IV**Figure (2): Nasoendoscopic evaluation of the velopharyngeal valve after tonsillectomy.** It shows Type of closure: Circular; Degree of closure III/IV

## DISCUSSION

The extent to which tonsillar hypertrophy affects the function of the velopharyngeal valve has not been completely unveiled. The current study investigates how tonsillar hypertrophy can affect the pattern and degree of

closure of structurally intact velopharyngeal valve and subsequently resonance of speech.

This study has been performed on 100 children in the age range of 4-10 years (mean age  $7 \pm 2.5$ ) because chronic tonsillitis is common among children in this age [14].

Kummer [15] postulated that in the presence of adenoid, tonsillar hypertrophy may cause hyponasality. In order to explore the effect of tonsillar hypertrophy alone, children with adenoid enlargement more than grade I have been excluded from the study. Adenoid size has been evaluated using plain X ray lateral view nasopharynx together with nasoendoscopy [13]. Functional causes of velopharyngeal insufficiency, such as sensorineural hearing loss [16] and mental retardation [17], have also been excluded.

Nasoendoscopy and nasometry are among the most prevalent techniques used in the assessment of velopharyngeal function [18]. Nasoendoscopic examination of children in the current study showed that the coronal pattern of closure prevailed over the circular pattern with a ratio of 2.6:1 (72 children (72%) exhibited a coronal pattern and 28 (28%) exhibited a circular pattern). The degree of closure was III/IV in 93 children (93%) and II/IV in 7 (7%) children. None of the children showed sagittal closure or circular closure with Passavant's ridge (table 1). The absence of the sagittal pattern of closure and the circular closure with Passavant's ridge in individuals with structurally intact palate has been noticed and reported by Jordan et al. [8] and El-Anwar et al. [19]. Manochiopinig et al. [20] reported the absence of the sagittal pattern of closure among normal Thai individuals as well. Passavant's ridge usually closes at a level lower than the level of closure of the velopharyngeal valve. Therefore, it is better to be assessed through multi-view video-fluoroscopy or dynamic magnetic resonance imaging that can visualize the vertical plane of closure of the velopharyngeal valve [8].

El-Anwar et al. [19] studied velopharyngeal closure patterns in children before adenotonsillectomy. They found that 50.5% of the children exhibited coronal closure and 49.5% exhibited circular closure. Seventy four percent of the children in their study had competent closure (grade IV/IV) and 27% showed incompetent closure (grade III/IV). The difference in the degree of closure between their study and the current study may be attributed to the lack of tonsillar or adenoid grading in

their study. El-Anwar et al. have not performed a post-operative evaluation.

D' Antonio et al. [21] highlighted the importance of reevaluation after tonsillectomy. They stated that tonsillar hypertrophy restricts the backward movement of the velum during velopharyngeal closure, and thus some children may exhibit a different pattern of closure after tonsillectomy. A period of three months interval between tonsillectomy and the reevaluation was considered adequate by March et al. [3]. All the children have underwent tonsillectomy by dissection with suturing the lower pole. Abou-Elsaad et al. [22] stated that non-complicated tonsillectomy has no effect on the velopharyngeal valve function in children with normal or cleft palate.

In the current study, postoperative examination showed changes in the patterns and degree of closure. Due to improvement of the palatal mobility after tonsillectomy; the coronal pattern increased to 83 and the circular pattern decreased to 17 and the closure was competent in 96 children and was III/IV in 4 children only (table 1). Abdel-Aziz et al. [23] studied the effect of tonsillectomy on 87 children with hypernasal speech by direct (nasoendoscopy) and indirect (speech analysis by nasometry and auditory perceptual assessment) measures. In their study, the children exhibited mild velopharyngeal gap and four patterns of closure as follows; fifty-eight percent showed coronal closure, 19% showed circular closure, 15% showed sagittal closure, 8% showed circular closure with Passavant's ridge. In the post-operative evaluation, the patterns of closure were distributed as follows; coronal in 69%, circular in 13.5%, sagittal in 12%, and circular closure with Passavant's ridge in 5.5% of the children, with improvement of the velopharyngeal gap. Their nasalance scores have shown significant improvement post-operatively but the changes in auditory perceptual assessment were non-significant. Nasalance score represents Nasal signal/ Nasal + Oral signals X 100 [18].

Regarding speech analysis of the current study, mild hypernasalnce has been noticed among the children, the mean nasalance of the nasal sentence was 57.48 and the mean nasalance of the oral sentence was 16.17. The degree of nasalance showed significant reduction in the post-operative evaluation, the mean nasalance of the nasal sentence was 55.11 and the mean nasalance of the oral sentence was 12.76. P value was 0.013 and 0.003 for the nasal and oral sentences respectively (tables 2&3). Similarly, Mora et al. [24] and Larangeira et al. [25] have reported reduction in the nasalance of speech post-tonsillectomy.

## CONCLUSION

Tonsillar hypertrophy may interfere with complete velopharyngeal closure leading to mild hypernasality. The vertical plane of the velopharyngeal valve needs to be examined using multiview video-fluoroscope or dynamic magnetic resonance imaging. Further studies on larger samples should be considered.

**Conflict of interest:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be constructed as a potential conflict of interest.

**Financial support:** Self-funded.

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## الملخص العربي

### تأثير تضخم اللوزتين على الرنين الأنفي للكلام و وظيفة الصمام اللهاى البلعومي

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#### ملخص البحث:

**الخلفية:** أن تأثير اللوزتين المتضخمتين على إغلاق البلعوم البلعومي ورنين الكلام محل جدل لفترة طويلة.

**الهدف:** تقييم علمي لدراسة تأثير تضخم اللوزتين على الرنين الأنفي للكلام و وظيفة الصمام اللهاى البلعومي في الاطفال الذين يعانون من تضخم اللوزتين.

**الطرق:** أجريت هذه الدراسة على مائة حالة من الأطفال الذين تتراوح أعمارهم من أربعة سنوات حتى عشرة سنوات وجميعهم يعانون من تضخم اللوزتين. و قد خضع جميع الأطفال الذين شملتهم الدراسة للفحوصات التالية: أشعه عاديه على البلعوم الأنفي لاستبعاد تضخم اللحمية الشديد. فحص إكلينيكي للأذن والأنف والحنجرة و فحص الصمام اللهاى البلعومي باستخدام منظار انفي بلعومي. قياس الرنين الأنفي باستخدام جهاز نازوميتر. اختبارات سمعية واختبار قدرات.

وبعد إجراء عملية استئصال اللوزتين بثمانية اسابيع تم إعادة تقييم الرنين الأنفي والصمام اللهاى البلعومي.

**النتائج:** أظهرت النتائج أن 72 مريضاً (72%) كان عندهم نمط إغلاق اكليلي و 28 مريضاً (28%) كان عندهم نمط إغلاق دائري. كانت درجة الإغلاق من الدرجة III/IV في 7 مريضاً (7%) و III / IV في 93 مريضاً (93%). بلغ متوسط درجة النف في الجملة الأنفية والجملة الفمية 57.48% و 16.17% على التوالي. في تقييم ما بعد الجراحة أظهر 83 طفلاً نمط إغلاق اكليلي وأظهر 17 طفلاً نمط إغلاق دائري. كان الإغلاق محكماً في 96 طفلاً بينما كان من الدرجة الثالثة- الرابعة في 4 أطفال، مع انخفاض كبير في درجة أنف الأنف بعد الجراح.

**الاستنتاجات:** يعد تضخم اللوزتين عاملاً مؤثراً على الصمام اللهاى البلعومي مما يؤدي إلى زيادة الرنين الأنفي

الكلمات المفتاحية: مقياس الرنين، رنين الكلام، تضخم اللوزتين، الصمام اللهاى البلعوم

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