



Oral Health Status and Salivary Properties Among Children Before and After Tonsillectomy

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ABSTRACT

Objectives: Enlarged adenoids can lead to obstruction of the nasopharyngeal airway and subsequent oral respiration. Oral breathing can cause dry mouth, dehydration in gingival tissue, and resistance to plaque accumulation. This study aimed to evaluate the impact of tonsillectomy on oral health status, salivary pH and flow rate, and common complications caused by tonsillar hypertrophy in children.

Materials and Methods: An analytical before-and-after study was conducted on 60 children aged 5-12 years who required tonsillectomy. We gathered data through a questionnaire and collected unstimulated saliva using the spitting method for five minutes. Salivary pH was measured by a pH meter and its volume was determined with a calibrated test tube. The plaque index, bleeding index and modified gingival index were determined using a disclosing tablet, Williams' probe and observational examination, respectively. All measurements were repeated one month after tonsillectomy. Paired t-test was used for data analysis.

Results: We found a significant increase in mean pH and salivary flow rate after tonsillectomy and observed a decrease in oral health indices among the children one month after surgery. Over half of the children who reported complications such as dry mouth, itchy nose and throat, snoring, night sweats, and sleep disturbances experienced complete recovery after tonsillectomy.

Conclusion: Based on the results obtained in the present study, children with enlarged adenoids showed significant improvements in salivary pH, salivary flow rate, and oral health indices, one month after tonsillectomy.

Keywords: Saliva; Oral Health; Tonsillectomy; Airway Obstruction.

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INTRODUCTION

Adenoid hypertrophy provides the ground for posterior nasal obstruction and consequently oral respiration [1]. Adenoids are lobular lymphoid-tissue masses located on the roof and posterior wall of the nasopharynx which are able to grow under adverse conditions such as chronic infection of upper respiratory tract or allergies or both [2]. Adenoidal

enlargement is a common childhood problem that calls for repeated adenoidectomy (due to adenoid hypertrophy alone) or adenotonsillectomy (due to hypertrophy of adenoid and palatine tonsils) [2]. Enlargement of these tissues can obstruct the nasopharynx airway, especially at night when the patient is asleep. Classically, physical symptoms of enlarged adenoids include nasal airway obstruction,

and oral breathing which are associated with nocturnal snoring [2]. In severe cases, this enlargement may lead to obstructive sleep apnea and speaking, tasting and swallowing difficulties [3]. According to the literature, dry mouth is among the most complications from which the oral breathers suffer [4].

Salivary flow is an important defense mechanism that prevents significant pH reduction in the oral environment [5] and one of its main functions is to mechanically wash away unstable bacteria, as well as remaining food and cell debris [4,5]. Any decline in salivary flow rate leads to reductions in the antimicrobial effect of saliva as well as the buffering capacity of oral acids. Intraoral pH imbalance reduces the acid neutralizing power of saliva and consequently increases the risk of tooth decay and degradation of dental restorative materials [4,5]. Studies have shown that the risk of dental erosion is higher in people suffering from dry mouth and low salivary pH than those with adequate saliva flow. Oral breathers may experience a reduction in salivary pH levels, particularly when sleeping. This can lead to a higher likelihood of dental decay/erosion, gingival infections, and periodontal diseases in this group [4,5].

Periodontal diseases result from the combined effect of local factors such as plaque and bacteria, as well as systemic factors, which lead to the degradation of gums and surrounding tissues of teeth. Oral breathing contributes to gingival disease and involves the elevation of the upper lip and the downward rotation of the mandible, leading to the tongue's forward movement. These actions can have adverse effects on the mucous membranes of the mouth, and lead to complications such as open mouth posture and an increase in the distance between the lips at rest. These complications further elevate the risk of plaque accumulation and gingivitis [6]. The mechanism by which oral breathing increase the risk of gingivitis is not yet known, but it seems that airflow in the oral cavity reduces salivary flow rate, dehydrates gingival surface, and reduces epithelial resistance to plaque [6].

Some studies have shown that oral breathing has no effect on the prevalence and extent of gingivitis unless there is a significant amount of germ in the oral cavity. Furthermore, an increased prevalence of gingivitis in oral breathers can be attributed to crowding. On the contrary, individuals who breathe through their mouth exhibit higher gingival and plaque indices in comparison to those who breathe normally. Moreover, these individuals are more susceptible to gingival inflammation and plaque accumulation in the anterior portion of the maxilla. As mouth breathers typically have obstructions in their upper respiratory tract, the diagnosis of their medical condition and referral to an otolaryngologist can aid in improving their oral health [6]. In this study, we aimed to examine the impact of tonsillectomy on oral pH, saliva production, and oral health among children aged 5-12 years. To the best of our knowledge, there has been no similar research conducted in Iran.

MATERIALS AND METHODS

Tonsillar hypertrophy complications

In this study, data was gathered from 60 children aged between 5 and 12 years who required adeno-tonsillectomy. Written consents were obtained from the parents and the study protocol was approved by the Ethics Committee of our university (IR.SSU.REC.1397.032). An otolaryngologist assessed nasal obstruction through nasal palpation, observation, anterior and posterior rhinoscopy, as well as nasal or oral endoscopy. To collect data, parents completed a questionnaire which included demographic information and questions regarding tonsillar hypertrophy complications, such as snoring, dry mouth, night sweats, daytime somnolence, bad breath, oral breathing, rhinolalia, failure to thrive, itchy nose and throat, and recurrent colds.

Evaluation of salivary properties

The children were instructed to abstain from consuming food or drinks, or brushing and rinsing their mouths, for a period of two hours. They were then instructed to swallow their saliva for 30 seconds and spit the accumulated saliva into a collection container at a rate of 1-2 times per minute, for a period of five minutes. The volume of the saliva was precisely measured

in the laboratory using an electric scale (NOTE BOOK, Japan) with a precision of 0.01. The collection container was weighed before and after sampling and the difference in weight was considered as the volume of collected saliva. This was based on the fact that each gram of saliva is equal to one milliliter saliva and therefore the weight of saliva was recorded as its volume [7]. The following equation was then used to measure unstimulated salivary flow rate (USF, ml/5 minutes).

$$\text{USF} = \frac{\text{the volume of collected saliva (liter)}}{\text{total saliva collection time (min)}}$$

After measuring the salivary flow rate, the pH of the collected samples was determined using a calibrated electric pH meter and a calibrated waterproof pH pen tester (ip57) with a precision of 0.1. The pH pen tester was calibrated with a neutral solution (pH=7) and an acidic solution (pH=4) prior to testing the samples. To ensure accuracy, the electrode was inserted into the samples twice, and the pH was recorded one minute after each insertion. Following each measurement, the pH meter's electrode was cleansed with physiological serum and re-calibrated.

Measuring gingival indices

To measure plaque index (PI), periodontal probes and dental mirrors were used to examine gums and teeth of patients in the hospital, under normal lighting conditions. Plaque disclosing tablets (Bolour Dandan-e Espadan Co., Isfahan, Iran) were then used to assess dental plaque. For this purpose, the patients were asked to chew the disclosing tablets and use their tongue to spread it all over their teeth. The number of discolored tooth surfaces was recorded as a measure of plaque accumulation.

Assessment of the modified gingival index (MGI) is a non-invasive observational technique used to assess the severity and extent of gingivitis. It includes:

Score 0: Normal gum, No inflammation

Score 1: Mild inflammation that affects only part of the marginal or papillary gingiva

Score 2: Mild inflammation that affects the entire marginal or papillary gingiva

Score 3: Moderate inflammation associated with

edema, redness, and hypertrophy of marginal or papillary gingiva

Score 4: Severe inflammation, obvious redness, edema or hypertrophy of marginal or papillary gingiva, spontaneous bleeding

The MGI score of each individual tooth was measured and then the mean MGI score of all teeth was taken as the MGI score of each patient [8].

Bleeding index (BI) was also measured for all teeth in the anterior and posterior regions of the oral cavity. In this method, 2mm of the periodontal probe was inserted into the gingival sulcus at the facial site of the posterior-most teeth in each quadrant (excluding the third molar) and was carefully swept towards the interproximal side of the teeth. After probing the sites in the quadrant, the presence or absence of bleeding on probing (BOP) was recorded as a percentage.

Statistical analysis

Complications due to tonsillar hypertrophy (questionnaire), salivary properties (pH and USF), and gingival indices (PI, BI, and MGI) were compared before and after tonsillectomy by paired t-test. $P < 0.05$ was considered significant.

RESULTS

The study included children between the ages of 5 and 12 years, with a mean age of 7.69 ± 2.3 years. Of the 60 participants, 60% were male and 40% were female.

Table 1 highlights the significant increase in mean post-surgical salivary pH and salivary flow rate (USF), based on the results of the paired-t-test ($P = 0.0001$, for both). Our findings also indicated a significant decrease in the mean pre-surgical plaque index ($P = 0.0001$), BI ($P = 0.0002$), and modified MGI ($P = 0.013$).

Table 2 shows that all parents of children with complications such as sleep disturbances, snoring, dry mouth, night sweats, and daytime somnolence reported improvement or disappearance of the issue post-surgery. However, 100% of children experiencing "failure to thrive" and 95% of participants with recurrent colds did not show any improvement following tonsillectomy.

Table 1. Comparison of salivary properties and periodontal indices before and after surgery.

| Variables | Mean±standard deviation | | | |
|-------------------------|-------------------------|--------------|------------|--------|
| | Pre-surgery | Post-surgery | Difference | P* |
| pH | 6.41±0.52 | 6.69±0.5 | 0.28±0.22 | 0.0001 |
| Salivary flow rate | 1.98±0.44 | 2.07±0.49 | 0.08±0.14 | 0.0001 |
| Plaque index | 24.8±12.5 | 19.6±11.4 | 5.22±5.31 | 0.0001 |
| Bleeding Index | 6.32±4.87 | 5.68±4.91 | 0.64±1.58 | 0.0002 |
| Modified gingival index | 0.95±0.72 | 0.85±0.65 | 0.1±0.3 | 0.013 |

*Paired t -test

Table 2. Frequency distribution of changes in tonsillar hypertrophy complications after surgery

| Complications | No complaint at baseline N (%) | No change N (%) | Improved N (%) | Disappeared N (%) |
|-----------------------|--------------------------------|-----------------|----------------|-------------------|
| Sleep disturbances | 20 (33.3) | 0 | 17 (42.5) | 23 (57.5) |
| Snoring | 3 (5) | 0 | 13 (22.8) | 44 (77.2) |
| Dry mouth | 4 (6.7) | 0 | 24 (42.9) | 32 (57.1) |
| Night sweats | 20 (33.3) | 0 | 14 (35) | 26 (65) |
| Daytime somnolence | 33 (55) | 0 | 14 (51.9) | 13 (48.1) |
| Bad breath | 0 | 13 (21.7) | 39 (65) | 8 (13.3) |
| Oral breathing | 0 | 3 (5) | 18 (30) | 39 (65) |
| Rhinolalia | 31 (51.7) | 4 (13.8) | 12 (41.4) | 13 (44.8) |
| Failure to thrive | 40 (66.7) | 19 (95) | 0 | 1(5) |
| Itchy nose and throat | 36 (60) | 0 | 8 (33.3) | 16 (66.7) |
| Recurrent colds | 12 (20) | 48 (100) | 0 | 0 |

DISCUSSION

Adenoidal enlargement is a common medical condition during childhood and a common reason for adeno-tonsillectomy. Adenoidal enlargement is a major cause of sleep disorders and respiratory problems, salivary pH reduction, as well as decrease in salivary flow rate. This medical problem can seriously endanger gingival and dental health [2]. In the present study, salivary pH, salivary flow rate and gingival health were evaluated in 60 children between the ages of 5 and 12 years, who had undergone adenotonsillectomy. Data were recorded before and 1 month after surgery.

According to the results, the mean salivary pH and salivary flow-rate increased significantly, one month after the surgery. Choi et al. [4] showed that intraoral pH was lower during oral respiration compared to nasal respiration. According to Al-Awadi et al. [5] salivary flow rate and pH were lower during

oral respiration. Therefore, the results of both studies were consistent with those of the present investigation.

Valera et al. [9] demonstrated that salivary flow rate, oral respiration and snoring were lower in patients with chronic obstructive airway disease compared to healthy individuals. Chronic obstructive airway disease involves adenoid hypertrophy alone or coupled with palatine tonsil hypertrophy [2]. In this study, patients suffered from both hypertrophy of the tonsils and the adenoids and experienced relative post-operative improvements in terms of salivary flow rate and oral breathing. According to Watanabe et al. [10], individuals with mild persistent asthma tend to have lower salivary pH during the nighttime as compared to daytime levels. This decrease in pH is typically associated with a decline in salivary flow rate, buffering capacity, and an increase in dental decay and erosion [11]. Moreover,

patients suffering from asthma and adenoid hypertrophy often experience dry mouth and salivary pH decline due to chronic oral respiration. Weiler et al. [12], however, report that there is no significant difference in salivary flow rate and buffering capacity between nasal and oral breathing. The present study used unstimulated saliva samples, collected 1.5 hours after the last food or drink intake, as opposed to stimulated saliva. Unstimulated saliva is a more reliable source for measuring salivary parameters, as stimulated saliva is mainly used to assess salivary gland function and lacks the necessary stability for analyzing qualitative and quantitative characteristics of saliva [13].

According to the findings of the present study, mean preoperative PI, BI and MGI were 24.8, 6.32, and 0.95, and decreased to 6%, 5.68%, and 85% one month after the surgery, respectively. The changes in these indices were found to be statistically significant in all cases. According to the literature, the decline in the afore-mentioned indices is indicative of improvements in gingival health [1]. Adenoid enlargement and posterior nasopharyngeal obstruction provide the ground for oral breathing in children [2]. Oral airflow leads to loss of saliva, dehydration of gingival surfaces and reduction of epithelial resistance to plaque [6].

Abrishami et al. [6] found that the gingival index in the anterior region of the mouth was significantly higher among oral breathers. As one breathes orally, the upper lip is raised and the lower jaw is maintained in an open posture and tongue drops to the floor of the mouth [14,15]. Changes in the oral mucous membrane, maintenance of mouth in open posture, and increased distance between the lower and upper lips during rest are all responsible for increasing the risk of plaque accumulation and gingival inflammation [16,17]. Thus, in the present study the rise in GI, PI, and BI before adenotonsillectomy can be attributed to oral-respiration-induced changes that provide the ground for gingival inflammation. Gulati et al. [18] reported that gingival and plaque indices were higher in oral breathers than normal breathers.; this difference, however, was not significant for plaque index which could be due

to adequate plaque control in the subjects. Wagaiyu et al. [17] also showed that gingival inflammation and plaque accumulation were more evident in the anterior maxillary region of oral breathers. Sharma et al. [19] found that oral breathers had higher GI and BOP in all regions of their mouth. These studies were consistent with the current investigation in terms of pre-adenotonsillectomy conditions. In contrast, a study showed that oral breathing is not associated with gingival bleeding [20]. Sharma et al. [19] and Nascimento Filho et al. [21] reported that oral breathing had no effect on the prevalence and extent of gingivitis unless there were significant amounts of germ in the mouth. Also, increased prevalence of gingivitis in oral breathers can be associated with dental crowding.

In the present study, a questionnaire that was administered to subjects before and one month after adenotonsillectomy, was used to measure the frequency of complications. According to the results, children experienced partial recovery after adenotonsillectomy.

Sleep efficiency increased statistically in children before and after tonsillectomy in a study by Ingram et al. [22]. We found that 42.5% and 57.5% of the children experienced partial and total post-operative recovery in terms of sleep disturbances, respectively.

Night-time snoring is one of the most common symptoms of obstructive sleep apnea. Nuyens et al. [23] showed that tonsillectomy led to improvements in airway obstruction symptoms such as snoring in 90% of cases. In the present study, 95% of the children suffered from snoring but 22.8% and of them experienced partial improvement, and 77.2% had total recovery one month after surgery.

Kasiri et al. [24] reported that oral breathing complications such as dry mouth were present in 80% of patients before surgery, but reduced to less than 10% after surgery. In the present study, 30% and 65% of patients experienced partial and total post-operative oral breathing recovery, respectively. Also, dry mouth complications partially disappeared in 49.9% and totally dissolved in 57.1% of the cases. Thus, it can be argued that adenotonsillectomy can lead to total recovery of airway obstruction,

increased salivary flow rate and consequently reduced sensation of dry mouth.

Children with night sweats were more likely to have sleep-related symptoms and respiratory and atopic diseases. In addition, they were more likely to be hyperactive. Night sweat was found to be significantly associated with tonsillitis and obstructive sleep apnea [25]. In the present study, adenotonsillectomy led to total and partial improvements of this problem in 65% and 35% of the cases, respectively.

Based on previous reports, 14.3% of Iranian children suffer from snoring have daytime somnolence [26]. However, we found pre-operative daytime somnolence in 45% of the children which may be due to the gravity of their medical condition. In other investigations, body activity and irritability are reportedly higher than somnolence. [27,28] Therefore, more precise studies and inclusion of psychological factors in assessment of other causes of daytime somnolence in children are necessary. Nevertheless, a significant improvement was observed after adenotonsillectomy, such that 48.1% of the children experienced partial and 51.9% had total post-operative recovery in terms of daytime somnolence. This can clearly reveal the influence of enlarged tonsils and adenoids on this manifestation in children.

According to the American Thoracic Society, chronic oral respiration and rhinolalia (hypernasal speech) are the most common enlarged tonsil symptoms in waking hours [27]. Re-examination of the above symptoms after adenotonsillectomy showed a statistically significant improvement in all of them. As for rhinolalia, we observed that 44.8% and 41.4% of children experienced partial and total post-operative recovery, respectively.

Unlike adults with apnea, who mostly suffer from overweight and obesity, most children with respiratory problems struggle with failure-to-thrive which can be attributed to difficulty in swallowing, increased metabolic need, nocturnal hypoxia, and decline in Insulin-like growth factor [29,30] Ray et al. [31] also reported improvement in physical thriving. In the present study, 33.3% of the children suffered from failure to thrive before surgery, but due to the shortage of follow-up time, it was impossible

to precisely evaluate changes in this factor.

Two separate studies have found that children who undergo tonsillectomy are less likely to experience cold-like symptoms, such as sore throat, and have fewer visits to the doctor due to such symptoms [32,33]. In the present study, 60% of children suffered from recurrent pre-operative colds, but the frequency of cold recurrences did not change after surgery as post-operative follow-up was short. However, patients reported a significant reduction in complaints of itchy nose and throat.

Al-Abbasi [34] reported complete improvement of halitosis in 70.4% of patients four weeks after tonsillectomy. Similarly, children with halitosis in the present study experienced significant post-operative improvement. Complications such as dry mouth, gingival problems, salivary pH and flow rate reduction may lead to dental decay and erosion in patients with adeno-tonsillar hypertrophy. Timely treatment of obstructive sleep apnea and adeno-tonsillectomy can help manage such complications.

This study has some limitations, including the challenge of recruiting and engaging children to participate in pre- and post-surgery oral examinations and ensuring their cooperation throughout the process. Additionally, the research was conducted at a single center. As such, further multicenter studies with longer follow-up periods are necessary to verify these findings.

CONCLUSION

The results obtained in the current investigation demonstrated significant improvements in salivary pH, salivary flow rate, and oral health indices, one month after tonsillectomy. Therefore, early diagnosis and treatment of enlarged adenoids in children is recommended.

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CONFLICT OF INTEREST STATEMENT

None declared

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