Original Paper

Folia Phoniatrica et Logopaedica

Folia Phoniatr Logop 2014;66:95–99
DOI: 10.1159/000365921

Published online: November 1, 2014

Adult Tonsillectomy: Anatomical Differences Affect Postoperative Transient Hypernasality

Olaf Zagólski[a] Paweł Stręk[b] Mariusz Gajda[c]

[a]ENT Day Surgery Department, St. John Grande's Hospital, and Departments of [b]Otolaryngology and [c]Histology, Jagiellonian University Medical College, Kraków, Poland

Key Words
Tonsillectomy · Hypernasality · Pharyngeal anatomy

Abstract
Objective: Our purpose was to determine how anatomical conditions of the throat influence the degree and duration of posttonsillectomy transient hypernasality. ***Patients and Methods:*** A total of 82 tonsillectomies were performed. The participants were divided into groups: 1 – small tonsils, high soft palate position; 4 – large tonsils, low soft palate position, and 2 and 3 – intermediate tonsil dimensions and soft palate positions. Variables studied included the diameter of vapor (DV) on the mirror positioned under the patient's nose while articulating nasal sentences before and after surgery, the distance from the uvular tip to the posterior pharyngeal wall, healing grading as well as the degree and duration of hypernasality. ***Results:*** The mean hypernasality after tonsillectomy was greatest in group 4 and lowest in group 2. Before tonsillectomy, the mean DV was largest in group 2 and smallest in group 4. After tonsillectomy, the mean DV was largest in group 4 and smallest in group 3. Overall, the mean DV was significantly greater after tonsillectomy compared to the value before surgery. ***Conclusion:*** The degree of hypernasality after tonsillectomy depends on the soft palate position in relation to the tongue base and the size of the tonsils. Hypernasality is greatest in patients with large tonsils and a low soft palate position in relation to the tongue base.

Introduction

Chronic tonsillitis and tonsillar hypertrophy cause alterations in the resonance characteristics of the pharyngeal cavity and make the voice disharmonic and harsh [1, 2]. Four weeks after tonsillectomy, a reduction of nasal resonance in most patients results in an improvement of voice and speech quality compared to the condition prior to surgery [1–4]. However, tonsillectomy has been associated with an elevated risk of transient, mild dysphonia and hypernasality due to pharyngeal edema occurring during several weeks after surgery [5, 6].

The term hypernasality refers to an auditory impression related to speech [7]. The most important physical variable determining the degree of nasality in healthy patients is the opening and closing of the velopharyngeal passageway between the oral vocal and the nasal tract [8]. In normal conditions, this opening is opened or closed by lowering and raising the velum or soft palate [8]. This in-

KARGER

E-Mail karger@karger.com
www.karger.com/fpl

1021–7762/14/0663–0095$39.50/0

Dr. Olaf Zagólski
ENT Day Surgery Department, St. John Grande's Hospital
ul. Dunin-Wąsowicza 20/II/9
PL–30-112 Kraków (Poland)
E-Mail olafzag@gmail.com

timate relationship between the tonsils and the velopharyngeal valve can be temporarily impaired after tonsillectomy, leading to transient hypernasality and, in rare cases, to permanent velopharyngeal insufficiency [9–11].

The purpose of the study was to determine how preoperative anatomical conditions of the throat influence the degree and duration of posttonsillectomy transient hypernasality.

Patients and Methods

A total of 82 tonsillectomies were performed during the period of January 2013 to March 2014 due to recurrent tonsillitis (disabling sore throat episodes 5 or more times per year and symptoms for at least 1 year; 55 patients) [12, 13], focus tonsil (20 patients) [14] and intense malodor (7 patients) [15]. All the patients operated on during this period were invited to participate in the prospective, observational, questionnaire-based study, and they accepted the invitation. Surgery was performed under general anesthesia with potassium titanyl phosphate (KTP) laser and multiple ligations of blood vessels within the tonsillar beds. The power of the AMS (San Jose, Calif., USA) Aura XP KTP/532 laser was set at 15 W. Palatal anomalies were excluded and the normal patency of the nose confirmed endoscopically in all participants. None of the participants had chronically used decongestants, antihistamine drugs, anticholinergic substances or topical/systemic corticosteroids within the 4 weeks preceding surgery. None reported having thyroid, lung or cardiovascular diseases or previous surgery of the tonsils, palate or nose.

Prior to surgery, the patients' tonsils' size was rated along the following scale: size 1 – tonsils are hidden within the pillars (23 patients); size 2 – tonsils extend to the pillars (19 patients); size 3 – tonsils extend beyond the pillars but not to the midline (25 patients), and size 4 – tonsils extend to the midline (15 patients) [16]. The participants' palate position was rated along the following scale: position I – allows visualization of the entire uvula and tonsils/pillars (25 patients); position II – allows visualization of the uvula but not the tonsils (19 patients); position III – allows visualization of the soft palate but not the uvula (21 patients), and position IV – allows visualization of the hard palate only (17 patients) [16]. The participants were divided into the following groups according to the position of the soft palate in relation to the tongue base and size of the tonsils: group 1 – palate position I–II, tonsil size 1–2 (23 patients; mean age = 31.2 years; 10 females, 13 males); group 2 – palate position III–IV, tonsil size 1–2 (21 patients; mean age = 29.8 years; 10 females, 11 males); group 3 – palate position I–II, tonsil size 3–4 (20 patients; mean age = 29.3 years; 8 females, 12 males), and group 4 – palate position III–IV, tonsil size 3–4 (18 patients; mean age = 32.1 years; 10 females, 8 males). The distance from the uvular tip to the posterior pharyngeal wall was also measured with a ruler. The data collected included patient variables such as age, gender and medical history.

A variable examined before and after surgery was the diameter of vapor (DV) on the mirror positioned under the patient's nose while articulating test sentences: the Glatzel mirror-fogging test [17]. We used nasal sentences [18] in Polish containing many nasal phonemes (see Appendix). The remaining phonemes were phonetically balanced, i.e. occurring at approximately the same frequency at which they occur in ordinary conversation in the language [18]. This frequency was established based on the data from a dictionary of the Polish language. The mirror-fogging test was applied to visualize nasality as measured by condensation [19] prior to the surgery and on the 4th postoperative day. The same person made all the measurements in the same room. The temperature (22–24°C) and relative air humidity (50–65%) of the test site were kept constant throughout testing. The protocol included acclimatizing the participants, who remained seated for 15 min in the test environment. During this period, the patients answered the questionnaire questions and the physical examination was performed. Subsequently, the participants breathed on the mirror. The sequence was 3 measurements of 30 s each. The mirror measurements were done on subjects seated with the head in the orthostatic position. Metal plates with a millimeter scale were used. The plate was placed horizontally under the participant's nostrils, with the mirror's zero point under the columella. The first condensation was disregarded, and the second was marked with an overhead transparency pen on the mirror itself and subsequently copied by transparency to standard paper. Care was taken when handling the plate to keep it from heating. The condensation contour was measured along its greater axis from the zero point to the longest dimension on both sides of the nose. The sum of the right and left nasal fossa unilateral values was calculated for the final assessment [17].

Other variables measured on the 4th postoperative day included the degree and duration of hypernasality and healing grading. By hypernasality duration we mean the postoperative period of time (in days) after which hypernasality completely subsided.

The speech samples for the evaluation of hypernasality were recorded before and every day after surgery for 7 days, and the degree of nasality was rated by 2 independent expert listeners on a 5-point scale: 4 – permanent and intense; 3 – permanent; 2 – frequent; 1 – occasional, and 0 – normal. Each patient's pharynx was also examined to assess healing and rated on a 5-point scale: 4 – redness and edema of vast regions of pharyngeal mucosa, including the uvula; 3 – edema of the uvula with or without redness and/or edema of anterior pillar mucosa; 2 – redness and edema of peritonsillar tissues excluding the uvula; 1 – redness of anterior pillar mucosa without edema, and 0 – normal mucosa, without redness or edema [20]. Edema of the uvula is an important factor of healing due to its symptoms: pain-causing dysphagia as well as dyspnea [20].

ANOVA with post hoc analysis by Duncan's test was performed to compare the age of the patients, the DV on the mirror positioned under the patient's nose while articulating nasal sentences prior to and after the surgery, the distance from the uvular tip to the posterior pharyngeal wall as well as the degree and duration of hypernasality and healing grading between the groups (Statistica software version 5; Statsoft Inc., Tulsa, Okla., USA). The same statistical procedure was used to compare the degree and duration of hypernasality according to the size of tonsils, palate position and distance of the uvular tip to the posterior pharyngeal wall. A paired t test was used to compare the DV on the mirror positioned under the patient's nose while articulating test sentences, obtained prior to and after surgery. Intraclass correlation coefficients were also calculated in order to assess the inter- and intrarater reliability of the results. Before the examination, all patients gave their informed consent to participate in the study in writing after being informed of the benefits, risks and complications of the procedures. The research plan was approved by the local medical ethics committee. The tenets of the Declaration of Helsinki were followed.

Table 1. Mean values with SD in parentheses of the measures in this study, presented by group (see text for group definitions)

	DV before tonsillectomy, cm	DV after tonsillectomy, cm	Distance from the uvular tip to the posterior pharyngeal wall, cm	Degree of hypernasality (1–4)	Duration of hypernasality, days	Healing grading (0–4)
Patients						
Group 1	3.7 (1.3)	4.6 (1.1)	1.5 (0.4)	0.9 (0.8)	4.6 (2.2)	1.3 (1.1)
Group 2	4.3 (0.5)	4.4 (1.4)	1.3 (0.1)	0.8 (0.7)	4.6 (3.8)	1.4 (1.4)
Group 3	3.1 (1.2)	4.2 (1.2)	1.7 (0.5)	1.6 (0.8)	6.3 (3.9)	2.1 (1.2)
Group 4	2.7 (0.8)	6.0 (1.1)	1.3 (0.7)	2.0 (0.8)	9.0 (6.8)	2.0 (1.7)
Statistics						
ANOVA	p = 0.04 F = 2.6 d.f. = 23	p = 0.03 F = 3.5 d.f. = 25	n.s.	p = 0.03 F = 1.8 d.f. = 25	n.s.	n.s.
Duncan's test (significant differences between groups)	2/4: p = 0.018	1/4: p = 0.048 2/4: p = 0.013 3/4: p = 0.007	–	1/4: p = 0.04 2/4: p = 0.03	–	–

ANOVA and post hoc statistical findings are provided. Significant post hoc pairwise contrasts for groups are shown as x/y (where x and y = a group) followed by exact probabilities. n.s. = No statistical significance; F = F statistic; d.f. = degree of freedom.

Results

The mean age and the gender of the patients did not significantly differ between the groups. No abnormalities in nasality were found prior to surgery. The mean hypernasality after tonsillectomy was significantly greatest in group 4 and lowest in group 2. The mean DV on the mirror positioned under the patient's nose while articulating nasal sentences was significantly greater after tonsillectomy compared to the mean value of this variable measured prior to surgery (mean = 4.4 cm, SD = 1.3 cm, vs. mean = 3.5 cm, SD = 1.1 cm; p = 0.0006). The mean DV on the mirror significantly differed between the groups and was highest recorded before tonsillectomy in group 2 and lowest in group 4 (table 1). The mean of the same variable measured after the surgery also significantly differed between the groups and was highest in group 4 and lowest in group 3. The mean values of the distance from the uvular tip to the posterior pharyngeal wall, hypernasality duration and healing grading scores did not differ between the groups. The degree of postoperative hypernasality significantly depended on the preoperative size of the tonsils (p = 0.036; F = 1.3; d.f. = 25) and was lowest with small tonsils and greatest with large tonsils (Duncan's test: p = 0.024). Hypernasality duration did not depend on the preoperative size of the tonsils. Also, palate position and the distance of the uvular tip to the posterior pharyngeal wall did not significantly influence the degree and duration of posttonsillectomy transient hypernasality. The intraclass correlation coefficients demonstrated good interrater (two-way mixed interclass correlation coefficient: 0.79; standard error of measurement: 0.22) and intrarater reliability (two-way mixed interclass correlation coefficient: 0.94; standard error of measurement: 0.11).

Discussion

The data from this study demonstrate that there are remarkable differences in grading of posttonsillectomy hypernasality related to preoperative anatomical conditions. This is the first attempt to investigate this problem.

No significant effects of age or gender on nasality values were obtained in previous studies [19, 21]; hence, overall normative values for the groups were reported. The mean DV on the mirror positioned under the patient's nose while articulating nasal sentences increases in the period immediately after tonsillectomy, reflecting the greater opening of the velopharyngeal passageway between the oral vocal tract and the nasal tract, increased airflow through the passageway and subsequent hypernasality. This observation is consistent with the findings reported in previous studies utilizing nasopharyngoscopy and acoustic analysis of speech samples [2, 22]. Tonsillectomy reduces the nasal resonance and improves average values of fundamental frequency, jitter percent, shimmer, noise-to-harmonics ratio, voice turbulence index,

soft phonation index, degree of voicelessness, degree of voice breaks and peak amplitude variation [3]. The low value of the mean DV recorded before surgery showed that the size of the velopharyngeal passageway was considerably reduced in patients with big palatine tonsils and/or a palate position that allowed visualization of the hard palate only [16]. Earlier studies utilizing nasopharyngoscopy, multiview videofluoroscopy and behavioral speech assessment gave results contrary to ours, proving that hypertrophic tonsils can alter resonance in the throat, particularly if they are interposed between the velum and the posterior pharyngeal wall [2, 23, 24]. This can lead to incomplete velopharyngeal closure and hypernasality, obstructing sound transmission into both the oral and the nasal cavity and causing a mixture of hyponasality and cul-de-sac resonance [2, 23, 24]. Tonsillectomy eliminates all of these characteristics [2, 24], and therefore it was established that this procedure was not contraindicated even in individuals with or at risk of velopharyngeal insufficiency [25]. The discrepancy between results of the previous and our studies may be caused by various shapes of the hypertrophic tonsils and different diagnostic methods used to assess the patency of the velopharyngeal passageway. However, the degree of postoperative transient hypernasality in patients with hypertrophic tonsils determined in the current study was greatest if large palatine tonsils had been removed, due to an increase in airflow through the velopharyngeal passageway.

Prior to tonsillectomy, the mean DV was greatest in patients with small palatine tonsils and a palate position allowing the examiner to visualize the entire uvula and tonsils or pillars. This can be explained by the fact that small palatine tonsils and a high soft palate do not influence the patency of the velopharyngeal passageway. This relationship was confirmed by a retrospective study [16]. The same mean variable measured after the surgery was significantly highest in group 4 and lowest in group 3. In group 4, a large amount of palatine tissue was removed from the throat, allowing a greater opening between the oral vocal and the nasal tract and causing temporal velopharyngeal insufficiency before the opening of the velopharyngeal passageway normalized [2]. This explains why the mean value of postoperative hypernasality was greatest in group 4 and lowest in the group with small palatine tonsils and a high soft palate position in relation to the tongue base. Also, if the size of the tonsils was considered an independent variable, the degree of transient hypernasality significantly depended on it and was greatest in patients in whom large tonsils had been removed. In the other groups, in which smaller palatine tonsils had been removed, the measures of postoperative velopharyngeal passageway patency applied in this study did not significantly differ from the preoperative ones.

Our results relating to wound healing might be hard to compare with the results obtained from patients after tonsillectomy performed by conventional methods, due to delayed wound healing after KTP laser surgery of the throat [26].

Several important conclusions can be drawn from this study. The results obtained will assist in evaluating the anatomy of the throat in all candidates for tonsillectomy, informing some of them about the increased probability of postoperative hypernasality and about timescales of its subsidence. Based on the obtained results, we note the position of the soft palate in relation to the tongue base and the size of the palatine tonsils prior to tonsillectomy and inform patients about the expected grade of postoperative transient hypernasality in their case.

Conclusions

The degree of transient hypernasality after tonsillectomy differs between groups of patients recruited based on their soft palate position in relation to the tongue base and the size of the tonsils. Its value is greatest in patients with large palatine tonsils and a high palate position and lowest in patients with small tonsils and a low palate position.

Before tonsillectomy, velopharyngeal passageway patency as measured by the DV on the mirror positioned under the patient's nose while articulating nasal sentences is lowest in patients with a low soft palate position and big tonsils. In these patients, velopharyngeal passageway patency increases most after tonsillectomy, causing the greatest postoperative transient hypernasality.

Appendix

Polish version of nasal sentences:

- Mama zmieszała dżem z malinami.
- Ten pan to Jan.
- Ładna panna niesie gong.
- On kłania się panu z bananem.

Disclosure Statement

The authors declare no conflict of interest.

References

1 Subramaniam V, Kumar P: Impact of tonsillectomy with or without adenoidectomy on the acoustic parameters of the voice: a comparative study. Arch Otolaryngol Head Neck Surg 2009;135:966–969.
2 Kummer AW, Billmire DA, Myer CM 3rd: Hypertrophic tonsils: the effect on resonance and velopharyngeal closure. Plast Reconstr Surg 1993;91:608–611.
3 Mora R, Jankowska B, Mora F, Crippa B, Dellepiane M, Salami A: Effects of tonsillectomy on speech and voice. J Voice 2009;23:614–618.
4 Behrman A, Shikowitz MJ, Dailey S: The effect of upper airway surgery on voice. Otolaryngol Head Neck Surg 2002;127:36–42.
5 Brosch S, Haase S: Open nasal speech and velopharyngeal insufficiency in adenoidectomy and tonsillectomy (in German). Laryngorhinootologie 2007;86:666–672, quiz 673–674.
6 Roth JA, Pincock T, Sacks R, Forer M, Boustred N, Johnston W, Bailey M: Harmonic scalpel tonsillectomy versus monopolar diathermy tonsillectomy: a prospective study. Ear Nose Throat J 2008;87:346–349.
7 Van Lierde KM, Wuyts FL, Bonte K, Van Cauwenberge P: The nasality severity index: an objective measure of hypernasality based on a multiparameter approach. A pilot study. Folia Phoniatr Logop 2007;59:31–38.
8 Brancamp TU, Lewis KE, Watterson T: The relationship between nasalance scores and nasality ratings obtained with equal appearing interval and direct magnitude estimation scaling methods. Cleft Palate Craniofac J 2010;47:631–637.
9 Finkelstein Y, Nachmani A, Ophir D: The functional role of the tonsils in speech. Arch Otolaryngol Head Neck Surg 1994;120:846–851.
10 Haapanen ML, Ignatius J, Rihkanen H, Ertama L: Velopharyngeal insufficiency following palatine tonsillectomy. Eur Arch Otorhinolaryngol 1994;251:186–189.
11 Wachtel JM, Kuehn DP, Weiss KS: Hypernasality after tonsillectomy without adenoidectomy in an adult. Otolaryngol Head Neck Surg 2000;122:112–113.
12 Silva S, Ouda M, Mathanakumara S, Ridyard E, Morar P: Tonsillectomy under threat: auditing the indications for performing tonsillectomy. J Laryngol Otol 2012;126:609–611.
13 Mattila PS, Tahkokallio O, Tarkkanen J, Pitkäniemi J, Karvonen M, Tuomilehto J: Causes of tonsillar disease and frequency of tonsillectomy operations. Arch Otolaryngol Head Neck Surg 2001;127:37–44.
14 Kataura A, Tsubota H: Clinical analyses of focus tonsil and related diseases in Japan. Acta Otolaryngol Suppl 1996;523:161–164.
15 Delanghe G, Ghyselen J, Feenstra L, van Steenberghe D: Experiences of a Belgian multidisciplinary breath odour clinic. Acta Otorhinolaryngol Belg 1997;51:43–48.
16 Friedman M, Ibrahim H, Bass L: Clinical staging for sleep-disordered breathing. Otolaryngol Head Neck Surg 2002;127:13–21.
17 Brescovici S, Roithmann R: Modified Glatzel mirror test reproducibility in the evaluation of nasal patency. Braz J Otorhinolaryngol 2008;74:215–222.
18 Bressmann T: Comparison of nasalance scores obtained with the Nasometer, the NasalView, and the OroNasal System. Cleft Palate Craniofac J 2005;42:423–433.
19 Bettens K, Wuyts FL, De Graef C, Verhegge L, Van Lierde KM: Effects of age and gender in normal-speaking children on the Nasality Severity Index: an objective multiparametric approach to hypernasality. Folia Phoniatr Logop 2013;65:185–192.
20 Zagólski O, Kulisiewicz J: Perioperative antibiotic in adenoidectomy with partial tonsillectomy: a randomized trial. ORL J Otorhinolaryngol Relat Spec 2012;74:86–92.
21 Luyten A, D'haeseleer E, Hodges A, Galiwango G, Budolfsen T, Vermeersch H, Van Lierde K: Normative nasalance data in Ugandan English-speaking children. Folia Phoniatr Logop 2012;64:131–136.
22 Rihkanen H, Soini I: Changes in voice characteristics after uvulopalatopharyngoplasty. Eur Arch Otorhinolaryngol 1992;249:322–324.
23 Shprintzen RJ, Sher AE, Croft CB: Hypernasal speech caused by tonsillar hypertrophy. Int J Pediatr Otorhinolaryngol 1987;14:45–56.
24 MacKenzie-Stepner K, Witzel MA, Stringer DA, Laskin R: Velopharyngeal insufficiency due to hypertrophic tonsils. A report of two cases. Int J Pediatr Otorhinolaryngol 1987;14:57–63.
25 D'Antonio LL, Snyder LS, Samadani S: Tonsillectomy in children with or at risk for velopharyngeal insufficiency: effects on speech. Otolaryngol Head Neck Surg 1996;115:319–323.
26 Saito T, Honda N, Saito H: Advantage and disadvantage of KTP-532 laser tonsillectomy compared with conventional method. Auris Nasus Larynx 1999;26:447–452.