

ORIGINAL ARTICLE

Medicine Science 2021;10(1):13-7

Assessment of tongue depressor-related tongue swelling in pediatric patients with ultrasonography: A prospective, case-controlled observational study Merih Onal*Selcuk University, Faculty of Medicine, Department of Otorhinolaryngology, Konya, Turkey*Received 07 September 2020; Accepted 29 September 2020
Available online 20.12.2020 with doi: 10.5455/medscience.2020.09.180Copyright©Author(s) - Available online at www.medicinescience.org
Content of this journal is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.**Abstract**

Adenoidectomy is one of the most common surgeries performed in children. The tongue depressor is being routinely used during adenoidectomy exerts high mechanical pressure on the tongue. We aimed to discover tongue swelling created by the compression of tongue depressor by using ultrasonography (USG) in pediatric patients who were undertaken adenoidectomy. Thirty-four patients who were undertaken adenoidectomy were involved in the study group. In the control group, 33 patients who were undertaken pediatric surgery were involved. The tongue surface area (TSA) measurement was achieved for two times. In the study group, TSA¹ was performed immediately following intubation, prior to the installment of the tongue depressor, TSA² was performed following the removal of the tongue depressor however prior to extubation. In the control group, TSA¹ was performed immediately following intubation, TSA² was performed prior to extubation. An important correlation was noticed among the severity of tongue swelling (defined as TSA² - TSA¹) (P = 0.000) and tongue depressor. Tongue depressor may provoke tongue swelling in adenoidectomy procedures that can be shown with USG. This tongue swelling seems to be a result of the pressure applied by the tongue depressor. Tongue depressor related tongue swelling may cause respiratory complications in patients with already restricted airway passage even if the patients are fully awake. The tongue swelling in pediatric patients under adenoidectomy surgeries was demonstrated for the first time in the literature by USG.

Keywords: Adenoidectomy, children, complications, tongue disease, ultrasonography**Introduction**

Adenoidectomy surgery, which is one of the most common ear, nose and throat procedures all over the world [1], is indispensable for children with obstructive symptoms such as nasal obstruction, sleep-disordered breathing, chronic otitis media, chronic sinusitis, as well as craniofacial changes [2]. Although the most important complication of adenoidectomy is bleeding with an incidence rate of 0.5% – 8%, postoperative respiratory complications can also be seen [3].

Although postoperative respiratory complications occur more in some risky patients, upper airway complications may also occur in healthy children with no risk factors [4]. In particular, massive swelling in the tongue and uvula can cause fatal outcomes by leading to upper airway obstruction even in healthy children [5,6].

Numerous cases of massive tongue swelling have been reported, and this life-threatening complication has been believed to be occurred due to the compression of tongue depressors, transesophageal probes, endotracheal tubes which exert direct pressure on the tongue [5].

Studies have shown that the tongue is an ideal and unique organ for ultrasonography (USG) evaluation due to its multiple muscle structure. The tongue surface area (TSA) can be easily measured when a USG probe is placed submental [7,8].

No studies have been conducted on the development and diagnosis of tongue swelling related to tongue depressor which can be a potential reason for postoperative respiratory complications in pediatric patients.

Thus, this study aimed to investigate the physiological effects of tongue depressor on the tongue and to determine through USG examination whether tongue swelling occurred in surgeries, such as adenoidectomy, which involves the short-term use of a tongue depressor.

*Corresponding Author: Merih Onal, Selcuk University, Faculty of Medicine, Department of Otorhinolaryngology, Konya, Turkey
E-mail: drmerihonal@gmail.com

Material and Methods

Study design

We prospectively performed submental USG analysis of the tongue in pediatric patients who underwent adenoidectomy surgery at a university hospital. This research was approved by the Selçuk University Medical Faculty Research Ethics Board (No. 2018/331), with ClinicalTrials.gov Identifier: NCT04256590 and it was conducted in accordance with the ethical principles laid down in the Declaration of Helsinki. Informed written consent was obtained from the parents of all the patients.

Participants

This study involved two groups of participants. The patients aged between 2 and 6 years were included for both groups. For both groups, the patients with a history of syndromic cranio facial abnormalities (e.g., Down syndrome, craniofacial trauma) and systemic disorders were excluded from this study.

The study group ($n = 34$) consisted of patients diagnosed with symptomatic adenoid hypertrophy and underwent adenoidectomy surgery. The second group ($n = 33$) consisted of the control group who underwent inguinal hernia and circumcision operation with endotracheal intubation under general anesthesia in pediatric surgery.

Measurements

For both groups, TSA values were measured twice per patient by submental USG by an experienced anesthesiologist who was trained by a staff pediatric radiologist regarding tongue assessment. Three measurements were taken, and an average of the two closest readings was used in the analysis for each measurement (Figure 1).



Figure 1. Tongue surface area image.

Primary outcome: The primary outcome was, the change in TSA depending on the use of tongue depressor. Our hypothesis was, depending on the use of the tongue depressor there would be an increase in TSA values measured by USG. In the study group, the first measurement (TSA^1) was performed quickly after endotracheal intubation but prior to the settlement of the tongue depressor. The second measurement (TSA^2) was performed following the completion of the adenoidectomy procedure and after the removal of the tongue depressor but just before extubation. In the control group, the first measurement (TSA^1) was performed quickly after endotracheal intubation but prior to the surgery, whereas the second measurement (TSA^2) was obtained at the end of the surgical procedure but just before extubation (Figure 2).

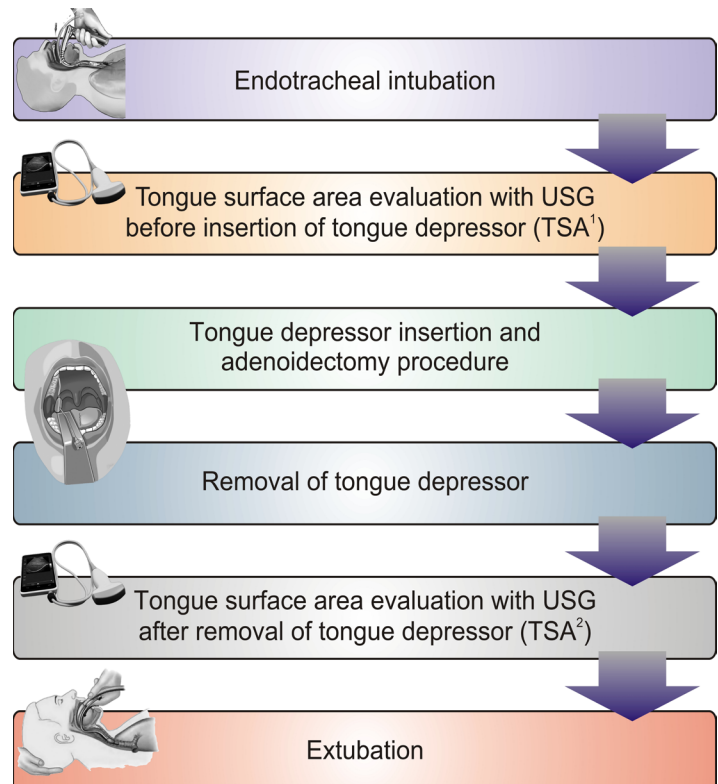


Figure 2. Flowchart of the study.

Secondary outcome: The secondary outcome was the presence of tongue swelling caused by tongue depressor shown with USG. Our hypothesis was that the tongue swelling associated with the tongue depressor could be evidenced by TSA values measured by USG. The difference between TSA^2 and TSA^1 (i.e., $TSA^2 - TSA^1$) was used to describe the tongue swelling for both groups.

Ultrasound Examination

TSA measurements were carried out in the Esaote MyLab (Genoa, Italy) ultrasound device with a convex probe operating at 4 MHz frequency in the coronal plane of the submental midline region. When the patient in the supine neutral position, the probe was placed under the chin without pressing too much, and when the whole tongue image was obtained on the monitor, the image was frozen. The following landmarks were identified to confirm consistent transducer placement for each subject: fascia between the mylohyoid muscle and intrinsic muscles of

the tongue and the interface between the soft palate and air in the oral cavity. Additionally, the image of the tongue was identified as “oval-shaped,” further confirming consistent positioning of the transducer. TSA borders were drawn manually and the TSA was calculated automatically.

Adenoidectomy procedure

The same two otolaryngologists performed all adenoidectomy procedures under general anesthesia; they used the conventional curettage adenoidectomy method, which was carried out blindly by an adenoid curette. The same Crowe–Dawson tongue depressor blade was used to keep the mouth open. Each patient was given standard general anesthesia, which was induced with methylprednisolone (1 mg/kg) (Prednole, Gensenta, Istanbul, Turkey) For each patient hydration was started with a mixed pediatric solution (Biof, Osel, Istanbul, Turkey), which was administered intravenously at a rate of 10 mL/kg/h. Each patient was intubated with an identical type of endotracheal tube that was appropriate for each patient's age, and the endotracheal tube was set at the center of the mouth. The tongue depressor was placed in the patient's mouth, and the duration was noted. The tongue depressor was not removed until the surgery was finished. If the tongue depressor was removed or had to be loosened before the surgery, the patient was excluded from the study.

Statistical analysis and sample size

All data are expressed as mean $\pm$ standard deviation (SD). A non-parametric Mann–Whitney U-test was used to determine whether the study and control groups differed on each variable. Data analysis was conducted using the Statistical Package for the Social Science software program (SPSS Version 17.0, IBM, Armonk, NY, USA). A P value of < 0.05 indicated statistical significance. We performed a pilot study in 10 patients from the adenoidectomy group to calculate the sample size. In the pilot study, the tongue surface area values before and after the replacement of tonsillar retractor were $1.98 \pm 0.29\text{cm}^2$ and $2.72 \pm 0.28\text{cm}^2$ respectively. Assuming an equal SD and to show a difference of 20% between the 2 groups, a 2-sided type I error of 0.05 and a power of 0.95 were applied. According to this calculation, when we included 16 patients per group, a significant difference would be found in terms of tongue surface areas.

Results

No significant difference was seen between the study and control groups in terms of demographics (Table 1). While 19 of the patients in the adenoid group, 17 of the patients in the control group were girls. According to the mean intubation duration no significant difference was revealed between the study (26.2 min), and control ($28.8 \pm \text{min}$) groups ($P = 0.6$). In terms of mean TSA^1 values, there was no significant difference between study and control groups respectively ($1.95 \pm 0.29\text{cm}^2$) ($2.03 \pm 0.17\text{cm}^2$) ($P = 0.183$). The mean TSA^2 values of the study group ($2.63 \pm 0.22\text{cm}^2$) were higher compared to the control group ($2.16 \pm 0.24\text{cm}^2$) ($P = 0.000$). Also, in terms of the tongue swelling values, the mean $\text{TSA}^2 - \text{TSA}^1$ values of the study group ($0.69 \pm 0.29\text{cm}^2$) were higher than the control group ($0.12 \pm 0.15\text{cm}^2$) and a significantly difference was

noticed between two groups ($P = 0.000$) (Table 2) (Figure 3).

Table 1. Comparison between the adenoidectomy and control groups in terms of descriptive statistics (Mann–Whitney U test)

	Adenoidectomy(n=34) Mean $\pm$ SD (min-max)	Control(n=33) Mean $\pm$ SD (min-max)	P value
Age (Years)	4.8 $\pm$ 1.23 (2.50-6.00)	4.5 $\pm$ 1.23 (2.5-6.00)	0.108(.914)
Weight (kg)	15.1 $\pm$ 3.35 (9.00-23.00)	15.51 $\pm$ 3.40 (9.50- 23.50)	-0.729(.466)

Table 2. Comparison between the adenoidectomy and control groups in terms of preoperative and postoperative tongue surface area (TSA^1 and TSA^2 respectively), tongue swelling ($\text{TSA}^2 - \text{TSA}^1$), tongue depressor and endotracheal intubation duration.

Parameter (cm ²)	Adenoidectomy group (n=34)		Control group (n=33)		p	
	Mean	SD	Mean	SD		
TSA^1	1.95	0.29	2.3	0.17	1.282	0.183
TSA^2	2.63	0.22	2.16	0.24	6.192	0.000*
$\text{TSA}^2 - \text{TSA}^1$ (Tongue swelling)	0.69	0.29	0.12	0.15	6.622	0.000*
Tongue Depressor Duration	24	3.33				
Endotracheal Intubation Duration			23.8	2.13		0.6

*Comparing adenoidectomy and control group.

Tongue depressor duration: The duration between inserting and removing the tongue depressor in the patient's mouth.

Endotracheal intubation duration: The duration between endotracheal intubation and extubation of the patient.

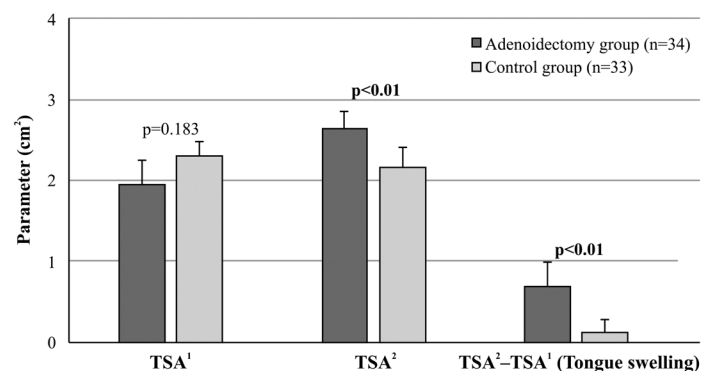


Figure 3. Comparison between the study and control groups in terms of preoperative and postoperative tongue surface area (TSA^1 and TSA^2) values and tongue swelling ($\text{TSA}^2 - \text{TSA}^1$) values.

Discussion

In our study, we determined that TSA values were increased by the ratio of 34% in adenoidectomy surgeries while the rate of increase was 6% in control group. Although the long-term compression of the tongue during a surgical procedure is thought to be the mechanical reason behind the development of massive tongue swelling, [5] we showed with that non-massive tongue swelling may also occur in short-term surgeries due to the high pressure exerted by the tongue depressor on the tongue in pediatric patients, as previously shown in adult patients who undergo suspension laryngoscopy [8].

At the end of our study, we also thought that there might be other differences between massive and non-massive tongue swelling formations in terms of their characteristics. Although massive tongues swelling can be observed with the naked eye, the non-massive tongues swelling could only be detected by USG. Additionally, when massive tongue swelling occurs, it can immediately cause airway obstruction even in healthy patients, whereas the non-massive tongues swelling may cause airway obstruction in patients with certain risk factors. Since, non-massive tongue swelling due to tongue depressor may cause respiratory complications arising from upper airway obstruction, by completely blocking the airway especially in high risk patient groups with an already narrowed upper airway, such as very young age (<2 years), obesity, Obstructive Sleep Apnea Syndrome (OSAS), Down syndrome, craniofacial trauma [4,9,10].

Namely; the tongue swelling does not necessarily have to be massive in order to block the airway completely. Because, although there has been no study on the definition of tongue swelling induced by tongue depressor or its clinical consequences, most of the postoperative respiratory complications after adenotonsillectomy have been known to be due to upper airway obstruction.

In support, in a study conducted by Chorney et al. [11] 16.9% of the patients who underwent adenoidectomy experienced serious postoperative respiratory-related events. The majority of those were children younger than 1.5 years old. This result might have been due to the fact that the tongues of very young children are relatively large and the airway passage has already narrowed during the preoperative period, and the non-massive tongue swelling may be developed in the post-operative period that may completely closed the airway passage.

In another two studies tongue-based obstruction is an important cause of postoperative respiratory complications and that adversely affects airway patency in patients with OSAS [12,13]. Given that the majority of adenoidectomy operations are due to the OSAS and narrowed airway patency, it can be said that the already narrowed airway patency of the patients further constricted due to nonmassive tongue swelling and upper airway obstruction tendency has increased [11]

The OSAS incidence is high in patients with Down syndrome who already have a large tongue in the preoperative period and who already have limited airway passages [14]. In two different studies, it was stated that respiratory complications seen in the post-operative period in children with Down syndrome will occur up to 8 times more than healthy patient group [15,16]. This may be related to the already restricted airway passage being completely closed by non-massive tongues swelling. In line with this, Walker et al. [17] found that the children who underwent adenoidectomy and tonsillectomy surgeries and who were followed up in pediatric intensive care unit for respiratory reasons were those with Down syndrome (9.8%). And also, they stated that tongue size and position could be the determining factors for respiratory events in these pediatric patients.

As reported by Gerkhe et al. [18], all of the patients who had experienced a respiratory complication 3–24 h post adenotonsillectomy surgeries had syndromes that cause the airway to narrow preoperatively. In another study, including patients with

craniofacial anomalies or they had been previously subjected to upper airway trauma that causes the preoperative narrowing of airway passage, implicated that respiratory complications were more common in these patients even if they were completely awake in the postoperative period [4]. Brown et al. [19] noted in a research that respiratory-related complications that did not develop in less than 1 h after adenotonsillectomy surgeries but emerged 1–8 h postoperatively constitute one-third of the respiratory complications; however, they did not investigate the causes of these complications. We want to note that the duration of being noticed clinical consequences of non-massive tongue swelling may take up to 2-2.5 hours [20].

In that patients, closure of the narrowed airway passage due to the gradually developing non-massive tongue swelling may be associated with postoperative respiratory complications caused by upper airway obstruction. It is important to note the diagnosis of non-massive tongue swelling by USG in children while undergoing adenoidectomy in order to prevent postoperative respiratory complications caused by upper airway obstruction.

Our study contributed to the current literature from 3 different perspectives. First, we determined that, non-massive tongue edema may occur even in short-term surgeries depending on the pressure applied by the tongue depressor on the tongue. Second, we determined that non-massive tongue edema cannot be seen with the naked eye, but can be detected by USG, and may only have clinical consequences in patients with a narrowed upper airway. Third, we made inferences about the differences between massive and non-massive tongue edema.

Limitation

Our study has some limitations. There is no available study in the literature evaluating TSA values in children. So, we do not know the normal range of TSA values in children and we cannot compare in terms of size. However, we would like to point out that the same trained anesthetist were conducted all measurements in terms of being objective. Low TSA values may be due to the small number of patients. In future studies with more cases in healthy children, the normal values of TSA measured by USG can be revealed. In this study, we measured TSA because it is more practical rather than measuring thickness and width. We could also have more objective results if we could perform the other tongue measurements such as volume, thickness several times in post-anesthesia care unit and ward with 3-dimension USG. Since the cases were children, we did not consider comparing them with CT to avoid radiation. However, comparative studies can be done with MRI in the future. A group of high-risk patients for post-operative upper airway obstruction would demonstrate our clinical results more objectively. The effects of non-massive tongue edema on clinical outcomes need to be examined.

Conclusion

In children who underwent adenoidectomy surgeries, non-massive tongue swelling may have emerged due to the compression exerted by the tongue depressor. Non-massive tongue swelling can be detected by USG and it may positively affect clinical outcomes by alerting the clinician early, in terms of upper airway obstruction especially in high-risk patients in whom used intraoperative

tongue depressors.

Conflict of interests

The authors declare that they have no competing interests.

Financial Disclosure

All authors declare no financial support.

Ethical approval

This research was approved by the Selçuk University Medical Faculty Research Ethics Board (No. 2018/331), with ClinicalTrials.gov Identifier: NCT04256590 and it was conducted in accordance with the ethical principles laid down in the Declaration of Helsinki.

References

1. Bhattacharyya N. Ambulatory pediatric otolaryngologic procedures in the United States: characteristics and perioperative safety. *Laryngoscope*. 2010;120:821-5.
2. Gabriel OT, Oyebanji O. A review and outcome of adenoidectomy performed in resource limited settings. *Indian J Otolaryngol Head Neck Surg*. 2019;71:1-4.
3. Sjogren PP, Thomas AJ, Hunter BN, et al. Comparison of pediatric adenoidectomy techniques. *Laryngoscope*. 2018;128:745-9.
4. Rosen GM, Muckle RP, Mahowald MW, et al. Postoperative respiratory compromise in children with obstructive sleep apnea syndrome: can it be anticipated? *Pediatrics*. 1994;93:784-8.
5. Tanaka N, Ibuki T, Araki A, et al. Airway obstruction caused by massive swelling of the tongue following bilateral tonsillectomy for sleep apnea syndrome. *Masui*. 2006;55:464-7.
6. Nasr VG, Bitar MA, Chehade JM, et al. Postoperative severe uvular edema following tonsillectomy in a child with a history of obstructive sleep apnea. *Paediatr Anaesth*. 2008;18:673-5.
7. Wojtczak JA. Submandibular sonography: assessment of hyomental distances and ratio, tongue size, and floor of the mouth musculature using portable sonography. *J Ultrasound Med*. 2012;31:523-8.
8. Onal M, Colpan C, Elsurur C, et al. Is it possible that direct rigid laryngoscope-related ischemia-reperfusion injury occurs in the tongue during suspension laryngoscopy as detected by ultrasonography: a prospective controlled study. *Acta Otolaryngol*. 2020;140:583-8.
9. Harris VC, Dalesio NM, Clark J, et al. Postoperative Respiratory Complications and disposition in patients with type I laryngeal clefts undergoing injection or repair – A Single Institution Experience. *Int J Pediatr Otorhinolaryngol*. 2020;131:109844.
10. Ekstein M, Zac L, Schwartz R, et al. Respiratory complications after adenotonsillectomy in high-risk children with obstructive sleep apnea: A retrospective cohort study. *Acta Anaesthesiol Scand*. 2020;64:292-300.
11. Chorney SR, Dailey JF, Zur KB. Pediatric adenoidectomy in the very young child and indications for postoperative inpatient admission. *Int J Pediatr Otorhinolaryngol*. 2020;130:109796.
12. Tasli H, Birkent H, Karakoc O, et al. The effect of obesity on transnasal flexible laryngoscopy. *J Voice*. 2019;23:30216-7.
13. Ishman SL, Chang KW, Kennedy AA. Techniques for evaluation and management of tongue-base obstruction in pediatric obstructive sleep apnea. *Curr Opin Otolaryngol Head Neck Surg*. 2018;26:409-16.
14. Farhood Z, Isley JW, Ong AA, et al. Adenotonsillectomy outcomes in patients with Down syndrome and obstructive sleep apnea. *Laryngoscope*. 2017;127:1465-70.
15. Thottam PJ, Choi S, Simons JP, et al. Effect of adenotonsillectomy on central and obstructive sleep apnea in children with down syndrome. *Otolaryngol Head Neck Surg*. 2015;153:644-8.
16. Goldstein NA, Armfield DR, Kingsley LA, et al. Postoperative complications after tonsillectomy and adenoidectomy in children with Down syndrome. *Arch Otolaryngol Head Neck Surg*. 1998;124:171-6.
17. Walker P, Whitehead B, Rowley M. Role of paediatric intensive care following adenotonsillectomy for severe obstructive sleep apnoea: criteria for elective admission. *J Laryngol Otol*. 2013;127:26-9.
18. Gehrke T, Scherzad A, Hagen R, et al. Risk factors for children requiring adenotonsillectomy and their impact on postoperative complications: a retrospective analysis of 2000 patients. *Anaesthesia*. 2019;74:1572-9.
19. Brown KA, Morin I, Hickey C, et al. Urgent adenotonsillectomy: an analysis of risk factors associated with postoperative respiratory morbidity. *Anesthesiology*. 2003;99:586-95.
20. Chan MT, Chan MS, Mui KS, et al. Massive lingual swelling following palatoplasty. An unusual cause of upper airway obstruction. *Anaesthesia*. 1995;50:30-4.