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Swallowing patterns after adenotonsillectomy in children

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ABSTRACT

Importance: Hypertrophy of the pharyngeal and palatine tonsils can interfere with breathing, physical and cognitive development, and quality of life, including sleep quality. There are important relationships between the muscles of the airways, the anatomy, and the pattern of breathing and swallowing.
Objective: The aims of the present study were to evaluate the swallowing process in children after adenotonsillectomy undertaken to treat obstructive breathing disorders.
Methods: Subjects were 85 children or adolescents who underwent adenotonsillectomy in a reference hospital between 2003 and 2007. For the clinical evaluation of swallowing, the protocol of orofacial myofunctional evaluation with scores (OMES) was used, videofluoroscopy of deglutition was performed, and the Dysphagia Outcome and Severity Scale (DOSS) and Classification for Severity of Dysphagia to Videofluoroscopy Scale were applied for analysis.
Results: Out of the 85 evaluated children, 43 were male (50.59%), the average age at evaluation was 12.11 years, the average age at the time of surgery was 6.73 years, and post-surgery time was 3.00–8.00 years. In the clinical evaluation of swallowing, half the sample (50.59%) recorded the poorest score for lip and tongue behavior. A score of 1 was observed in 67.06% of subjects for other behaviors, and in 15.30% of subjects for efficiency of swallowing. Videofluoroscopic analysis demonstrated that the most frequent swallowing alterations were labial sealing (50.59%), residue in vallecula (51.76%), and use of compensatory maneuvers (61.18%). Analysis of DOSS showed that normal swallowing was attributed to 48.31% of subjects at level 7, 44.95% at level 6, and 6.74% at level 5. For the Classification for Severity of Dysphagia to Videofluoroscopy, 75.28% were classified as having mild dysphagia.
Interpretation: Alterations in the dynamics of swallowing are common in children who have undergone surgery of the tonsils, even at late follow-up.

KEYWORDS
Deglutition, Deglutition disorders, Adenoids, Palatine tonsil, Child

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INTRODUCTION

Hypertrophy of the pharyngeal and palatine tonsils occurs mainly in children aged between 3 and 5 years (preschool age), a period during which most tonsillar growth is observed. This growth can interfere with breathing patterns, resulting in predominant mouth-breathing, or even obstructive breathing disorders such as snoring and apneas, causing various consequences including changes in physical and cognitive development, school learning development, behavior, and life quality, including sleep quality.[1,2]

Sleep-disorder breathing is correlated not only with hypertrophy of the tonsils, but also with reduced muscular coordination and alteration of orofacial functions involving the stomatognathic system, consisting of suction, mastication, swallowing, nasal breathing and speech (phonetics).[3-5]

There are important relationships between the muscles of the airways, the anatomy, and the patterns of breathing and swallowing. Any alteration of this physiologic system may induce deficits in the development of the stomatognathic system.[3,6] Studies show, with a moderate level of evidence, a correlation between atypical swallowing in children and nasal obstruction;[7] however, little research has been conducted into the dynamics of swallowing from the oral phase to the pharyngeal phase. A study of children with acute tonsillitis and recurrent tonsillitis showed abnormally high electric activity of the masseter and infrahyoid muscles during swallowing, indicating the importance of this investigation type.[8]

The indication for adenotonsillectomy is obstructive sleep-disordered breathing in almost 77% of children, and adenotonsillectomy is recommended as the gold standard treatment for obstructive sleep apnea (OSA).[9-11] Although adenotonsillectomy is widely applied worldwide, the success rate is not 100%. Thus, it is essential to carefully consider the apnea-hypopnea index (AHI), oxygen desaturation index (ODI), pulse oxygen saturation (SpO_2) nadir and the presence of rhinitis and/or obesity to determine the best treatment with measurable benefits following treatment interventions.[6,12,13]

At long-term follow-up after surgery, it is still unclear how frequently some symptoms persist as a result of craniofacial growth disorders already established during the period of airway obstruction.[3] The obstructive symptoms can continue after adenotonsillectomy alone,[14] with AHI worsening over time in 68% of cases.[15] Thus, long-term follow-up studies are needed to monitor specific parameters such as orofacial functions. Improvement in myofunctional status seems to occur in children immediately after surgery, predominantly during the first 6 months after the surgical procedure; however, in the long term, myofunctional status may be hampered by persistent obstructive symptoms.[16]

The aims of the present study were to evaluate the swallowing process at the late follow-up stage in children who had undergone adenotonsillectomy to correct obstructive breathing disorders.

METHODS

The present study was approved by the Ethics Committee at the Botucatu Medical School/UNESP (protocol number 3447/2010), and the evaluation was carried out after obtaining written informed consent from the parents or carers responsible for the participants.

We invited all 900 children or adolescents who underwent adenotonsillectomies at the reference hospital between 2003 and 2007, to allow for a minimum of 3 years of follow-up at the date of request. The indications for adenotonsillectomy in all the children were obstructive breathing disorders characterized clinically by loud and persistent snoring for at least four nights per week during the last month, predominant mouth-breathing, observed apneas, restless sleep, presentation of pharyngeal tonsils at grade III or IV on the Brodsky scale at routine otolaryngologic examination, and adenoids occupying more than 80% of the cavum.[17] Children with neurological diseases and genetic syndromes were excluded.

The validated orofacial myofunctional evaluation with scores (OMES) protocol was used to clinically evaluate swallowing.[18] The evaluated items referring to swallowing function were: lip behavior (sealing of the oral cavity and presence of tension); tongue behavior (tongue position during swallowing); other behaviors (tension in other muscles or food escape); and efficiency of swallowing (how many deglutitions are necessary to complete swallowing). Each item was scored from 3 (best condition) to 1 (worse condition).

Videofluoroscopy of deglutition was carried in the radiography sector (Prestilix, model 1600X, 1000 mA, 130 kV; GE). The examination table for the radiological exam was positioned at a 90° angle. The images were transmitted to a video monitor (Sony, model PVM-95E) and were recorded on video and then digitized. The children were seated to expose a lateral view to the X-ray equipment. They were offered 5 mL of a liquid mixture of 50% barium sulfate (apple flavored barium sulfate contrast 100%, Cristalia/Brazil) and 50% water.[19]

To assess the videofluoroscopy of swallowing, we considered the following areas.

- A description of deglutition considering[20] the labial seal, anterior oral leak, tongue-palate contact, oral ejection, residue in the oral cavity, oral transit time, posterior oral leak, nasal escape, residue in the valleculae, residue in the pharynx, pharyngeal transit

TABLE 1 Age, sex, and postoperative follow-up time of subjects

Characteristics	Mean (years)	SD	Median	Minimum	Maximum
Age at surgery	6.73	2.31	7.00	3.00	13.00
Age at postoperative evaluation	12.11	2.36	12.00	7.00	19.00
Postoperative follow-up time	5.38	1.39	5.00	3.00	8.00
Body mass index	22.08	5.54	21.62	13.42	40.31

SD, standard deviation

time, laryngeal elevation, presence of penetration and/or aspiration, coughing, and the use of compensatory maneuvers. The assessment recorded the presence or alteration of all items, except for oral ejection, oral transit time, and pharyngeal transit time, which were recorded as being normal or slowed.

· Dysphagia Outcome and Severity Scale (DOSS)[21]: The scale classifies the degree of swallowing dysfunction ranging from 7 (normal swallowing) to 1 (severe dysphagia: incapable of safe oral feeding).
· Classification for Severity of Dysphagia to Videofluoroscopy[22]: The severity is classified as normal swallowing, mild dysphagia, moderate dysphagia or severe dysphagia, through analysis of oral control, pharyngeal response, residue in vallecula, penetration, and laryngotracheal aspiration.

Normative data were based on the literature, as normal patterns of swallowing dynamics are already well established. The inclusion of a control group composed of healthy children was not permitted by the local Ethics Committee, as the exposure to radiation was considered unnecessary and harmful.

Data analysis of the descriptive statistics was performed using the mean, standard deviation, minimum and maximum age at surgery, age at postoperative follow-up evaluation, post-surgery time, weight, height and body mass index. The findings of the swallowing dynamics were described by their frequency (%).

Inductive statistics were performed to correlate the clinical evaluation of swallowing, swallowing characteristics, and videofluoroscopy scales with sex, age at surgery, age at postoperative follow-up evaluation, post-surgery time, and body mass index. Statistical analysis was undertaken using the ANOVA test, Pearson's correlation, *t*-test and chi-squared test. A *P* value less than 0.05 was considered to be significant.

RESULTS

Of the 900 children who underwent adenotonsillectomy during the inclusion period, 220 patients were able to be contacted by phone, and 85 children agreed to return for re-evaluation.

Of these, 43 were male (50.59%), and the average age at evaluation was 12.11 years. Postoperative follow-up time varied between 3.00 and 8.00 years, and the mean age at surgery was 6.73 years. Table 1 outlines the age, sex, and postoperative follow-up time of the study subjects.

For the OMES protocol, the descriptive results for each item were as follows. For lip behavior, 18.82% of the participants recorded a score of 3, 30.59% a score of 2, and 50.59% recorded the poorest performance with a score of 1. In the item tongue behavior, 27.06% recorded a score of 3, 14.12% a score of 2, and more than half (58.82%) recorded a score of 1. Regarding other behaviors, 18.82% had a score of 3, 14% a score of 2, and 67.06% a score of 1. Scores for efficiency of swallowing were 25.88% (score 3), 58.82% (score 2) and 15.30% (score 1) (Figure 1). The poorest results were in other behaviors, associated with head movement during swallowing.

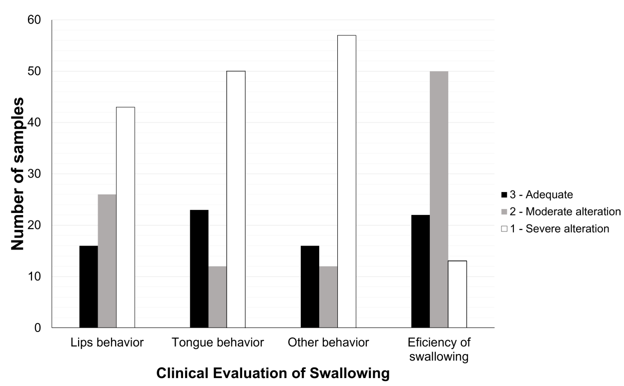

FIGURE 1 Clinical evaluation of the swallowing item using the validated orofacial myofunctional evaluation with scores (OMES) protocol.[18]

The final OMES scores showed a mean value of 7.31 (standard deviation 1.78) with a minimum score of 4 (the poorest score, related to greater change) and a maximum of 12 (the best score).

The analysis of videofluoroscopy demonstrated that the most frequent swallowing alterations were labial sealing in (50.59%), residue in vallecula (51.76%) and use of compensatory maneuvers (spontaneous maneuvers involving backward movement of the head during swallowing; 61.18%). Individuals presented with anterior oral leak, oral transit time, and adequate pharyngeal transit time; none presented with coughing, penetration, aspiration, posterior oral leak, or nasal leak of the food (Table 2).

TABLE 2 Swallowing characteristics from the analysis of videofluoroscopy (*n* = 85)

Swallowing characteristics	Adequate *n* (%)	Alteration *n* (%)
Labial sealing	42 (49.41)	43 (50.59)
Anterior oral leak	84 (98.82)	1 (1.18)
Tongue-palate contact	85 (100.00)	0 (0.00)
Oral ejection	76 (89.41)	9 (10.59)
Residue in oral cavity	73 (85.88)	12 (14.12)
Oral transit time	84 (98.82)	1 (1.18)
Posterior oral leak	82 (96.47)	3 (3.53)
Nasal leak	85 (100.00)	0 (0.00)
Residue in vallecula	41 (48.24)	44 (51.76)
Residue in pharyngeal	80 (94.12)	5 (5.88)
Pharyngeal transit time	84 (98.82)	1 (1.18)
Laryngeal elevation	85 (100.00)	0 (0.00)
Penetration and/or aspiration	85 (100.00)	0 (0.00)
Cough	85 (100.00)	0 (0.00)
Use of compensatory maneuvers	33 (38.82)	52 (61.18)

DOSS showed normal swallowing in 48.31% of participants at level 7, 44.95% at level 6, and 6.74% at level 5. In our sample, no child showed swallowing patterns compatible with levels 4, 3, 2 or 1 (Figure 2).

However, when analyzing the Classification for Severity of Dysphagia to Videofluoroscopy[22] Scale, in which oral motor control is considered, poorer results were observed, with 24.72% and 75.28% of the children being classified as having normal swallowing and mild dysphagia, respectively. No individuals recorded moderate or severe dysphagia, as no penetration or aspiration was observed (Figure 3).

Among all the correlations of the inductive statistics, significancy was verified only between oral ejection and sex, with oral ejection alterations being more common in females (Table 3).

DISCUSSION

The biological function of the upper airway structures is to promote the passage of air and food from the oral cavity to the oropharynx. The dynamics of these structures

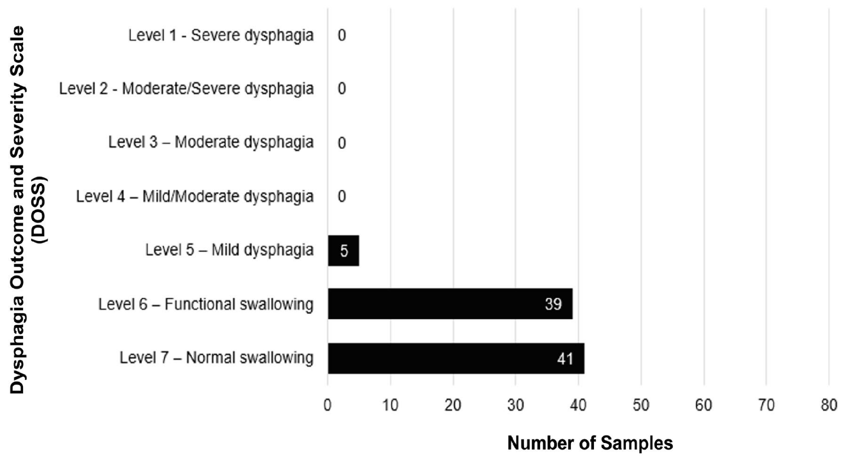

FIGURE 2 Results of the Dysphagia Outcome and Severity Scale (DOSS[21]; number of children at each level).

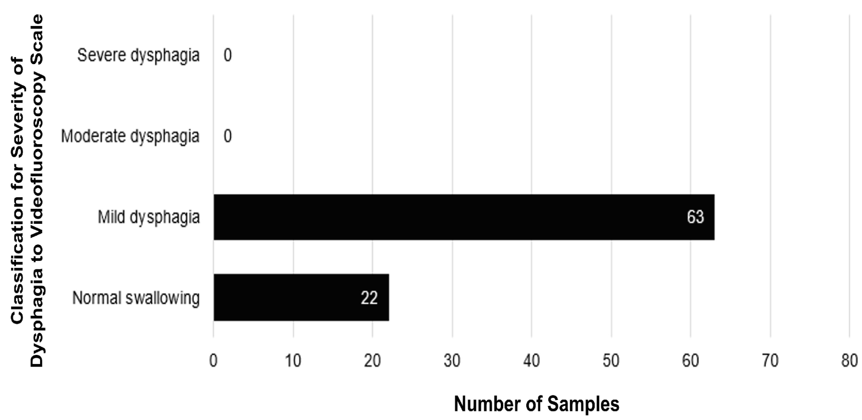

FIGURE 3 Results of the Classification for Severity of Dysphagia to Videofluoroscopy Scale, measuring normal swallowing, and mild, moderate or severe dysphagia.

TABLE 3 Correlation between clinical evaluation of swallowing, swallowing characteristics, and videofluoroscopy scales with sex, age at surgery, age at postoperative follow-up evaluation, postoperative follow-up time, and body mass index.

Variables	Gender	Age at surgery	Age at postoperative follow-up evaluation	Postoperative follow-up time	BMI
Clinical evaluation of swallowing	0.56	0.20	0.36	0.56	0.94
Swallowing characteristics - Oral ejection	0.01*	0.50	0.89	0.17	0.63
Videofluoroscopy Scales- DOSS	0.33	0.22	0.59	0.27	0.49
Videofluoroscopy Scales- Classification for Severity of Dysphagia to Videofluoroscopy	0.58	0.45	0.58	0.76	0.30

BMI, Body mass index; *, $P < 0.05$ was considered significant; Statistical tests used: Chi square test, *t*-test, ANOVA test, and Pearson test

may be impaired when there are obstructive factors in the upper airway. Lack of coordination between breathing and swallowing or actual obstruction can interfere with the pharyngeal phase of swallowing and result in symptoms of dysphagia. These alterations in oropharyngeal sensitivity are associated with the attenuation of modulatory inputs of the reflex and central control of swallowing.[23]

In the clinical evaluation of swallowing, we observed important alterations in the four categories assessed: lips, tongue, other behaviors, and the efficiency of swallowing. These findings are in accordance with previous studies in the literature that evaluated children with tonsillar hypertrophy and OSA and reported lower swallowing scores.[4,5]

Chronic oral breathing causes sagging of the muscles and alterations to the habitual position of the orofacial structures that can interfere directly with the swallowing dynamic.[7] Although only 1.18% of participants in this study presented with anterior oral leak, there was no labial sealing in 50.59% of our sample, causing a decrease in intraoral pressure and consequently, decreased sensitivity/sensibility and coordination of the phases of swallowing.[5,24] In contrast, participants who could manage labial sealing (49.41%) may have required higher muscular effort due to the requirement of sealing f without lip competence during functional activities.[25]

For the ability to achieve oral ejection, 10.59% of participants recorded alterations, and 14.12% had residue in the oral cavity. The poor performance of lip and tongue behavior observed at the clinical evaluation can explain the oral ejection alteration, demonstrating the close relationship between clinical and instrumental evaluation.[26] This highlights the fact that one protocol does not exclude the other due to the possibility of silent aspiration which is verified by videofluoroscopy.[27]

Residue in vallecula was found in 51.76% of cases, which may be explained by alterations in the oral phase.[28] This may be related to the use of compensatory maneuvers during swallowing, given that backward movement of the head was observed in 61.18% of participants as an attempt to improve the mobility of the oropharyngeal region, mobilize the food, and compensate for the swallowing alterations.[29] Similar compensatory maneuvers were observed in another study that evaluated deglutition in mouth-breathing children with hypertrophy of the tonsils.[30]

Analysis of DOSS and the Classification for Severity of Dysphagia to Videofluoroscopy Scale revealed that more than half of our studied population recorded mild alterations to deglutition (51.69% and 74% respectively). This difference may be attributed to the inclusion of motor control criteria. These results were not able to be compared with other studies because of the lack of publications in the pediatric population.

The findings of the present study indicate that even after the removal of the tonsils, sequelae persist in the orofacial structures and functions, specifically in the swallowing function. Long-term follow-up studies are lacking, but there is growing evidence that a multidisciplinary approach has been more effective and is now recommended as the standard for following up children after tonsil surgery.[31]

Persistent changes in the dynamics of swallowing were common among the subjects studied. Surgery alone did not result in complete resolution of obstructive breathing disorders during sleep caused by hypertrophy of the tonsils. Thus, we strongly recommend that patients should be offered follow-up multidisciplinary evaluations involving oral functions such as swallowing.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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