Research Article

Oral and oral preparatory phase of swallowing in children with tonsil hypertrophy: Videofluoroscopy study

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Suggested Citation

Grechi, T. H., et al. (2015). Oral and oral preparatory phase of swallowing in children with tonsil hypertrophy: Videofluoroscopy study. *International Journal of Orofacial Myology*, 41(1), 6-15.

DOI: <https://doi.org/10.52010/ijom.2015.41.1.1>

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ORAL AND ORAL PREPARATORY PHASE OF SWALLOWING IN CHILDREN WITH TONSIL HYPERTROPHY: VIDEOFUOROSCOPY STUDY

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ABSTRACT

The purpose of this research was to determine the effect of respiratory obstruction due tonsils hypertrophy on bolus organization, lip posture, bolus propulsion, and on associated head and mandible movements during the preparatory oral and oral phases of swallowing in children. This is a transversal study in children with tonsils hypertrophy (Group 1 - n = 21, 8 girls and 13 boys; mean age 4.5 years) and nasal breathers children without tonsils hypertrophy (Group 2 - n = 10, 4 girls and 6 boys; mean age 4.6 years). The groups were evaluated for respiratory patterns (oroscopia, anterior rhinoscopy and nasopharyngoendoscopy), dental evaluation and videofluoroscopy of swallowing, for liquids and paste food. No significant differences were detected ($p>0.05$) between groups regarding liquid volume ingested, bolus organization, lip posture, bolus propulsion, or the presence of associated head and mandible movements. The results indicate that respiratory obstruction caused by tonsil hypertrophy in children with normal occlusion did not influence the variables studied regarding the preparatory oral and oral phases of swallowing for both consistencies.

KEYWORDS: Videofluoroscopy; Mouth breathing; Swallowing;

INTRODUCTION

Hypertrophy of the pharyngeal and palatine tonsils is considered to be one of the main etiologic factors of mouth breathing in childhood (Niedzielska, Kotowski, & Niedzielski, 2008; Ysunza, Pamplona, Ortega, & Prado, 2008). Chronic respiratory obstruction in the nasal and/or pharyngeal region may cause obstructive sleep apnea (Grycznska, Powajbo, & Zkrzewska, 1995; González Rivera, Corominalsern, & Gay Escoda, 2004; Ward, & Marcus, 1996), snoring (González Rivera, Corominalsern, & Gay

Escoda, 2004; Valera, Trawitzki, Mattar, Matsumoto, Elias, & Anselmo-Lima, 2003), increased episodes of respiratory infection (Valera et al., 2003, Aydogan, Toprak, Hatun, Yuksel, & Gokalp, 2007; Emerick, & Cunningham, 2006), otitis (Haapaniemi, 1995), and mouth breathing (Valera, et al., 2003; Haapaniemi, 1995; Bahadir, Caylan, Bektas, & Bahadir, 2006).

The change in breathing pattern from nasal to oral, when prolonged, alters the orofacial

musculature and may have negative effects on craniofacial growth and development (González Rivera, et al., 2004; Valera, et al., 2003; Gola, Cheynet, Guyot, Richard, & Sauviant, 2000; Nishimura, & Suzuki, 2003; Valera, Trawitzki, & Anselmo-Lima, 2006). The dental and skeletal changes frequently described in this population are: vertical increase in the lower third of the face (Valera, et al., 2003; Pereira, Motonaga, Faria, Matsumoto, Trawitzki, Lima, & Anselmo-Lima, 2001) and dental occlusion alterations such as cross bite (Schlenker, Jennings, Jeiroudi, & Caruso, 2000). The muscular and functional characteristics detected in mouth breathers mainly consist of modifications of lips and of the tongue (Valera, et al., 2003; Pereira, et al., 2001), changes in mastication and oral phase of swallowing (Valera et al., 2003; Pereira et al., 2001; Jäghagen, Berggren, & Isberg, 2000; Jäghagen, Franklin, & Isberg, 2003; Lundeborg, McAllister, Graf, Ericsson, & Hultcrantz, 2009).

In a previous study by our group (Valera et al., 2003) it was observed that mouth breathing children aged 3 to 6 years presented a predominance of absent or a systematic lip sealing, lower tongue position, and interposition of tongue and lips during swallowing. By interviewing the parents, it was also determined that these children preferred foods of liquid or paste consistency and drank fluids during the ingestion of solids as a possible facilitating strategy during the mastication.

Studies using videofluoroscopy of swallowing have reported alterations in bolus control and swallowing dysfunction for liquid and solid consistency in adult snorers and in adult patients with obstructive sleep apnea (Jäghagen et al., 2000; Jäghagen et al., 2003). In contrast to a clinical functional evaluation, assessment of swallowing by videofluoroscopy records, permits a detailed and precise analysis of the behavior of swallowing without altering it during the exam. Its advantages include the ability to provide a dynamic view of all the stages of swallowing, and its use in children is increasingly widespread and it is

considered by many to be the gold standard test (Hiorns, & Ryan, 2006). The objective of the present study was to assess the effects of nasal obstruction by tonsillar hypertrophy in children with normal occlusion on the volume of ingested fluid, bolus organization, lip posture, bolus propulsion, associated head and mandible movements during the preparatory oral and oral phases of swallowing regarding liquid and paste consistency.

METHOD

The study was approved by the Research Ethics Committee of the University Hospital, School of Medicine of Ribeirão Preto, University of São Paulo (nº. 12462/2004). All persons responsible for the volunteers gave written informed consent to participate.

Two groups of children participated in the study: mouth breathers (group 1) with tonsils and adenoids hypertrophy $n = 21$, 8 girls and 13 boys; age range: 3 years-6 years and 8 months; mean age: 4.5 years) and nasal breathers (group 2) with absence of hypertrophy of the adenoids and tonsils ($n = 10$, 4 girls and 6 boys; age range: 3-6 years; mean age: 4.6 years). Both groups underwent otorhinolaryngologic and orthodontic evaluation in order to determine if they fulfilled the inclusion and exclusion criteria.

In the clinical otorhinolaryngologic evaluation, anterior rhinoscopy was used to determine the presence of septal deviation and changes in the color and trophism of the nasal turbinates. Examination of the oral cavity (oroscopy) was used to investigate the degree of palatine tonsil hypertrophy based on the classification of Brodsky (1989). Nasopharyngoendoscopy was performed using a Pentax FNL – 10RP2 flexible fiberscope 3.4mm and the adenoids size was estimated by the percentage of the area of the posterior choana occluded by them. Patients were classified as mouth breathers when presenting with respiratory complaints for more than 3 months, even if only at night, and who presented obstructive alteration, i.e., adenoids hypertrophy (more than 70%

obstruction of the posterior area of the choana), associated or not with tonsils hypertrophy (Brotsky grade 3 or 4). The children classified as nasal breathers did not present respiratory symptoms for more than 15 consecutive days, and adenoids hypertrophy occupying less than 40% of nasopharynx and palatine tonsils of Brotsky grade 1 and 2 as well as absence of nasal changes such as septal deviation and hypertrophy of the inferior turbinates.

Orthodontic evaluation consisted of intraoral clinical inspection to determine the dentition phase and to assess the occlusal characteristics, as well as the dental conditions of the children. Dental occlusion was considered to be normal when a straight terminal plane or a plane with a mesial step was identified in the second deciduous molars, with the mesial surface of the cusp of the upper canines occluding the distal surface of the lower canines (Class I pattern), and with the presence of normal overbite and overjet of the deciduous incisors. All children included in the study were free of extensive caries and had normal occlusion. Children with genetic syndromes, congenital and acquired dental facial deformities, dental malocclusion, extensive dental caries and those with a history of neurologic, gastro esophageal reflux, functional orthodontic and/or orthopedic and speech therapy treatments were excluded from the study.

Swallowing was evaluated by videofluoroscopic examination, considered the gold standard for the qualitative assessment of swallowing, allowing general observation of the events in the pharyngeal and laryngeal cavities and a complete analysis of bolus transit, with minimal exposure to radiation (Hiorns, & Ryan, 2006; Beck, & Gayler, 1990). The examinations were performed at the Radiology Service of HCFMRP-USP using a Philips model BV Pulsera instrument. The images were recorded on a Philips DVD+RW using a recorder coupled to the instrument, Medical DVD Recorder, MDVDR – 100. The same investigator performed all examinations. During the videofluoroscopic evaluation of

swallowing the children sat on a chair with a back support adapted for their height and wore a lab coat for radiologic protection. The liquid bolus consisted of 50 mL of chilled orange juice plus 15 mL of liquid (viscosity 701,4 centipoises) barium sulfate contrast (Bariogel® 100%, Cristália, Itapirica, SP, Brazil) offered in a disposable plastic cup. The bolus of paste consistency was prepared with 50 mL of chilled yogurt plus 15 mL of liquid barium sulfate offered on a standardized 3 mL spoon. The videofluoroscopic images of swallowing were captured in the lateral view. The recordings were obtained during swallows, with an acquisition rate of 30 frames per second, and stored on DVD+RW (Philips). The average time of exposure to radiation was 2.5 minutes. Since this is a radiological exam, the exposure to radiation was initially a matter of great concern among the authors. Guidelines disagree about the maximum exposure time, varying from 30 seconds to 5 minutes (mean 2.3 – 3.5 minutes) (Jolley, McClelland, & Mosesso-Rousseau, 1995).

The liquid volume (mL) ingested was estimated by the investigator. The child produced a free swallow and returned the cup to the investigator, who measured the volume left to estimate the volume swallowed. The paste bolus was offered in a controlled volume of 3 mL. The paste bolus was extracted with a disposable syringe and deposited on a metal spoon.

The types of bolus organization considered were: tipper, when the food bolus was positioned directly on the dorsum of the tongue and the tip of the tongue was positioned in contact with the anterior region of the maxilla (Dodds, Taylor, Stewart, Kern, Logemann, & Cook, 1989); dipper, when most of the bolus was positioned beneath the anterior part of the tongue and the tip of the tongue was projected antero-inferiorly at the beginning of swallowing (Dodds et al., 1989) elongated when the bolus was positioned on the tongue from the anterior to the posterior region at the level of the soft palate (Junqueira, & Costa, 2013); unstable, when difficulty in keeping the bolus on the tongue was observed, with oscillation in its

intraoral position and without constancy of its organization (Junqueira, & Costa, 2013). Lip posture was observed during the preparatory oral phase of swallowing, with the lips being considered to be sealed when the upper and lower lips touched, or not sealed in the absence of this touch. Bolus propulsion, i.e., the posterior displacement of the bolus, was classified as adequate when the entire volume ingested was propelled towards the pharynx in a single movement, and as multiple when at least two swallows were necessary to propel it. The presence of associated head movements and of mandible dislocation forward and laterally during bolus propulsion was also observed.

Statistical Analysis

The Fisher exact test was used to determine the association between categorical variables (organization of the bolus, lip posture, bolus propulsion and presence of associated head and mandible movements). The Mann-Whitney

test was used for the analysis of the volume variable. The statistical analysis of this methodology was performed using the PROC FREQ procedure of the SAS ® 9.0 software.

RESULTS

The degree of tonsils hypertrophy of both groups is presented in Table 1. No significant difference in mean liquid volume ingested with each swallow was observed between groups Table 2.

There was no significant difference ($p>0.05$) between the groups regarding variables of bolus organization, lip posture, bolus propulsion and the presence of associated head and mandible movements during the ingestion of the liquid or paste bolus Tables 3 and 4.

Table 1. Degree of tonsils hypertrophy in both groups.

Groups	N	Degree of adenoids hypertrophy	Degree of tonsils hypertrophy
Mouth breathers	21	6 (29%) - 90 – 100% 15 (71%) - 70 – 80%	12 (57%) degrees 3 and 4 9 (43%) degrees 1 and 2
Nasal breathers	10	10 (100%) - 30 – 40%	10 (100%) degrees 1 and 2
N: number of subjects			

Table 2. Volume (mL) of liquid consistency swallowed by each group.

Groups	Consistency	N	Mean	SD	Minimum	Median	Maximum	P-value
Mouth breathers	Liquid	21	5.7	2.9	2	5	14	0.91
Nasal breathers	Liquid	10	6.1	3.9	2	5	17	
Mann-Whitney test								
N: number of subjects								
SD: Standard deviation								

Table 3. Association between categorical variables (bolus organization, lip posture, bolus propulsion and presence of associated movements) for a bolus of liquid consistency.

Variables		Groups		P-value
		Mouth breathers	Nasal breathers	
Bolus organization	Tipper	9 (42.9%)	4 (40.0%)	0.58
	Dipper	8 (38.1%)	6 (60.0%)	
	Elongated	2 (9.5%)	0 (0.0%)	
	Unstable	2 (9.5%)	0 (0.0%)	
Lip posture	Not sealed	8 (38.1%)	3 (30.0%)	1.00
	Sealed	13 (61.9%)	7 (70.0%)	
Bolus propulsion	Adequate	19 (90.5%)	8 (80.0%)	0.58
	Multiple	2 (9.5%)	2 (20.0%)	
Associated movements	Absent	18 (85.7%)	6 (60.0%)	0.17
	Head	0 (0.00%)	0 (0.00%)	
	Mandible	3 (14.3%)	4 (40.0%)	

Fisher Exact Test.

P-value of <0.05 was considered statistically significant.

Table 4. Association between categorical variables (bolus organization, lip posture, bolus propulsion and the presence of associated movements) for a bolus of paste consistency.

Variables		Groups		P-value
		Mouth breathers	Nasal breathers	
Bolus organization	Tipper	10 (47.6%)	4 (40.0%)	0.21
	Dipper	8 (38.1%)	4 (40.0%)	
	Elongated	0 (0.0%)	1 (10.0%)	
	Unstable	3 (14.3%)	1 (10.0%)	
Lip posture	Not sealed	4 (20.0%)	2 (20.0%)	1.00
	Sealed	16 (80.0%)	8 (80.0%)	
Bolus propulsion	Adequate	15 (71.4%)	8 (80.0%)	1.00
	Multiple	6 (28.6%)	2 (20.0%)	
Associated movements	Absent	12 (57.1%)	4 (40.0%)	0.62
	Head	1 (4.8%)	0 (0.0%)	
	Mandible	8 (38.1%)	6 (60.0%)	
Fisher Exact Test.				
P-value of <0.05 was considered statistically significant.				

DISCUSSION

Chronic nasal obstruction due to tonsillar hypertrophy can have negative effects on dentofacial growth and development in addition to causing changes in the orofacial musculature, with an impact on oral functions (Valera et al., 2003; Valera et al., 2006; Pereira et al., 2001). Changes in the mastication and oral phase of swallowing have been observed in studies on children who are mouth breathers due to tonsillar hypertrophy and have occlusion alterations, but using only clinical evaluation (Valera et al., 2003; Valera et al., 2006). The gold-standard exam to evaluate the swallowing pattern is videofluoroscopy. A great advantage of the exam is that it can be recorded and later analyzed in greater detail regarding the visualization of the dynamics of swallowing. Studies that use videofluoroscopy of swallowing usually perform a quantitative

analysis with measurements of transit time between swallowing phases and a qualitative analysis considering the presence of stasis, penetration, and laryngeal aspiration. However, few studies have analyzed the patterns of bolus organization and propulsion and no study has performed this analysis in children with chronic nasal obstruction, perhaps due to the concern about the radiation exposure, since there were few indications about the secure exposure time for children. Although this matter, using just clinical evaluation can be inaccurate to access the intraoral movements and because of that the videofluoroscopy was used, concerning to use the minimal time of exposure.

The occlusal alterations that are commonly found in mouth breathers, such as atresia

maxilla (Lime, 1991), cross bite (Principato, 1991; Schelenker, Jennings, Jeiroudi, & Caruso, 2000) and anterior open bite (Bresolin, Shapiro, Shapiro, Dassel, Furukawa, Pierson, Chapko, & Bierman, 1984), directly influence the phases of swallowing (Junqueira, & Costa 2013). To eliminate such interference, the children with malocclusion have been eliminated to investigate more clearly the real effects of nasal obstruction in swallowing dynamics, which do not appear to be significant and suggesting that the occlusal alterations can play a key role in the stages of swallowing.

The mean volume (mL) of liquid bolus ingested in the present study was similar in mouth breathers and nasal breathers, with mean values at the range of 6 mL. A wide intragroup variability in the ingested volume was also observed in the sample studied. Other studies on healthy children of different age ranges have reported a mean volume of ingested liquid of 6.9 mL (Junqueira, & Costa, 2013) and 2.6 mL (Selley, Parrott, Lethbridge, Flack, Ellis, Jonstons, Foumeny, & Tripp, 2001).

Different patterns of bolus organization between groups were observed, which have not been described in the literature for this age range. In a study conducted on older children aged 8 to 12 years, organization of the tipper type was detected in 9% of children with normal occlusion (Junqueira, & Costa, 2013).

The lip seal and the swallowing movements of the tongue are important for the preparation, oral control and bolus propulsion (Kahrilas, Lin, Logemann, Ergun, & Facchini, 1993; Logemann, 2007). However, in mouth breathing children with enlarged tonsils and adenoid aged 3 to 6 years, mastication can occur with the absence of lip sealing, favoring tongue interposition during swallowing (Valera et al., 2003). Sealed lips were found in both groups during the preparatory oral and oral phase of swallowing, with no significant difference. In another clinical study on mouth breathers with enlarged adenoids aged 7 to 10 years, lip sealing during mastication of a piece

of bread occurred in 35.72% of cases and in a non-systematic manner in 42.85%, a fact that did not show relevance in this study. However, tongue interposition during swallowing of fluid was considered to be relevant because it occurred in 85.71% of cases (Pereira et al., 2001). An important aspect to be considered is that, in contrast to the cited clinical studies (Valera et al., 2003; Pereira, et al., 2001), in the present study the children had no occlusal changes. The cephalometric alterations observed in the cited studies may have contributed to the changes in the preparatory and oral phases of swallowing.

Bolus propulsion was adequate in both groups studied for the liquid and paste consistency, i.e., the entire volume ingested was propelled towards the pharynx in a single movement. Adequate bolus propulsion was reported to occur in 95% of the swallows in normal children aged 8 to 12 years (Junqueira & Costa, 2013).

Associated head movements during bolus propulsion were not observed, although a previous study of Valera et al. (2003) found the presence of this associated movement in 23% of swallows of solid consistency among children who were mouth breathers due to tonsil and adenoid hypertrophy.

In view of the above findings, some suggestions could be proposed for future studies using the same methodology, among them using food of solid consistency for analysis and children with different occlusion alterations.

CONCLUSION

The nasal obstruction due to adenoids and tonsils hypertrophy in children with normal occlusion did not influence videofluoroscopic pattern regarding liquid volume ingested, bolus organization, lip behavior, bolus propulsion, or the presence of movements associated head and mandible, for liquid and paste consistencies.

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