Case Report

https://doi.org/10.1590/2317-6431-2022-2741en

Audiology Communication Research
ISSN 2317-6431

Nasal patency in mouth breathing children

Patência nasal em crianças respiradoras orais

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ABSTRACT

Several studies have shown the importance of quantitative assessment in nasal patency and functional status of the upper airways to provide clinical and diagnostic information in oral breather individuals, which are of great interest to speech therapy. The aim of the study was to evaluate the effect of nasal saline solution irrigation on the upper airways through nasal aeration and active anterior rhinomanometry in oral breathing children. This was an eight case series study, carried out in children aged 7 to 10 years with an otorhinolaryngological clinical diagnosis of mouth breathing. The study consisted of three stages: (I) initial evaluation; (II) intervention; and (III) final evaluation. The questionnaires of the Index for the Identification of Oral Breathing Signs and Symptoms and disease-specific quality of life in pediatric patients with sinonasal complaints were applied, nasal aeration assessments and the anterior active rhinomanometry exam were carried out. The intervention was performed by irrigating nasal saline solution with 10ml. Afterwards, they were re-evaluated by nasal aeration evaluation and rhinomanometry to compare the results. Regarding nasal aeration and rhinomanometry evaluation, from the 16 comparative measurements between pre and post nasal irrigation, we obtained significant changes in nasal aeration and nasal resistance. Nasal irrigation resulted in improvement in nasal aeration measurements while nasal flow measurements from rhinomanometry remained unchanged considering pre and post nasal irrigation.

Keywords: Mouth breathing; Respiratory function tests; Rhinomanometry; Airway resistance; Diagnostic techniques respiratory system

RESUMO

Vários estudos mostram a importância da avaliação quantitativa na patência nasal e do estado funcional das vias aéreas superiores para fornecer informações clínicas e diagnósticas em indivíduos respiradores orais, as quais são de grande interesse para a fonoaudiologia. O objetivo deste estudo foi avaliar o efeito da irrigação de solução salina nasal nas vias aéreas superiores através da aeração nasal e rinomanometria anterior ativa em crianças respiradoras orais. Estudo de série de oito casos, realizado em crianças com idades entre 7 e 10 anos, com diagnóstico clínico otorrinolaringológico de respiração oral. O estudo consistiu em três etapas: avaliação inicial; intervenção e avaliação final. Foram aplicados os questionários do Índice de Identificação dos Sinais e Sintomas da Respiração Oral e qualidade de vida específica para doenças em pacientes pediátricos com queixas sinonasais. Realizaram-se as avaliações da aeração nasal e o exame da rinomanometria anterior ativa. A intervenção foi realizada por meio da irrigação de solução salina nasal com 10 ml. Em seguida, os pacientes foram reavaliados pela avaliação da aeração nasal e rinomanometria, para comparar os resultados. Em relação à avaliação da aeração nasal e rinomanometria, das 16 medidas comparativas entre pré e pós-irrigação nasal, constataram-se mudanças significativas na aeração nasal e na resistência nasal. A irrigação nasal resultou em melhora nas medidas da aeração nasal, enquanto para o fluxo nasal da rinomanometria, as medidas permaneceram inalteradas entre pré e pós-irrigação nasal.

Palavras-chave: Respiração bucal; Testes de função respiratória; Rinomanometria; Resistência das vias respiratórias; Técnicas de diagnóstico do sistema respiratório

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Conflict of interest: No.
Authors' contribution: MFIC, DAC, and HJS were responsible for conceptualization; MFIC and SRCM were responsible for methodology; DAC and HJS were responsible for supervision; SRCM, TFPB, LBCF, and NSL were responsible for assistance in completing the collections; MFIC, DAC, HJS, and TFPB were responsible for writing, review, and editing. All authors contributed significantly to this manuscript.
Funding: None.
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Received: November 09, 2022; **Accepted:** February 26, 2023

INTRODUCTION

Mouth breathing (MB) is an adaptation of the regular breathing pattern that can obstruct upper airways, thus hampering or even preventing the free passage of air through the nasal cavity. Among the nasal obstruction caused by several types of nasal diseases, the most frequent are rhinitis, nasal septum deviation, and pathological hypertrophy of adenoids and/or tonsils. Such changes in breathing favor the increase of nasal resistance, altering the nasal airflow, hence reducing nasal patency[(1)].

Nasal patency measures nasal aperture and is not equivalent to airflow or resistance to airflow. Currently, different instruments have been used to quantify nasal patency, such as Active Anterior Rhinomanometry (AARM). This test describes nasal patency by measuring the resistance of the nasal cavity to the passage of transnasal airflow and a pressure gradient throughout the breathing cycle[(2)].

Quantitative methods have an important role in evaluating the magnitude of the symptom, thus allowing the comparison of potential changes and features of the nasal function that interfere with nasal patency, hence with the breathing mode, in addition to providing results based on several treatments aimed at the improvement of nasal ventilation[(3)]. Thus, the more thorough the diagnosis, the greater the possibilities of prevention and control of changes in the stomatognathic system.

Some interventions aim to adequate the breathing through nasal irrigation to recover the breathing through the nasal cavities by improving nasal patency. In this context, the evaluation methods for nasal patency of Altmann Millimeter Nasal Mirror and Active Anterior Rhinomanometry might contribute to analyzing the efficacy of nasal ventilation and nasal resistance for comparing the different results of speech therapy interventions in mouth breather children[(4)].

It is worth highlighting the importance of nasal patency evaluation in mouth breathers since the breathing might be effective in improving nasal patency with the effect of irrigation of nasal saline solution on the upper airways.

This study aimed to evaluate the effect of irrigation with nasal saline solution on the upper airways through nasal ventilation and Active Anterior Rhinomanometry in mouth breather children.

PRESENTATION OF THE CLINICAL CASES

This study was approved by the Ethics Research Committee of the Federal University of Pernambuco, decision nº 3550527. We selected eight mouth-breather children aged between 7 and 10 years old, female and male, with complete otorhinolaryngologic evaluation and clinical diagnosis of nasal obstruction. All participants were recruited at the School Speech Therapy Clinic and Department of Clinic and Preventive Odontology of the Federal University of Pernambuco. The signs and symptoms of the mouth breathing mode were evaluated by a speech therapist. All parents or caretakers were instructed on the procedures and signed a Free and Informed Consent Form (TCLE).

Evaluation instruments

We applied the protocol of Identification dos Signs and Symptoms da Mouth Breathing (PISSRO)[(1)] consisting of a practical and efficient questionnaire for the clinical diagnosis of mouth breathing, both in the research and clinical practice scopes of speech therapy. Parents and children answered the questionnaire with questions on breathing mode, signs and symptoms related to breathing mode, nosological diagnosis, and classification of palatine tonsils. All questions presented the following three answer options: “no”, “sometimes”, and “yes”. The diagnosis was defined according to the percentages: 51% to 60% - mixed breathing mode; 61% to 70% - mild mouth breathing; 80% to 90% - moderate mouth breathing, and above 90% - severe mouth breathing.

Subsequently, the children were referred to the Outpatient Service of Otolaryngology of the Hospital of the Federal University of Pernambuco. The otorhinolaryngological diagnosis of mouth breathing was confirmed in the children who took the nasal fibroscopy test for detecting the degree of airway obstruction, and the presence of mechanical and anatomical changes.

The children were selected according to the following exclusion criteria: neurological disorders; severe heart disease; genetic syndromes; orofacial malformations (cleft lip and/or palate), history of nose surgery; use of functional orthodontic or orthopedic appliances for the jaws; breathing-related physiotherapy treatment, speech therapy, otolaryngology, allergology, pneumology; anatomic nasal changes (obstructive septal deviation, nasal septum perforation, full unilateral nasal obstruction), and use of corticosteroid systemic or nasal topical, antihistamines, or any other medications.

The patients answered a questionnaire on nasal quality of life for specific diseases in pediatric patients with sinonasal complaints (SN-5) This is a validated and subjective instrument that evaluates pediatric nasal and sinus quality of life[(5)]. The SN-5 covers five areas represented by a Visual Analogic Scale (VAS): sinusitis, nasal obstruction, allergy symptoms, emotional pain, and restricted activities. Such fields must be marked by the parents of the patients. Each item scored on a seven-score scale designed to evaluate the frequency of symptoms. The VAS assigns a score from 0 to 10, with 0 representing the absence of nasal obstruction and 10 indicating maximum obstruction. This scale has been applied to measure the treatment effect after medical and surgical interventions on children with nasal and sinus difficulties.

The collection was conducted in two steps: evaluation of nasal patency and final evaluation. The techniques of nasal ventilation and Active Anterior Rhinomanometry were applied, in addition to the classification of mouth breathing. Subsequently, we investigated the immediate effect of nasal irrigation.

Evaluation of nasal patency

We performed the nasal ventilation using an Altmann Millimeter Nasal Mirror that measured nasal air leakage through blue hydro color marking on the blurry area pre-nasal irrigation and red hydro color marking post-irrigation. The register was done by copying the marked area on a special millimeter sheet, calculated in cm^2 on the Image J 1.46r software[(6)].

After the collection of the nasal ventilation data, the specific test of nasal patency was carried out through Active Anterior Rhinomanometry (AARM) (Rhinomanometer NR6, GM Instruments, Kilwinning, United Kingdom), whose analysis allowed quantifying the transnasal airflow and provided the nasal resistance index. The rhinomanometer was calibrated whenever it was turned on (Figure 1). All measurements were performed in a test room at a temperature between 22°C and 24°C and humidity from 40% to 70%.

For the AARM, the contralateral nostril of the examined cavity was obstructed by taping a sensor (Figure 2A) inserted by piercing the tape and attaching it to a flexible silicone tube that led to the gauge pressure port. Care was taken not to interfere with the tested nostril. The tube was placed around the transparent mask. For the AARM to be performed, all patients were instructed to use the mask, close their mouths, and breathe (Figure 2B). Each nostril had a rhinogram registered and computerized that related the inspiratory and expiratory nasal airflows to the transnasal pressure (Figure 3). All AARM measurements were performed by the same examiner through the same instrument.

Nasal resistance was measured at 150 Pa through Active Anterior Rhinomanometry in the left and right nostrils, respectively, whereas the opposite nostril was blocked using an adequate nasal plug. Four regular breaths were required for measuring the values of the unilateral left (LR) and right (RR) nasal resistance, total resistance, and other parameters, like nasal flow, calculated according to the Ohm Law[7]. All measures were taken by the same examiner.

Figure 1. Rhinomanometer NR6. Adapted from GM Instruments

Intervention

The children and respective parents or caretakers answered a questionnaire of specific information to allow for an analysis of associated diseases and symptoms of upper airway impairment. The patients were instructed to stay sitting in an erect position looking at the computer screen. Subsequently, we carried out the procedure of nasal irrigation and instructed the patient to inspire 10 ml of saline solution at 0.9%, at room temperature, for each nostril, using a syringe without a needle. Soon after the serum insertion, we performed circular massages using the thumb on the lateral nasal region, ten times on each side. Next, the child was instructed to blow one side of the nose at a time on a paper tissue, thus removing all secretion[1,4]. Subsequently, nasal ventilation and Active Anterior Rhinomanometry were assessed again, repeating the same aforementioned procedure.

The date were analyzed using the paired Wilcoxon test for comparing the results of pre- and post-nasal irrigation. Additionally, we verified the differences in the medians, measures of nasal ventilation, and parameters of nasal airflow and nasal air resistance. All analyses considered the significance level of 5% and were carried out on the R Core Team 2020 software.

Figure 2. Performing the active anterior rhinomanometry exam
Subtitle: A = Fixation of the pressure probe in the nostril; B = Positioning of the mask on the face

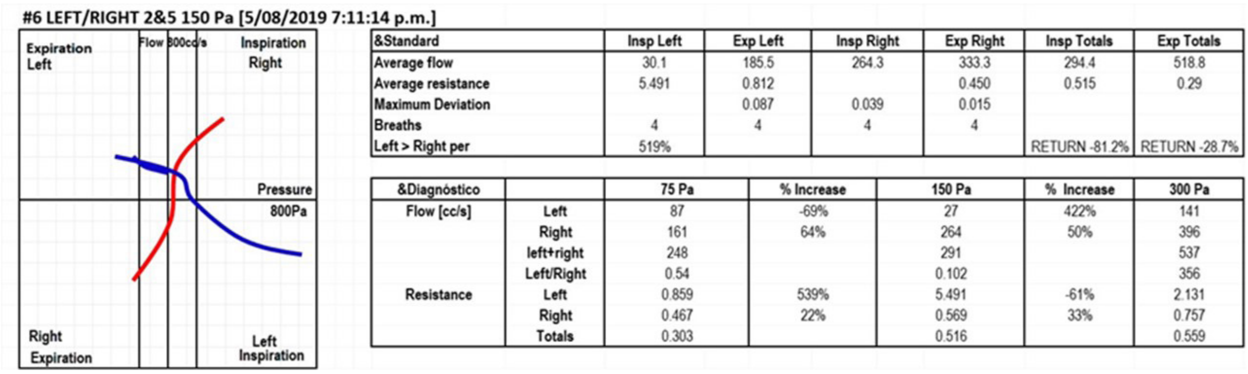

Figure 3. Chart of the results of the rhinomanometry test

Table 1. Clinical description of the cases according to gender, age, and breathing mode

Case	Gender	Age	ORL Diagnosis	Protocol of Identification of Signs and Symptoms of Mouth Breathing (PISSMB)				
				Aspects of breathing	Aspects of sleep	Aspects of nutrition	Aspects of education	Total classification of breathing mode %
1	Female	7 years and 3 months	Mild intermittent rhinitis	21	21	12	18	72% Mild mouth breathing
2	Male	7 years and 1 month	Adenoid hypertrophy 90%	25	22	15	18	80% Moderate mouth breathing
3	Male	7 years and 6 months	Adenoid hypertrophy 80%	28	18	21	6	73% Mild mouth breathing
4	Male	10 years and 3 months	Adenoid hypertrophy 50%	22	19	14	6	61% Mild mouth breathing
5	Male	7 years and 3 months	Adenoid hypertrophy 60%	27	21	11	12	71% Mild mouth breathing
6	Female	10 years and 2 months	Mild intermittent rhinitis	24	13	12	2	51% Mixed breathing
7	Male	10 years and 1 month	Mild intermittent rhinitis	22	19	10	4	55% Mixed breathing
8	Female	8 years and 11 months	Adenoid hypertrophy 60%	22	24	16	1	63% Mild mouth breathing

Subtitle: ORL = Otolaryngology; % = Percentage

For the characterization and description of the MB cases, we collected the information gathered by the clinical investigation on age, gender, otorhinolaryngological diagnosis, and breathing mode. Table 1 presents the population distribution of mouth-breather children, most of them aged seven years old (mean of 8.25 years) and male individuals (n=5; 62.5%) presenting mouth breathing mode (n=6; 74%). Most of the participants were diagnosed with mouth breathing by the questionnaire for the Index of Identification of Signs and Symptoms of Mouth Breathing. All other participants presented oronasal breathing (mixed) (n=2; 26%).

Table 2 shows the significant difference between pre- and post-treatment for nasal ventilation and nasal resistance in Active Anterior Rhinomanometry. No significant difference was found between the pre- and post-irrigation nasal values for the variable of nasal airflow parameter in the AARM.

Table 3 shows the significant increase in the comparative measures of the 16 right and left nostrils pre- and post-intervention for the variables of nasal ventilation and AARM nasal resistance.

DISCUSSION

Mouth breathing can be detrimental to children's global development, craniofacial growth, teeth positioning, body posture, and stomatognathic functions, such as chewing, swallowing, speech, and voice[8]. Thereby, an early diagnosis must be established through complementary tests for gathering quantitative information on the repercussions of the breathing mode and its interferences on the nasal physiology of mouth breathing.

Our study observed that male individuals had a higher frequency of mouth breathing than female individuals, which corroborates other authors[9]. The fields of nasal and sinus quality of life with the highest scores in patients with mouth breathing covered the symptoms of sinus allergy and infection. The analysis of quality of life for the item of visual analogic scale (VAS) revealed a low score varying between worse and better quality of life. Different research findings[10] were reported

Table 2. Descriptive analysis of the tests of nasal ventilation and Active Anterior Rhinomanometry in mouth breathers and comparison of the values of the tests pre- and post-nasal irrigation

Test	Variables	Technique Irrigation nasal	Mean	Minimum	Maximum	Standard deviation	Median	Q1	Q3	RQ	P value
Nasal ventilation evaluation	Total nasal ventilation (cm^2)	Pre	12.99	6.04	17.55	3.82558	13.54	10.94	15.49	4.55	**0.0356***
		Post	15.02	8.44	21.57	3.96607	14.92	13.1	16.95	3.85	
Active Anterior Rhinomanometry (AARM)	Total flow (cm^3/s)	Pre	222.63	107	479	129.364	182.5	140.25	253.25	113	0.1614
		Post	279.13	230	330	44.3571	277	240.25	320	79.75	
	Total resistances ($Pa/cm^3/s$)	Pre	0.86	0.31	1.41	0.39744	0.84	0.61	1.09	0.47	0.09289
		Post	0.55	0.46	0.65	0.08733	0.55	0.47	0.62	0.16	

*Significant values ($p \leq 0.05$) – Wilcoxon normality test

Subtitle: AARM = Active anterior rhinomanometry pre- and post-irrigation nasal; Q1 = First quartile; Q3 = Third quartile; RQ = Interval interquartile; Pa = Pascal; cm^3/s = Cubic centimeters per second

Table 3. Analysis of the comparative measures of both the left and right nostrils in the assessments of nasal ventilation, flow, and resistance of nasal cavities before and after irrigation nasal

		Nasal ventilation (cm^2)		Active Anterior Rhinomanometry (AARM)			
CASE	Nasal cavities	Pre-irrigation nasal ventilation	Post-irrigation nasal ventilation	Pre-irrigation flow (cm^3/s)	Post-irrigation flow (cm^3/s)	Pre-irrigation resistance ($Pa/cm^3/s$)	Post-irrigation resistance ($Pa/cm^3/s$)
1	R	5.64	6.42	181	173	0.831	0.865
	L	4.57	6.16	479	146	0.504	1.030
2	R	2.53	3.02	37	163	4.045	0.922
	L	2.68	3.73	107	160	2.152	0.936
3	R	5.5	6.34	34	94	4.407	1.589
	L	4.59	6.59	154	148	1.245	1.013
4	R	9.41	6.76	124	100	1.211	1.499
	L	4.1	7.22	222	130	1.527	1.157
5	R	3.08	3.53	52	100	2.886	1.499
	L	4.34	5.12	150	135	1.527	1.11
6	R	7.36	8.95	56	109	2.672	1.38
	L	5.04	4.85	347	221	0.515	0.678
7	R	7.13	8.48	46	109	3.241	1.38
	L	6.87	8.88	111	199	2.310	0.753
8	R	4.74	6.29	81	113	1.846	1.324
	L	3.83	5.21	211	133	1.153	1.127
P value		**0.00717***		0.8563		**0.02289***	
Mean		5.17	6.15	145.4	140	371.76	69.74
Standard deviation		2.23817	2.3575	125.698	50.746	962.52296	257.23189
Min		2.53	3.02	34	94	0.5	0.68
Max		9.41	8.95	479	221	3241	1030
Median		4.74	6.34	111	135	1.85	1.16
Q1		4.22	4.98	54	109	1.23	0.93
Q3		6.26	6.99	167.5	161.5	3.47	1.44
RQ		2.04	2.01	113.5	52.5	2.24	0.51

*Significant values ($p \leq 0.05$) – Wilcoxon normality test

Subtitle: R = Right nostril; L = Left nostril; Min = Minimum; Max = Maximum; Q1 = First quartile; Q3 = Third quartile; RQ = Interval interquartile; Pa = Pascal; cm^3/s = Cubic centimeters per second

indicating better quality of life for the fields of sinus infection, nasal obstruction, and restricted activities of children with cystic fibrosis, based on the caretaker's answers in the SN-5. However, considering that the patients were not subjected to long-term treatment, the cause of such an improvement was not indicated.

Nasal patency showed a significant increase between the measures of nasal ventilation pre- and post-nasal irrigation, as well as in the nostrils of the left and right nasal cavities. In this sense, other authors[4,11] have also reported the same results when analyzing the area of nasal ventilation pre- and post-nasal cleaning, thus suggesting that the intervention benefits patients with mouth breathing.

As to the measures assessed by the AARM, we found a significant increase in the comparative measures of the right and left nasal cavities for nasal resistance pre- and post-nasal irrigation. This result allows us to conclude that the applied procedure favored the effect on the breathing mode and produced relevant changes in the physiological variables of breathing.

Study[12] demonstrated that the technique of atomized nasal douche in adults with rhinosinusitis generated a significant improvement in the nasal functions of rhinomanometry resistance and nasal volumes – assessed by rhinometry – compared with nasal wash with regular saline solution (using a syringe of 20 ml).

The analysis of the nostrils indicated a post-nasal irrigation decrease in the parameter of nasal flow. Likewise, another study[13] has identified a group of patients with higher resistance to nasal airflow assigned to the presence of paradoxical nasal vasodilation with the use of a vasoconstrictor. The mechanism of this nasal physiological phenomenon remains unclear but might be related to the presence of chronic rhinitis[14]. The receptors of the nasal mucosa and nasal vestibule might have been compromised, which implies that nasal patency is determined by several factors, including the congestion of the nasal mucosa and thermoreceptors by the perception of the transnasal flow.

Furthermore, there might have been a component for the impairment of the nasal valve that could have contributed to the dynamic collapse of the lateral nasal wall during inspiration. A compromised nasal valve area results in nasal airflow obstruction[15].

In this context, nasal irrigation during the interventions is a commonsense procedure applied in different age groups through circular nose massages that favor the sensitizing of the nasal cavity, directing the airflow to the nasal region.

Even though this study addresses nasal patency evaluation, our search in the literature indicated very few studies concerning quantitative methods for evaluating mouth breathing in clinical speech therapy. The irrigation of nasal saline solution proved to improve the patency of nasal cavities regarding nasal ventilation in mouth breathers. As to its effect on nasal function, the resistance of 150 Pa showed statistically significant differences in both the right and left nostrils. Therefore, there was neither variation in the breathing flow between the right and left cavities nor a significant increase in nasal patency, which might be associated with some impairment in the nasal valve region during the nasal cycle, as previously described.

The low number of participants is among the limitations of this study and could not be changed due to the coronavirus pandemic (COVID-19). It is also worth mentioning the availability of complementary tests like the AARM to health professionals, especially speech therapists, orthodontists, and otolaryngologists. Such tests can provide additional information and contribute to the diagnosis and treatment planning of individuals with MB.

For a better understanding of the consequences of mouth breathing on nasal patency, further studies on this topic should include larger samples and comparisons of healthy groups, mouth-breathing groups, and nose breathers, as well as outcomes of long-term treatments.

FINAL COMMENTS

The irrigation of solution saline nasal had the immediate effect of improving nasal ventilation and promoting significant changes in the nasal resistance of nasal cavities after the nasal irrigation. However, there were varying restoration degrees of the nasal physiology phenomenon, interfering with nasal irrigation regarding the nasal flow in the AARM applied in children with mouth breathing.

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