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Case reports

# Nasal airflow measures and peak inspiratory flow in mouth-breathing children before and after nasal cleansing and massage maneuvers

**Silvio Ricardo Couto de Moura**[1]
https://orcid.org/0000-0002-6648-5288

**Hilton Justino da Silva**[1]
https://orcid.org/0000-0002-6852-3233

**Merly Fernanda Illera Castellanos**[1]
https://orcid.org/0000-0002-2263-3728

**Luciana de Barros Correia Fontes**[1]
https://orcid.org/0000-0002-2349-1215

**Niedje Siqueira de Lima**[1]
https://orcid.org/0000-0001-5338-3509

**Thiago Freire Pinto Bezerra**[1]
https://orcid.org/0000-0003-3420-5074

**Daniele Andrade da Cunha**[1]
https://orcid.org/0000-0002-3987-9740

[1] Universidade Federal de Pernambuco – UFPE, Recife, Pernambuco, Brasil.

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## ABSTRACT

This study aimed at investigating the effects of nasal cleansing and massage maneuvers on upper airway patency in mouth-breathing children. This is a case report on eight children, aged 7 to 10 years, with a speech-language-hearing diagnosis of mouth breathing and otorhinolaryngological assessment and clinical diagnosis of rhinitis. Nasal airflow and patency were respectively assessed with the Glatzel mirror and Peak Nasal Inspiratory Flow (PNIF). Then, they were submitted to nasal cleansing and massage maneuvers with a saline solution, followed by reassessment with the Glatzel mirror and PNIF to compare results. The medians of total nasal airflow quantification were significant. Data on unilateral nasal cavity measurement indicated a sharp increase in nasal airflow in each nostril, with statistically significant differences between before and after nasal cleansing and massage maneuvers. The medians of the total PNIF were significant after the cleansing. It is concluded that the nasal airflow increased in PNIF after the cleansing maneuver.

**Keywords**: Mouth Breathing; Respiratory Function Tests; Diagnostic Techniques, Respiratory System; Airway Obstruction; Child

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**Corresponding address:**
Silvio Ricardo Couto de Moura.
Rua Doutor Henrique Lins, 118 - Brasília Teimosa
CEP: 51010-380 - Recife, Pernambuco, Brasil
Email: silvio.cmoura@ufpe.br

## INTRODUCTION

The function of nasal breathing is to protect the upper airway, promote adequate oxygenation for the organism, and help develop craniofacial structures[1]. When the nasal airway is somehow obstructed, an adaptive mouth-breathing pattern can be triggered as a compensatory mechanism to keep the organism functioning properly[2].

Mouth breathing may be related to organic changes and poor habits, possibly causing postural changes[3] and unbalanced stomatognathic functions[4,5]. The most frequent causes include pharyngeal and palatine adenoid hypertrophy, nasal septum deviation or deformation, and allergic rhinitis. This last one is pointed out as one of the main causes of mouth breathing in children, with impacts on their quality of life when not properly treated[6].

The most frequent orofacial changes in mouth-breathers are open mouth or parted lips; everted, large lower lip; dry lips; forward head posture; tongue postural changes in habitual position, swallowing, and speech; mastication and voice changes[7]; postural adaptations[8]; and consequences to the child's nutritional status[9].

Nasal cleansing and massage maneuvers are part of the speech-language-hearing procedures to adapt breathing and make it as normal as possible. These maneuvers are the clinical procedure referred to as nasal cleansing, which enables balanced bilateral airflow through both nostrils. Moreover, they help compare the relationship between parametric nasal areas, helping analyze the effectiveness of airway patency procedures[10].

Speech-language-hearing therapists have some nasal airflow measurement alternatives. One of them is the Glatzel mirror, which identifies nasal airflow changes in individuals of any age; it can be used to compare results before and after speech-language-hearing therapy and encourage the functional use of the nose[11,12]. The Peak Nasal Inspiratory Flow (PNIF) is a quantitative method that assesses nasal airflow and measures variations in peak forced first-second inspiratory flow and nasal patency. Its importance lies in that it is a reliable, simple, noninvasive, low-cost method. This instrument is expected to provide more precise and reliable results, aiding speech-language-hearing therapy[13,14].

Despite the usefulness and validity of these instruments, these quantitative methods are scarcely used to assess mouth breathing in speech-language-hearing clinical practice. Given the importance of nasal patency to establish physiological nasal breathing[15] (as nasal obstruction negatively impacts stomatognathic functions) and precisely analyze treatments, techniques that include these assessments can benefit clinical practice[16].

Thus, based on the importance of these variables to nasal patency and airflow assessment, this study aimed at investigating the effect of the nasal cleansing and massage maneuver on upper airway patency in mouth-breathing children.

## CASE PRESENTATION

This research was approved by the Research Ethics Committee of the *Universidade Federal de Pernambuco*, Brazil, under no. 355527. All parents/guardians signed an informed consent form. This is a clinical case series conducted with a convenience sample at the speech-language-hearing teaching clinic at the *Universidade Federal de Pernambuco*. The clinic receives people of all ages and follows up mouth-breathing children, referred from various health services and departments.

Eight children of both sexes, aged 7 to 10 years, participated in the study. The inclusion criteria were as follows: mouth-breathing children, having completed their otorhinolaryngological assessment and being clinically diagnosed with rhinitis. Children with neurological disorders, severe cardiopathies, genetic syndromes, orofacial malformations, previous nasal surgery, or orthodontic appliances were excluded from the study. All children underwent nasal endoscopy and otorhinolaryngological and dental assessments.

Initially, personal data were collected from each patient, who also signed an informed assent form. Then, the Mouth-Breathing Signs and Symptoms Identification questionnaire (PISSRO)[17] was administered to them. This questionnaire was developed by the Stomatognathic System Pathophysiology Research Group to characterize the mouth-breathing diagnosis as functional.

Afterward, each child's nasal airflow was assessed. They were taken to a separate room, in which they were weighed and measured, and then instructed to breathe habitually and keep their eyes closed, while the researchers examined them with the Glatzel mirror. It was placed under their nostrils, by the anterior nasal spine; after 1 minute of habitually breathing in and out, the condensation area on the plate was outlined with a blue overhead projector marker. The area was then transferred to a marking sheet in the Glatzel mirror reference notebook and scanned one by one.

Measures were taken with an In-Check Inspiratory Flow Meter (Clement Clarke International)® to assess the inspiratory nasal flow. Patients were instructed to stand, with the silicone mask covering their mouths and noses. The children then breathed out completely and breathed in deeply through the nose, as much as they could. Three flow measures were taken, of which the highest value was considered.

In the nasal cleansing and massage maneuver, 10 ml of 0.9% saline solution at room temperature was applied in each nose cavity with a needleless syringe, followed by circular massages with the thumb on the sides of the nose. The patients were then instructed to blow their noses on facial tissues, removing all secretions. After the nasal cleansing, the examination procedures were repeated.

Statistical analysis was made in the Statistical Package for the Social Sciences (IBM SPSS), version 24; the significance level was set at 5% ($p < 0.05$). The Kolmogorov-Smirnov normality test was applied to the quantitative variables. The Wilcoxon test was used to compare two samples and visualize each observation of the first intragroup sample in relation to the second one. Intergroup variables were crossed with the Spearman test or simple linear regression correlation test to quantitatively verify the correlation between study variables.

## RESULTS

Data analysis shows that the children's PISSRO results were above 60%, characterizing the mouth-breathing diagnosis as functional (Table 1).

The Glatzel mirror identified each patient's nasal airflow area before and after nasal cleansing maneuvers. Airflow area increased in all patients, except for patients number 4 (in whom it was not expressive) and 6 (in whom it decreased) (Table 2).

Median values in total nasal airflow quantification were 13.54 before and 14.92 after the nasal cleansing, with significance in the nasal airflow area ($p < 0.03$). Values found in the left nasal cavity were 4.455 before and 5.685 after the cleansing, with a significance of $p < 0.01$ (Table 3).

In total PNIF, median values were 60.00 before and 67.50 after the cleansing, with a significance of $p < 0.00$*. In the right nasal cavity, values were 42.50 before and 47.50 after the cleansing, with a significance of $p < 0.03$*. Values in the right nostril were 47.50 before and 50.0 after the nasal cleansing, with a significance of $p < 0.04$* (Table 4).

**Table 1.** Sample characterization regarding sex, age, and breathing mode, according to the Mouth-Breathing Signs and Symptoms Identification questionnaire (PISSRO). Recife, 2022

| Patients | Sex | Age (years) | ORL Diagnosis | Breathing-related aspects | Sleeping-related aspects | Eating-related aspects | School-related aspects | Breathing mode classification Total % |
|---|---|---|---|---|---|---|---|---|
| P1 | F | 7 | Mild seasonal rhinitis | 21 | 21 | 12 | 18 | 72% Mild mouth breathing |
| P2 | M | 7 | Adenoid hypertrophy 90% | 25 | 22 | 15 | 18 | 80% Moderate mouth breathing |
| P3 | M | 7 | Adenoid hypertrophy 80% | 28 | 18 | 21 | 6 | 73% Mild mouth breathing |
| P4 | M | 10 | Adenoid hypertrophy 50% | 22 | 19 | 14 | 6 | 61% Mild mouth breathing |
| P5 | M | 7 | Adenoid hypertrophy 60% | 27 | 21 | 11 | 12 | 71% Mild mouth breathing |
| P6 | F | 10 | Mild seasonal rhinitis | 24 | 13 | 12 | 2 | 51% Mixed breathing mode |
| P7 | M | 10 | Mild seasonal rhinitis | 22 | 19 | 10 | 4 | 55% Mixed breathing mode |
| P8 | F | 8 | Adenoid hypertrophy 60% | 22 | 24 | 16 | 1 | 63% Mild mouth breathing |

**Table 2.** Quantification of each patient's nasal airflow area before and after the nasal cleansing and massage maneuvers. Recife, 2022

| Patients | TN area Pre | RN area Pre | LN area Pre | TN area Post | RN area Post | LN area Post |
|---|---|---|---|---|---|---|
| P1 | 15.035 $cm^2$ | 5.642 $cm^2$ | 4.574 $cm^2$ | 18.246 $cm^2$ | 6.420 $cm^2$ | 6.159 $cm^2$ |
| P2 | 6.039 $cm^2$ | 2.530 $cm^2$ | 2.684 $cm^2$ | 8.440 $cm^2$ | 3.016 $cm^2$ | 3.726 $cm^2$ |
| P3 | 12.048 $cm^2$ | 5.497 $cm^2$ | 4.591 $cm^2$ | 15.226 $cm^2$ | 6.335 $cm^2$ | 6.593 $cm^2$ |
| P4 | 16.631 $cm^2$ | 9.407 $cm^2$ | 4.098 $cm^2$ | 16.515 $cm^2$ | 6.761 $cm^2$ | 7.224 $cm^2$ |
| P5 | 11.150 $cm^2$ | 3.083 $cm^2$ | 4.341 $cm^2$ | 12.107 $cm^2$ | 3.525 $cm^2$ | 5.116 $cm^2$ |
| P6 | 15.113 $cm^2$ | 7.362 $cm^2$ | 5.041 $cm^2$ | 14.609 $cm^2$ | 8.948 $cm^2$ | 4.852 $cm^2$ |
| P7 | 12.080 $cm^2$ | 5.133 $cm^2$ | 3.729 $cm^2$ | 19.910 $cm^2$ | 8.782 $cm^2$ | 6.880 $cm^2$ |
| P8 | 17.551 $cm^2$ | 7.132 $cm^2$ | 6.869 $cm^2$ | 21.572 $cm^2$ | 8.475 $cm^2$ | 8.876 $cm^2$ |

Captions: RN = right nostril measures; LN = left nostril measures; TN = total nostril measures

**Table 3.** Descriptive analysis of nasal airflow quantification before and after the nasal cleansing maneuver. Recife, 2022.

| Nasal Airflow | Mean | Minimum | Maximum | SD | Median | CI | p-value |
|---|---|---|---|---|---|---|---|
| **TN** | | | | | | | |
| Pre | 12.9862 | 6.040 | 17.55 | 3.82 | 13.54 | 5.72 | p<0.03* |
| Post | 15.020 | 8.44 | 21.57 | 3.96 | 14.92 | 2.89 | |
| **RN** | | | | | | | |
| Pre | 5.6737 | 2.53 | 9.41 | 2.281 | 5.57 | 3.8 | p<0.08 |
| Post | 6.2237 | 3.02 | 8.95 | 2.083 | 6.38 | 3.83 | |
| **LN** | | | | | | | |
| Pre | 4.502500 | 6.8700 | 6.8700 | 1.1873350 | 4.455000 | 1.03 | p<0.01* |
| Post | 5.970000 | 8.8800 | 8.8800 | 1.6046005 | 5.685000 | 2.14 | |

* Significant values ($p \leq 0.05$) – Wilcoxon normality test.
Captions: SD = standard deviation; CI = confidence interval; RN = right nostril measures; LN = left nostril measures; TN = total nostril measures

**Table 4.** Descriptive analysis of peak nasal inspiratory flow quantification before and after the nasal cleansing maneuver. Recife, 2022

| Nasal Inspiratory Flow | Mean | Minimum | Maximum | SD | Median | CI | p-value |
|---|---|---|---|---|---|---|---|
| **TN** | | | | | | | |
| Pre | 66.25 | 50 | 130 | 26.559 | 60.00 | 15 | p< 0.00 * |
| Post | 70.63 | 50 | 130 | 25.416 | 67.50 | 18 | |
| **RN** | | | | | | | |
| Pre | 44.38 | 35 | 60 | 9.797 | 42.50 | 18.75 | p<0.03* |
| Post | 50.00 | 30 | 80 | 16.257 | 47.50 | 23.75 | |
| **LN** | | | | | | | |
| Pre | 50.00 | 35 | 80 | 14.142 | 47.50 | 15 | p<0.04* |
| Post | 49.38 | 30 | 80 | 15.684 | 50.00 | 18.75 | |

* Significant values ($p \leq 0.05$) – Wilcoxon normality test.
Captions: SD = standard deviation; CI = confidence interval; RN = right nostril measures; LN = left nostril measures; TN = total nostril measures

## DISCUSSION

This study aimed at investigating the effects of the nasal cleansing and massage maneuver on upper airway patency in mouth-breathing children. The clinical assessment of the breathing mode with PISSRO showed a greater occurrence of signs and symptoms due to genetic factors, nasal obstruction (in various degrees and durations), or inadequate oral habits[6].

Nasal cavity analysis with the Glatzel mirror showed a statistically significant increase in nasal airflow values between before and after the nasal cleansing in both nasal cavities. This information corroborates the findings of another study[11], which also used the Glatzel mirror to verify changes in nasal airflow areas after the cleansing and massage, quantitatively confirming improved airflow after the cleansing and massage[12].

Another study on 40 patients also used the Glatzel mirror to observe the nasal airflow area. Its results pointed to the effectiveness of this instrument, as it makes it easier to measure nasal airflow and reach a possible prognosis in mouth-breathing patients[11].

Nasal airflow probably increases because nasal cavity secretions are eliminated or reduced. This helps understand more in-depth nasal respiratory physiology, as it portrays the nose response to the technique applied to it. It can also be inferred that the tactile-kinesthetic stimulation of the massage makes the nasal cavity more sensitive, thus directing airflow to this region[16].

In the present study, the nasal airflow area measured with the Glatzel mirror decreased in only one child (patient 6) after applying the nasal cleansing and massage technique. A retrospective study on 36 patients with paradoxically increased airway resistance analyzed in their previous rhinomanometry data a group of patients with vasodilation after taking vasoconstrictors[18]. No studies were found proving the reasons behind this mechanism; however, it may be related to chronic rhinitis[19]. Hence, it is believed that this patient was more sensitive to the saline solution at the time of the assessment.

Regarding PNIF in this study, the inspiratory flow measures significantly increased after the nasal cleansing and massage maneuvers. This result was also found in an analytical descriptive study, which found 90 children with acute rhinosinusitis after nasal obstruction treatment. Nasal patency values showed a significant PNIF increase in both nostrils after using nasal cleansing and massage maneuvers[20] - corroborating the data in this study, which found significant PNIF values after the procedures.

In a study on 6- to 12-year-old children, PNIF data were correlated with craniocervical measures. It pointed out that the person's posture changes as the nasal patency decreases, extending the head and diminishing the curve of the cervical spine. These results show that PNIF can be used to identify nasal obstructions and that it efficiently associates nasal obstruction with body posture[21].

Unilateral PNIF in both nasal cavities also found higher values in comparison with before the nasal cleansing and massage. This finding was also observed in a study[22] that compared unilateral PNIF measures and rhinomanometry in 125 subjects, demonstrating that PNIF can be an excellent method for diagnostic accuracy of unilateral and bilateral nasal obstruction[23].

The nasal cleansing and massage maneuvers proposed in this study aimed for immediate therapeutic effects – which is scarce in the researched literature, as such studies pointed to long-term treatment. However, further scientific production is needed to better understand the results obtained in this study.

Also, other studies should be conducted with larger samples and a control group to analyze patency improvements in mouth-breathing and nasal-breathing patients. The lack of comparative literature on the topic (few similar studies using the same technique in different populations were found) was a limiting factor in this study.

## CONCLUSION

The nasal cleansing and massage immediately improved nasal airflow and patency in mouth-breathing children. Furthermore, the clinical respiratory characteristics agreed with the PNIF assessment results; hence, this instrument proved to be effective and sensitive to changes in complementing and confirming speech-language-hearing findings.

Further controlled studies with larger samples are needed to confirm the effectiveness of nasal inspiratory flow measures and better understand the consequences of mouth breathing.

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