

# Key Clinical Studies

4-phase  
rhinomanometry

## Usage of Four-Phase High-Resolution Rhinomanometry and Measurement of Nasal Resistance in Sleep-Disordered Breathing.

Toh ST, Lin CH, Guilleminault C, Laryngoscope 2012 Oct;122(10):2343-9.

---

**Objectives:** To investigate the ease of use of four-phase high-resolution rhinomanometry (HRR), a new way of measuring nasal resistance, in measuring change in nasal resistance from supine to inclined position in a clinical sleep laboratory setting, and to correlate findings with continuous positive airway pressure (CPAP) tolerance.

**Results:** From the supine to inclined position, reduction in total nasal resistance was observed in 87.5% (35 out of 40). There was a mean reduction of nasal resistance by  $37.1 \pm 21.6\%$ . Five (12.5%) out of 40 subjects showed no change or mild increase in nasal resistance. Subjects with nasal resistance unresponsive to the inclined position change tended to have difficulty using nasal CPAP based on downloaded compliance card data.

**Conclusion:** Four-phase HRR and acoustic rhinometry are tests that can be easily performed by sleep specialists to characterize nasal resistance in SDB patients and determine changes in resistance with positional changes. In this study, we found that patients who did not demonstrate a decrease in nasal resistance with inclined position were more likely to be noncompliant with nasal CPAP. These measurements may help us objectively identify patients who might have trouble tolerating nasal CPAP.

## Comparison of nasal hyperosmolar xylitol and xylometazoline solutions on quality of life in patients with inferior turbinate hypertrophy secondary to nonallergic rhinitis.

Cingi C, Birdane L, Ural A, Oghan F, Bal C, Int. Int Forum Allergy Rhinol. 2014 Jun;4(6):475-9.

---

**Objectives:** The purpose of this study was to objectively determine and compare the efficacy and effectiveness of xylitol solution (Xlear Nasal Spray®) compared with xylometazoline and physiological saline with respect to quality of life (QoL) in patients with nasal congestion.

**Results:** VAS scores and 4-phase rhinomanometry scores were better in the group treated with xylometazoline compared to those treated with xylitol or saline. The xylitol procedure yielded better results than the saline procedure, but differences were not statistically significant in both objective and subjective evaluation methods. For overall QoL, there was a significant improvement from baseline for the xylometazoline and xylitol groups. However, the improvement in the xylometazoline group was significantly greater than that obtained in the xylitol group.

**Conclusion:** Xlear Nasal Spray® is an effective modality in the treatment of nasal congestion and has positive effect on the QoL of patients. Further studies are needed in order to plan an ongoing treatment of Xlear Nasal Spray® at certain intervals for continuous relief of symptoms and a better and longstanding QoL.

## Airway assessment by four-phase rhinomanometry in septal surgery.

Vogt K, Zhang L, Curr Opin Otolaryngol Head Neck Surg. 2012 Feb;20(1):33-9.

---

**Objectives:** This article updates the state of the art in functional ventilation tests of the nasal airway. Multidisciplinary international cooperation has led within the last years to the development of four-phase rhinomanometry (4PR) by eradicating the errors of the 'classic' rhinomanometry.

**Results:** Physical experiments, mathematical models and comprehensive statistical analyses implicate that the nasal breath consists of four phases of different diagnostic importance. Presuming the motility of the nasal entrance, it is necessary to depict the elastic behavior within the rhinomanometric curve, as well as to use new parameters for the clinical evaluation of the nasal obstruction. The parameters logarithmic vertex resistance and logarithmic effective resistance are related to the sensing of the patient. Their clinical importance was proved in studies of more than 12000 patients.

**Conclusion:** The human eye is not able to estimate the degree of impairment in nasal breathing. Therefore, a functional diagnosis is mandatory to avoid unnecessary surgery and to control the results. 4PR is a substantial improvement over the currently used methods. It should be implemented in the standards of the international standardization committee for the objective assessment of the upper airway (ISOANA). Practical hints for correct measurements are given.

## Quality of life in patients with chronic hypertrophic rhinitis after CO<sub>2</sub> laser turbinoplasty.

Ungureanu R, Sarafoleanu D, Rom J Rhinol. 2012;2(8).

---

**Objectives:** The aim of this study was to evaluate the effectiveness of CO<sub>2</sub> LASER turbinoplasty in patients with chronic hypertrophic rhinitis in terms of QoL.

**Material and methods:** The prospective study was performed on 174 patients with chronic hypertrophic rhinitis. All patients underwent CO<sub>2</sub> LASER turbinoplasty. The evaluation was performed before surgery and then 1 month, and 6 and 12 months after surgery, by using a visual analogue scale (VAS) assessing subjective symptoms like nasal obstruction, rhinorrhea, sneezing, smell disorders. 4-phase-rhinomanometry was used to assess the objective outcomes.

**Results:** The results showed that the mean value of VAS for "nasal obstruction" parameter decreased from 7.86 before surgery to 4.4. one month after surgery and to 5.4, 12 months after surgery. Also, VAS scores showed significant statistic improvement ( $p < 0.05$ ) as far as concerns the other specific symptoms of the chronic rhinitis: rhinorrhea, sneezing, itching, smell disorders.

**Conclusion:** This study provides evidences that CO<sub>2</sub> LASER turbinoplasty is an effective treatment for chronic hypertrophic rhinitis and can positively influence patients' quality of life.

## Rhinomanometry assessment of outcomes after intranasal corticotherapy in allergic rhinitis.

Jianu E, Sarafoleanu C, Enache R, Rom J Rhinol. 2012;2(8).

---

**Objectives:** The study presents the authors' experience in objective evaluation of the therapeutic results after 6 months administration of intranasal mometasone furoate in each nostril.

**Results:** The reevaluation performed after 6 months showed a statistically significant improvement in nasal obstruction in 31.13% of the patients. The rhinomanometric measurements revealed an improvement of nasal patency with a significant reduction ( $p < 0.05$ ) of the nasal airway resistance (NAR). The mean value of total NAR before treatment was 1.07 Pa/ccm/s at 150 Pa. Rhinomanometry performed after 6 months showed a reduction in mean total resistance from the pretreatment level to 0.78 Pa/ccm/s. The objective data were similar to the VAS results.

**Conclusion:** Intranasal corticotherapy is the first choice in the management of allergic rhinitis. The use of rhinomanometric measurements before and after treatment represents a specific and useful way to evaluate nasal obstruction due to chronic allergic hypertrophic rhinitis.

## Seated, Supine And Post-Decongestion Nasal Resistance In World Trade Center Rescue And Recovery Workers (wtc Snore)

Rohan Patel et al., American Journal of Respiratory and Critical Care Medicine 2014;189:A5053

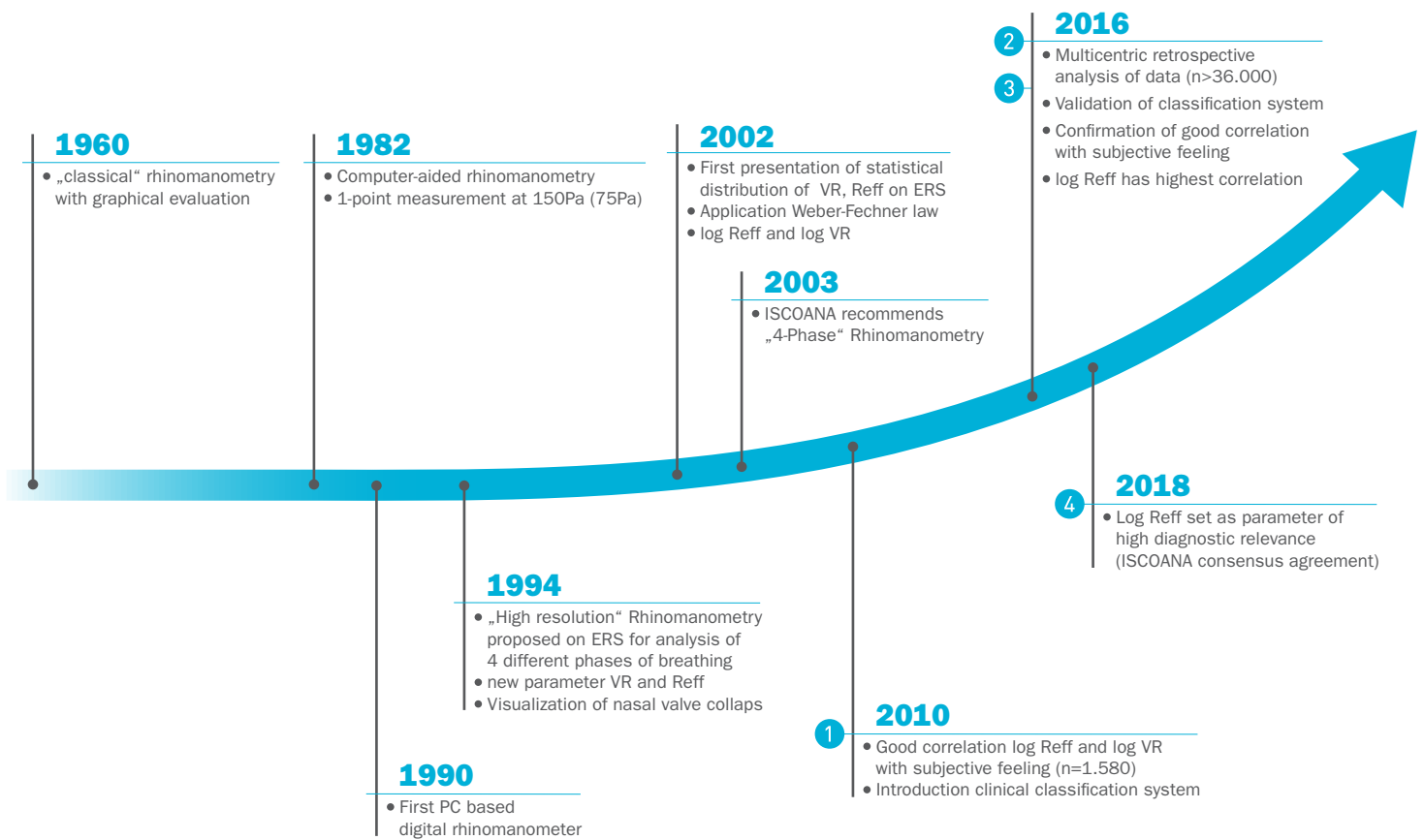
---

**Objectives:** A high prevalence of obstructive sleep apnea (OSA) and chronic rhinosinusitis has been reported in WTC rescue and recovery workers, including 2700 workers enrolled in the Monitoring and Treatment Program at Rutgers-RWJMS and NYU. We are examining the relationship of nasal resistance and inflammation to the pathophysiology of OSA. In this abstract we report preliminary nasal resistance data.


**Results:** Women had higher TNR pre-decongestion than men (supine 0.97 vs. 0.68,  $p = 0.03$ , sitting 0.73 vs 0.58,  $p = 0.13$ ). TNR sitting and supine were correlated, both before ( $r = 0.6$ ,  $P < 0.0001$ ) and after ( $r = 0.6$ ,  $P < 0.0001$ ) decongestion. There were no significant correlations between the symptom score and TNR. There was an increase in TNR from sitting to supine pre-decongestion ( $p < 0.001$ ) but not post-decongestion, although both sitting and supine TNRs were reduced ( $p < 0.001$ ) post-decongestion (See Figure). There was a modest negative correlation between the effect of decongestion and effect of positioning on TNR ( $r = -0.28$ ,  $p = 0.008$ ). BMI did not correlate with any measurement of TNR or with change in TNR from sitting to supine. Higher BMI was associated with a smaller change in TNR post-decongestion ( $r = -0.28$ ,  $p = 0.04$ ).


**Conclusion:** Preliminary results in WTC rescue and recovery workers show the expected differences in TNR with gender and changes with position and decongestion. However, symptoms of chronic rhinosinusitis do not appear to predict nasal resistance. Our data do not support an effect of greater positional fluid shifts in the obese as BMI did not correlate with any measurement of TNR or change in TNR with position, and higher BMI was not associated with a larger change in TNR post-decongestion. Our data suggest either sitting or supine nasal resistance can be used and that it is not necessary to consider the effect of obesity on nasal resistance when assessing the role of nasal resistance in the pathophysiology of OSA.


## Evolution of Rhinomanometry




## Clinical Evidence of 4-Phase Rhinomanometry, Fundamentals, New Standard

- 

**4-Phase- Rhinomanometry (4PR)-basics and practice 2010.**  
Vogt K, Jalowayski AA, Althaus W, Cao C, Han D, Hasse W, et al., Rhinol Suppl. 2010[21]:1-50.
- 

**Four-phase rhinomanometry: a multicentric retrospective analysis of 36,563 clinical measurements.**  
Vogt K, Wernecke KD, Behrbohm H, Gubisch W, Argale M, Eur Arch Otorhinolaryngol 2016 May;273(5):1185-98.
- 

**Classification of total nasal obstruction in 10,933 cases by 4-phase-rhinomanometry**  
Vogt K, Wernecke KD, Argale M, Kaulina Krista, Romanian Journal of Rhinology, Vol. 6, No. 23, July-September 2016
- 

**The new agreement of the international RIGA consensus conference on nasal airway function tests.**  
Vogt K, Bachmann-Harildstad G, Lintermann A, Nechyporenko A, Peters F, Wernecke KD, Rhinology 56: 0-0, 2018, Open Access.