The Journal of Laryngology & Otology (2018), ***132***, *404–407*.

doi:10.1017/S0022215118000531

MAIN ARTICLE

Improving the rhinomanometry technique using benzoin tincture

F ARSLAN[1], Ü YILDIZOĞLU[2], A DURMAZ[3], S ÇETINKAYA[4]

[1]*Department of Otolaryngology, Head and Neck Surgery, Beytepe Murat Erdi Eker State Hospital, Ankara,*
[2]*Department of Otolaryngology, Head and Neck Surgery, Ünye State Hospital, Ordu, and, Departments of*
[3]*Otolaryngology, Head and Neck Surgery, and* [4]*Toxicology, Gulhane Medical School, Ankara, Turkey*

Abstract

Objective: In order to achieve a faster and more reliable anterior rhinomanometric evaluation, nasal skin was prepared using benzoin tincture solution, which provides simpler and better adhesion of the foam tape to the nasal skin.

Method: Two consecutive anterior rhinomanometry measurements were made, one with and one without benzoin tincture application.

Results: The average time taken to perform classic foam tape anterior rhinomanometry without benzoin tincture application was 281.32 seconds, and the average coefficients of variation for the right and left passages were 7.48 and 7.59 per cent, respectively. When benzoin tincture was used, the average time taken for completion of the tests was 121.24 seconds, and the average coefficients of variation for the right and left passages were 2.17 and 2.32 per cent.

Conclusion: The use of benzoin tincture to clean the nasal skin before placing foam tape shortens the procedure duration and significantly increases test reliability.

Key words: Benzoin; Airway Resistance; Data Accuracy; Rhinomanometry

Introduction

Rhinomanometry is a method for measuring the pressure variations along the airway and the airflow passing through the nose during breathing.[1,2] In the last 20 years, in parallel with technological developments, significant advances have been made to the rhinomanometry devices and in the measurement techniques. Furthermore, a consensus report aiming to standardise the application has been published.[3]

Rhinomanometry is a spirometric measurement that can be performed in three different ways. At present, active anterior rhinomanometry is considered the most appropriate method for examining nasal respiratory physiology, and it is the most practical to use. Consequently, it is the most common method and consensus has been reached regarding its use.[4–6] Anterior rhinomanometry measures the nasopharyngeal pressure through the anterior nares. The resistance of both nasal cavities is measured separately and the total resistance is calculated. Rhinomanometry is the foremost objective test used to demonstrate the effectiveness of surgical and medical treatments.[7,8] It is recommended for the objective evaluation of nasal obstruction, which is a subjective sensation, and is accepted as the 'gold standard' for this evaluation.[9,10]

Although consensus has been reached regarding the reliability of rhinomanometry, efforts to develop the technique and to make it more practical continue. In the process of developing measurement techniques, some changes have been made with respect to the method of nasal passage blockage during the pressure difference measurement. At present, adhesive surgical foam tapes are recommended for greater reliability, as these tapes do not create any change in the nasal vestibule.[3,11] However, if the foam tape does not adhere properly to the skin, the reliability of the measurement decreases because of air leaks, and the duration of the test increases.

In daily practice, the adhesion of the foam tape to the skin is ensured by first wiping the skin with alcohol or skin disinfectant solutions before applying the foam tape. Providing simpler and better adhesion of the foam tape to the nasal skin would ensure an easier and faster test, and more reliable results. Therefore, the present study aimed to examine the effect of applying a benzoin tincture (already in general use in our

Accepted for publication 30 November 2017 First published online 18 April 2018

clinic to prepare the nasal skin) on the rhinomanometry test duration and measurement results.

Materials and methods

The study was conducted, with the approval of the local ethics committee (approval number 580/2014), between January 2015 and December 2015. Patients who consulted the out-patient clinic of the ENT Department of the Medical Academy (Gulhane Medical School, Ankara, Turkey), presenting with diseases other than those concerning the nose, were informed about the study and volunteers were enrolled.

Rhinomanometric evaluation of the cases was performed using the active anterior rhinomanometry principle, with a MasterScope Rhino device (Jaeger, Hoechberg, Germany) and an anaesthetic face mask. Technical regulations were adhered to, and data measurement and assessment were conducted, in accordance with the International Committee on Rhinomanometric Standards proposal.[3]

Every patient was informed about the measurement technique in the test room. After the nasal examination, and cleaning of any secretions and crusts with the help of an aspirator, we prepared the probe, used to measure the nasopharyngeal pressure from the nose, and the medical foam tape (Microfoam Surgical Tape; 3M Health Care, Saint Paul, Minnesota, USA) that would provide the nasal blockage. Foam tape pieces were prepared separately for the right and left sides of the nose. If the tape was removed for any reason, new tape was prepared to prevent loss of adhesion.

A trial run of the measurement technique was first performed to familiarise the patients with the test requirements and to eliminate time differences due to a learning curve. After the trial run and before the first measurement, the nasal skin was cleaned with skin disinfectant (70 per cent alcohol), the foam tape was applied, and the time taken to conduct the measurements was recorded.

The test was performed separately on the right and the left sides of the nose. A total of five sets of measurements were taken for each nose. Each set consisted of three respiratory events (related to inspiration and expiration). An air pressure difference of at least 150 Pa was the goal for each measurement. The data obtained for each set of respiration measurements were input into an MS Excel® spreadsheet and a formula was applied for analysis; we aimed for a coefficient of variation of not more than 10 per cent. Any measurement sets with coefficients greater than 10 per cent were discarded and new measurements were taken. Thus, a total of five sets of measurements with coefficients of variation of 10 per cent or lower were obtained per nose.

The total time spent obtaining the measurements was recorded. New foam tapes and probes were then prepared for the second measurement. The columella, both alar wings and the nasal base skin were first cleaned with benzoin tincture (Tinctura Benzoes 90 per cent at a ratio of 1:5; Botafarma, Ankara, Turkey), and then the foam tape was placed and the measurements were repeated. Again, a total of five nasal resistance values with coefficients of variation of 10 per cent or lower were obtained for each nose and the total time spent was recorded.

The mean of the total time spent and the coefficients of variation for the first and second sets of respiratory measurements were compared statistically using SPSS software for Windows, version 15.0 (SPSS, Chicago, Illinois, USA). The variables were investigated using Shapiro–Wilk's test to determine whether or not they were normally distributed. As the nasal resistance values were not normally distributed, the Wilcoxon signed rank test was used to compare these parameters. Values of $p < 0.05$ were considered statistically significant.

Results

The 41 patients included in the study (34 men and 7 women) had a mean age of 23.15 ± 6.2 years (range, 18–48 years). In the first rhinomanometry measurement (conducted without benzoin tincture application), the right nasal resistance mean value was 0.38 ± 0.11 Pa/ml/second (range, 0.20–0.70 Pa/ml/second), and the left nasal resistance mean value was 0.35 ± 0.10 Pa/ml/second (range, 0.20–0.67 Pa/ml/second). The average time taken to complete the first test was 281.32 ± 32.82 seconds (range, 199–365 seconds) (Table I).

In the second rhinomanometry measurement, for which the benzoin tincture was applied, the mean value

TABLE I
RHINOMANOMETRY TEST FINDINGS: NASAL RESISTANCE, TEST COMPLETION TIME AND COEFFICIENTS OF VARIATION*

Measurement	Nasal resistance (Pa/ml/second)		Test duration (seconds)	Coefficient of variation (%)	
	Right	Left		Right	Left
1st measurement (mean ± SD), without benzoin tincture	0.38 ± 0.11	0.35 ± 0.10	281.32 ± 32.82	7.48 ± 2.04	7.95 ± 1.82
2nd measurement (mean ± SD), with benzoin tincture	0.38 ± 0.10	0.35 ± 0.09	121.24 ± 6.09	2.17 ± 1.04	2.32 ± 1.13
P value	0.71	0.77	<0.001	<0.001	<0.001

*$n = 41$. SD = standard deviation

https://doi.org/10.1017/S0022215118000531 Published online by Cambridge University Press

TABLE II
COMPARISON OF NASAL RESISTANCE MEASUREMENTS ACCORDING TO GENDER*

Measurement	Right	Left
1st measurement (mean ± SD), without benzoin tincture		
– Male	0.39 ± 0.11	0.34 ± 0.09
– Female	0.34 ± 0.07	0.40 ± 0.13
– *P* value	0.4	0.4
2nd measurement (mean ± SD), with benzoin tincture		
– Male	0.39 ± 0.11	0.35 ± 0.08
– Female	0.35 ± 0.07	0.39 ± 0.12
– *P* value	0.4	0.6

Data represent nasal resistance measurements (Pa/ml/second), unless indicated otherwise. *$n = 41$. SD = standard deviation

for the right nasal resistance was 0.38 ± 0.10 Pa/ml/second (range, 0.20–0.69 Pa/ml/second), and the left nasal resistance mean value was 0.35 ± 0.09 Pa/ml/second (range, 0.20–0.64 Pa/ml/second). The average time taken to complete the tests, with the benzoin tincture application, was 121.24 ± 6.09 seconds (range, 110–133 seconds). All 41 tests (100 per cent) performed with the benzoin tincture had a shorter duration than those conducted without the tincture, and the difference was statistically significant ($p < 0.001$) (Table I).

The mean coefficients of variation for the first tests (in which benzoin tincture was not used) were 7.48 ± 2.04 per cent (range, 2.07–10.43 per cent) for the right nasal passage and 7.95 ± 1.82 per cent (range, 4.66–10.54 per cent) for the left nasal passage. The mean coefficients of variation for the second tests (using benzoin tincture) were 2.17 ± 1.04 per cent (range, 0.75–5.54 per cent) for the right nasal passage and 2.32 ± 1.13 per cent (range, 0.14–4.83 per cent) for the left nasal passage. All the tests performed with benzoin tincture ($n = 41$, 100 per cent) showed lower coefficients of variation than those without the tincture, and this decrease in both nasal passages was statistically significant ($p < 0.001$) (Table I).

The results obtained in the first test and the tests using the benzoin tincture revealed no change in mean nasal resistance. Statistical comparison of both tests showed no difference between the two measurements ($p = 0.71$ for the right passage, $p = 0.77$ for the left passage) (Table I). There was also no statistical difference between female and male individuals' nasal resistance measurements, both with and without benzoin tincture use (Table II).

Discussion

Nasal obstruction is a subjective complaint, and understanding its severity and evaluating its changes after treatment are among the most difficult and complex challenges in rhinology. Patients with nasal obstruction require a quantitative evaluation of nasal respiration using objective methods.[9] Rhinomanometry is the best method for the objective evaluation of nasal resistance and obstruction. The advent of modern rhinomanometry use was in 1950s, but efforts to develop more practical and reliable rhinomanometry methods have continued into the 2000s.[11–14]

The development of the technique has resulted in some changes in the probing of the nasal passage used to measure the pressure difference. At first, disposable plugs were used to probe the nose. Later, upon realising that these plugs made some shape changes to nasal entry and affected the reliability of the measurement results, they were replaced with surgical foam tape.[3,11] However, the foam tapes were not fully adequate for a smooth measurement. Nasal skin is greasy and has a structure open to contamination. Therefore, the dirt and grease on nasal skin must be cleaned before the foam tape is applied, in order to obtain a reliable measurement, and the foam tape must be changed before every measurement. If the foam tape fails to adhere properly to the skin, this will cause isolation problems, the measurement reliability will decrease, and the time needed to complete the test will increase. In our daily routine, we generally use alcohol or skin disinfectant solutions to clean nasal skin.

The use of surgical foam tape, even when the skin is properly cleaned, may still cause isolation problems. This will decrease test reliability and necessitate the repetition of measurements, resulting in time losses. Furthermore, each failed test disrupts the conformity of both the person who carries out the test and the one who is being tested. We found that benzoin tincture use provided easier and better adhesion of the foam tape to nasal skin.

Benzoin tincture is a solution of benzoin resin in alcohol that is often applied to skin before applying tape or other adhesive bandages.[15] It is frequently used in otolaryngology clinics after rhinoplasty, in order to improve the adhesive power of the tape. It can also be applied to minor skin cuts as an antiseptic, and can be used as an oral mucosal protectant for recurring sores, blisters and so on. In our study, we used benzoin tincture to ensure better adhesion of the foam tape to the nasal skin for the rhinomanometry measurements.

The use of benzoin tincture significantly reduced the time needed to perform the measurements. Another important advantage was that the test seldom needed to be repeated, which meant it could be administered at more constant intervals. This increases the conformity of the patient and allows the person conducting the test to plan their time more easily. In addition, it relieves the short-term anxiety that test repetition creates in the patient and practitioner.

Another important issue in rhinomanometric measurements is their reliability. In the present study, the measured coefficients of variation of 10 per cent or lower were accepted as valid.[5] The data above this value were thought to arise from air leaks in the mask

https://doi.org/10.1017/S0022215118000531 Published online by Cambridge University Press

or/and foam tape during application, or other problems, and those test data were excluded from the assessment.[5] Although values of 10 per cent or lower were considered reliable, values closest to zero indicate a better application. The use of alcohol or other skin disinfectants creates isolation problems, so we repeated the test, but still failed to see values below 5 per cent. Nevertheless, the use of benzoin tincture provided results in a shorter time and within conservative coefficient of variation constraints, so we believe it can make an important contribution to the rhinomanometry technique.

- **Rhinomanometry is the gold standard method for nasal resistance measurement**
- **Simpler and better adhesion of foam tape to nasal skin would ensure easier and faster testing and more reliable results**
- **The use of benzoin tincture significantly reduced the time needed to perform the measurements**
- **Benzoin tincture, which cleans nasal skin, significantly increased test reliability**

Benzoin tincture is a chemical solution; thus, we cannot exclude the possibility that this solution might alter the nasal resistance. However, according to our results, the nasal resistance values obtained either with conventional methods or with benzoin tincture were similar. Therefore, benzoin tincture does not appear to have any effect on nasal structures that would affect nasal resistance measurements.

Conclusion

Anterior rhinomanometry is the best method for the objective evaluation of nasal obstruction. Benzoin tincture was used to clean the nasal skin prior to the application of foam tape in the nasal passage. This shortened the time needed to measure pressure differences and significantly increased test reliability. Its use also improved the adaptation of the patient undergoing the test.

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Author for correspondence:
Dr Fatih Arslan,
Department of Otolaryngology,
Beytepe Murat Erdi Eker State Hospital,
Beytepe 06500,
Ankara, Turkey

Fax: +90 3129 060 814
E-mail: drfatiharslan@gmail.com

Dr F Arslan takes responsibility for the integrity of the content of the paper
Competing interests: None declared

https://doi.org/10.1017/S0022215118000531 Published online by Cambridge University Press