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Comparison of nasal airway obstruction with sonoelastography and nose obstruction symptom evaluation scores in children with allergic rhinitis

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What is already known on this topic?

- *To the best of our knowledge, this is the first study to evaluate a Turkish version of the NOSE scale and sonoelastography in children with allergic rhinitis. In addition, different methods were compared and the results were found to be compatible with each other.*
- *As a result, the Turkish version of the Nose Obstruction Symptom Evaluation scale and sonoelastography can be used to evaluate nasal obstruction due to inferior turbinate hypertrophy in children with allergic rhinitis.*

What this study adds on this topic?

- *The attached paper entitled "Comparison of nasal airway obstruction with different methods in children with allergic rhinitis" sought to determine any correlation between different nasal obstruction measurements in children with allergic rhinitis.*
- *Nasal airway obstruction (NAO) was assessed using sonoelastography, a Turkish version of the Nose Obstruction Symptom Evaluation (T-NOSE), Rhinoconjunctivitis Total Symptom Score (RTSS), and visual analog scale (VAS)] methods in children with allergic rhinitis and the results were compared with a healthy control group.*

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ABSTRACT

Objective: Nasal airway obstruction caused by inferior turbinate hypertrophy is the most troublesome symptom for patients with allergic rhinitis. The aim of this study was to determine any correlation between different nasal obstruction measurements in children with allergic rhinitis.

Material and Methods: Nasal airway obstruction was assessed with Sonoelastography, Turkish version of the Nose Obstruction Symptom Evaluation scale, Rhinoconjunctivitis Total Symptom Score and visual analog scale methods in children with allergic rhinitis and the results were compared with a healthy control group.

Results: Evaluation was made of a total of 68 patients (40 boys and 28 girls [male: female ratio, 1.42]) with a mean age of 13.35±3.35 (range, 7–18) years. The Rhinoconjunctivitis Total Symptom Score, visual analog scale, and Turkish version of the Nose Obstruction Symptom Evaluation scale scores were significantly higher in the AR group than in the control group (p=0.001, p=0.001, p=0.001, respectively). The sonoelastography scores were significantly higher in the AR group than in the control group (p=0.001). Although a positive significant correlation was determined between Rhinoconjunctivitis Total Symptom Score, visual analog scale, and Turkish version of the Nose Obstruction Symptom Evaluation scale scores in terms of AR severity, no relationship was found with the sonoelastography scores (p=0.022, p=0.009, p=0.001, and p=0.0751, respectively).

Conclusion: The Turkish version of the Nose Obstruction Symptom Evaluation scale and sonoelastography can be used to evaluate nasal obstruction due to inferior turbinate hypertrophy in children with allergic rhinitis.

Keywords: Allergic rhinitis, children, nasal airway obstruction, sonoelastography, Nose Obstruction Symptom Evaluation Score

Introduction

Allergic rhinitis (AR) is an inflammatory disease that causes symptoms such as nasal discharge, blockage, itching, and sneezing, affecting about 20–40% of the population worldwide (1). Nasal airway obstruction (NAO) is a key symptom in allergic rhinitis, and eosinophilic inflammation is a hallmark of allergic diseases. Allergic rhinitis has been significantly associated with nasal eosinophilia and reversible nasal airway obstruction suggesting chronic inflammation and structural remodeling of the nasal mucosa in children (2).

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Hypertrophy of the inferior turbinates is the most important cause of nasal airway obstruction. Coblation inferior turbinate reduction resolves nasal obstruction and has a favorable impact on associated respiratory symptoms (3). Nasal airway obstruction can be evaluated with subjective and objective scales. Visual analog scales (VAS), the Rhinoconjunctivitis Total Symptom Score (RTSS), and the Nose Obstruction Symptom Evaluation (NOSE) scale are the used subjective methods, whereas rhinomanometry and acoustic rhinometry are accepted as objective evaluations (4-6). Despite the high prevalence of NAO, there is no universally accepted diagnostic tool to determine the severity of the obstruction. Sonoelastograpy (UE) is a relatively new technique for measuring tissue stiffness and evaluating tissue fibrosis. In previous adult studies, the use of UE to evaluate inferior turbinates has been shown to be a reliable, non-invasive method and could be capable of staging disease activity (7, 8). There is a limitation in the detection of the severity of allergic rhinitis, mainly based on the subjectivity due to the perception of the symptoms of patients.

The NOSE scale, which has been developed in recent years and has been validated in Turkish, is used as a non-invasive method to evaluate nasal obstruction subjectively (6, 9).

To the best of our knowledge, the Turkish Nasal Obstruction Symptom Score (T-NOSE) has not been evaluated previously in children with AR.

The purpose of this study was to determine a reliable, non-invasive measurement tool that could easily grade and scale nasal airway obstruction in the pediatric population. Thus, different techniques were evaluated using T-NOSE, RTSS, VAS, and sonoelastography–methods. The secondary aim of the study was to assess the T-NOSE as a subjective tool to determine NAO in children with allergic rhinitis.

Material and Methods

Study population

This case-control study was conducted in the Pediatric Allergy, Otorhinolaryngology and Radiology Outpatient clinics of our hospital between May and September 2018. The study was conducted in concordance with the Declaration of Helsinki-Ethical Principles for Medical Research Involving Human Subjects. Ethics committee approval was obtained for the study (University of Health Sciences Antalya Training and Research Hospital Ethics Committee. Date and number: 2018-175) and written informed consent was provided by the parents or legal guardians of the patients. The AR phenotype and severity was classified by the physicians in accordance with the Allergic Rhinitis and Its Impact on Asthma (ARIA) classification in children who had nasal symptoms within the previous 12 months (10).

A total of 46 children (29 boys, 17 girls) with AR aged 9-18 years were recruited to the study. Otolaryngologic examinations were performed by the same otolaryngologist. The exclusion criteria included sinonasal infection and/or inflammation in the preceding month, history of septal deviation, and prior sinonasal surgery.

The control group included 22 children (11 boys and 11 girls) without any present or past record of atopic disease, history of paranasal sinus surgery and adenoid hypertrophy, sinonasal infection and/or inflammation in the preceding month that may cause nasal obstruction. The demographic and clinical characteristics of the patients were also evaluated in the study.

Evaluation of disease activity

Disease activity was assessed with the RTSS and VAS.

Rhinoconjunctivitis Total Symptom Score (RTSS): The severity of symptoms of nasal and ocular symptoms was evaluated according to the symptom scoring system. A total of six allergic symptoms (four rhinitis symptoms and two conjunctivitis symptoms) were measured on a scale from 0 to 3 (i.e. none to severe symptoms) and the sum of both provided the rhinoconjunctivitis score (5).

Visual analog scale (VAS): To record symptoms of obstruction, rhinorrhea, itching, and sneezing, VAS of 10 cm was used to quantify the severity of a patient's symptoms subjectively. VAS has been found to relate well to ARIA severity classification in allergic rhinitis (4).

Nasal Obstruction Symptom Evaluation (NOSE) scale: NOSE is a questionnaire that focuses on nasal obstruction. It is composed of 5 questions related to nasal obstruction. Each question is scored using a 5-point Likert scale and higher NOSE scores related to severe nasal obstruction. Recently the Turkish version of the NOSE questionnaire (9) has been validated. The parents of the study independently completed the questionnaire.

Sonoelastography: All of UE assessments were performed using a Toshiba Aplio 500 (Toshiba America Medical Symptoms, Inc., CA) ultrasonography device. Assessments were made according to a previous study by Kısmalı et al. (7). At least five valid measurements were performed for each turbinate. The quantitative elasticity values were measured in kilopascals (kPa) and the median value of these five measurements was used in the analysis. Higher propagation rates are associated with harder tissue because the speed of sound waves in a solid medium is higher. The opposite applies to lower velocity values.

Statistical analysis

As a result of the simulation study conducted before the study (priori power analysis), the sample width required to reach 80.80% power was determined as 49 in the case group and 25 in the control group. However, due to the limitations of the study, the study was completed with 46 subjects in the case group and 22 subjects in the control group with 77.47% (posterior power analysis) power. Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS ver. 20.0, IBM SPSS Corp.; Armonk, NY, USA). Continuous variables are defined as mean±standard deviation and/or median(min-max), and categorical variables are defined as number and percentage. The normality hypothesis was tested using the Kolmogorov-Smirnov test. For continuous numerical variables, the Mann–Whitney U test was used to determine whether there was any difference between the study group and the controls, and for the categorical variables, the Chi-square test. Kruskal–Wallis variance analysis was used to determine differences within the groups. When significant differences emerged in the measurements, the Bonferroni-Dunn test was used in pairwise comparisons.

Spearman's correlation analysis was used to investigate the correlations between variables. P-values of less than 0.05 were accepted as statistically significant.

Table 1. The demographic and clinical characteristics of children with allergic rhinitis

Characteristics	Allergic rhinitis (n=46)
Sex	
F	17 (37%)
M	29 (63%)
Age, years, (mean±SD)	13.06±3.2
Rhinitis duration, years (mean±SD)	3.56±2.11
Asthma comorbidity, n	27 (58.9%)
Family history of atopy, n	31 (67.4%)
Allergic rhinitis severity,	
ARIA classification, n (%)	
Mild intermittent	8 (17.4)
Mild persistent	18 (39.1)
Moderate	16 (34.8)
Severe	4 (8.7)
Total serum IgE, IU/mL (mean±SD)	354±381 (18-1492)
Eosinophilia, % (mean±SD)	5.18±3.39

Values in parentheses are percentages; ARIA: Allergic Rhinitis and its Impact on Asthma; SD: standard deviation; F: female; M: male

Table 2. A comparison of the allergic rhinitis total symptom scores, visual analoque scale and sonoelostography scores of allergic rhinitis and healty controls

	Allergic rhinitis (n=46)	Healty controls (n=22)	p
RTSS (mean±SD)	9.34±2.24	1.86±1.65	0.001[a]
Rhinitis symptom score (mean±SD)	7.94±5.58	1.62±1.45	0.001[a]
Ocular symptom score (mean±SD)	2.23±1.75	0.33±0.65	0.001[a]
T-NOSE score (mean±SD)	25.23±15.24	6.62±5.79	0.001[a]
VAS, (mean±SD)	5.89±2.24	1.48±1.20	0.001[a]
Sonoelostography, (kPa) (mean±SD)	42.82±8.24	13.03±6.31	0.001

RTSS: Rhinoconjunctivitis Total Symptom Score; T-NOSE: Turkish Version of Nasal Obstruction Symptom Evaluation; VAS: visual analog scale; SD: standard deviation; Results are expressed as n (%), [a]Mann-Whitney U test

Table 3. Pairwise comparisons and adjusted p values of the groups in terms of the rhinoconjunctivitis total symptom score, visual analog scale and sonoelastography scores

	Mild intermittent AR vs. control	Mild persistent AR vs. control	Moderate AR vs. control	Severe AR vs. control
RTSS (mean±SD)	0.015	0.001	0.001	0.001
VAS (mean±SD)	0.002	0.002	0.001	0.003
T-NOSE score (mean±SD)	0.026	0.001	0.003	0.001
Sonoelastography (kPa) (mean±SD)	0.001	0.001	0.001	0.004

AR: allergic rhinitis; RTSS: Rhinoconjunctivitis Total Symptom Score; T-NOSE: Turkish version of Nasal Obstruction Symptom Evaluation; VAS: visual analog scale; SD: standard deviation

Results

The final evaluation was made with a total of 68 patients (40 boys and 28 girls [male: female ratio, 1.42]) with a mean age of 13.35±3.35 (range, 7-18) years. There was no statistically significant difference between the AR group and the control group in respect of age or sex (Mann-Whitney U test, p=0.251, Chi-square test, p=0.430). In the AR group, eight patients (17.4%) were classified as having mild intermittent, 18 (39.1%) as having mild persistent, 16 (34.8%) as having moderate AR, and four (8.7%) as having severe AR. The median duration of AR was 3.5 (range, 1-10) years. Multiple allergies were determined in 31 (58.9%) patients and a single allergy in 15 (41.3%) patients. Asthma was determined together with AR in 27 (58.9%) patients. In the AR group, there was a positive family history in 31 (67.4%) patients (Table 1).

The RTSS, VAS, and T-NOSE scores were significantly higher in the AR group than in the control group (Mann-Whitney U test, p=0.001, p=0.001, p=0.001, respectively). The sonoelastography scores were significantly higher in the AR group than in the control group [42.82±8.24 (range, 25.6-68.2) kPa, 13.03±6.31 (range, 10.2-37.2) kPa, respectively, Mann-Whitney U test, p=0.001] (Table 2). To determine which subgroups were responsible for these differences, pairwise comparisons using the Bonferroni-Dunn test were performed. The results of this test revealed that there were significant differences between all subgroups of the AR and control groups (adjusted p<0.01) (Table 3).

There were significant differences between the AR subgroups in terms of RTSS, VAS, and T-NOSE scores (p=0.022, p=0.009, p=0.001, respectively). The sonoelastography scores were statistically similar between the AR subgroups (p=0.075) (Table 4).

Spearman's correlation analysis was used to investigate the correlations between variables such as age, disease duration, total IgE, eosinophil count, VAS, RTSS, T-NOSE, and sonoelastography scores in patients with AR. There was a positive and moderate correlation between age and the elastography scores (r=0.50, p=0.001). Total IgE, eosinophil counts, and duration of allergic rhinitis were not correlated with the elastography measurements (r=0.072, p=0.254; r=-0.155, p=0.353; r=0.227, p=0.130, respectively).

There was a positive and moderate correlation between the T-NOSE score and RTSS and VAS, but no relationship between age and disease duration in the AR group (r=0.578, p=0.001; r=0.571, p=0.01; r=0.113, p=0.455; r= -0.003, p=0.984, respectively).

Discussion

This paper is the first to study the Turkish version of the NOSE scale and sonoelastography in children with AR. In addition, inferior turbinate hypertrophy was evaluated using sonoelastography and the correlations with NAO subjective measurements were examined. Sonoelastography and its correlation with RTSS, VAS, and T-NOSE scales were evaluated. The results of this study showed that VAS, RTSS, T-NOSE, and sonoelastography scores were compatible and significantly higher in the AR group. Owing to the positive correlation between T-NOSE, VAS,

Table 4. A comparison of the rhinoconjunctivitis total symptom score, visual analog scale and sonoelastography scores of according to the allergic rhinitis frequency and severity

	Mild intermittent, AR (n=8)	Mild persistent AR (n=18)	Moderate AR (n=16)	Severe AR (n=4)	p
RTSS (mean±SD)	7.75±3.2	8.17±3.11	11±3.36	13.25±5.5	0.022[a]
VAS (mean±SD)	4.67±1.91	5.88±2.88	7.13±1.58	7.25±2.5	0.009[a]
T-NOSE score (mean±SD)	18.61±12.34	20.63±10.5	30±9.12	52.5±27.5	0.001[a]
Sonoelastography (kPa) (mean±SD)	41.99±8.81	42.30±9.26	42.28±8.12	43.28±6.87	0.075[a]

[a]Kruskal-Wallis test. AR: allergic rhinitis; RTSS: Rhinoconjunctivitis Total Symptom Score; T-NOSE: Turkish version of Nasal Obstruction Symptom Evaluation; VAS: visual analog scale; SD: standard deviation, Kruskal-Wallis test

and RTSS, T-NOSE can be used as a subjective method for the detection of nasal obstruction in children with AR.

Comparisons were also made of the relationships between these tests and disease severity. Although there was a positive remarkable correlation between the RTSS, VAS, and T-NOSE scores in terms of AR severity, no correlation was found between AR severity and sonoelastography scores.

Nasal obstruction due to inferior turbinate hypertrophy in AR is one of the most frequently seen conditions in otorhinolaryngology practice. Objective assessments such as rhinomanometry and acoustic rhinometry are the reference methods, but because they are difficult to perform in children, they are not considered very reliable or reproducible (11-13). Sonoelastograpy objectively measures inferior turbinate elasticity and indirectly assesses inferior turbinate hypertrophy. In adult studies, evaluating the inferior turbinate using sonoelastography might be an objective and non-invasive method (7, 8). Turhal et al. (8) found no difference between a group of adult patients with AR and a control group in respect of sonoelastography scores. However, in the current study, the sonoelastography scores were significantly higher in the AR group. The differences between the two studies might be due to the duration of AR, the age of the patients, and the small size of the study groups. The previous study included 23 patients with a mean age of 28.27 years with a mean duration of AR as 7 (range, 1-24) months, whereas, in the current study, an evaluation was made of 46 patients with a mean age of 13.06±3.2 years with a mean duration of AR of 3.56 (range, 1-5) years. A positive relationship between age and sonoelastography values was determined in the current study.

Many studies used VAS and RTSS scores to assess AR disease activity (14, 15). The NOSE scale is a simple, subjective, frequently used, and well-validated quality of life (QoL) tool specific to NAO (6). Data about the correlation between RTSS, VAS, and NOSE scale are limited and based on studies of the general adult population (16, 17). Very few studies have used the NOSE scale in children with AR. In the current study, the Turkish version of the NOSE scale was evaluated in children with AR and correlations were examined between T-NOSE and RTSS and VAS. The results demonstrated that the T-NOSE scale is a valid tool for assessing pediatric patients with AR with NAO, and it was seen to be compatible with other NAO measurements.

No currently available objective measure can be considered a standard for the evaluation of NAO (18). Sonoelastograpy is a relatively new technology, with the first commercial release in 2003 and the first rhinology study published in 2015. Sonoelastograpy uses non-ionizing radiation and is therefore safe for repeated clinical use (7, 19). The results of this study suggest that ultrasound elastography may be suitable for use as a non-invasive, objective test for evaluating inferior turbinate hypertrophy in children with AR.

The limited number of patients in the study group and the lack of objective evaluations such as rhinomanometry to compare with sonoelastography due to technical reasons are the major limitations of our study. The strength of our study is the presentation of the first and concomitant use of T-NOSE and ultrasound elastography in the evaluation of NAO in children with AR.

In this study, inferior turbinate hypertrophy was evaluated using sonoelastography and the T-NOSE scale in children with AR. Additionally, subjective NAO measurements such as VAS and RTSS were assessed. T-NOSE and sonoelastography scores were compatible with subjective NAO tests such as VAS and RTSS, and were significantly higher in the AR group.

Sonoelastograpy objectively measures inferior turbinate elasticity and indirectly assesses inferior turbinate hypertrophy. It may be used as an objective method for NAO. There is a need for further studies comparing sonoelastography with other tests. According to our results, it can be suggested that the T-NOSE scale and sonoelastography can be used to evaluate nasal obstruction due to inferior turbinate hypertrophy in children with AR.

Ethical Committee Approval: Ethics committee approval was received for this study from the ethics committee of University of Health Sciences Antalya Training and Research Hospital (Date and number: 2018-175).

Informed consent: Written informed consent was provided by the parents or legal guardians of the patients.

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Conflict of Interest: The authors have no conflicts of interest to declare.

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References

1. Small P, Keith PK, Kim H.Allergic rhinitis. Allergy Asthma Clin Immunol 2018; 14(Suppl 2): 51. [Crossref]
2. Bousquet J, Jacquout W, Vignola AM, et al. Allergic rhinitis: a disease remodeling the airways? J Allergy Clin Immunol 2004; 113: 43-9. [Crossref]

3. Siméon R, Soufflet B, Souchal Delacour I. Coblation turbinate reduction in childhood allergic rhinitis. Eur Ann Otorhinolaryngol Head Neck Dis 2010; 127: 77-82. [Crossref]
4. Klimek L, Bergmann K-C, Biedermann T, et al. Visual analogue scales (VAS): measuring instruments for the documentation of symptoms and therapy monitoring in cases of allergic rhinitis in everyday health care: Position Paper of the German Society of Allergology (AeDA) and the German Society of Allergy and Clinical Immunology (DGAKI), ENT Section, in collaboration with the working group on Clinical Immunology, Allergology and Environmental Medicine of the German Society of Otorhinolaryngology, Head and Neck Surgery (DGHNOKHC). Allergo J Int 2017; 26: 16-24. [Crossref]
5. Canonica GW, Baena-Cagnani CE, Bousquet J, et al. Recommendations for standardization of clinical trials with Allergen Specific Immunotherapy for respiratory allergy. A statement of a World Allergy Organization (WAO) taskforce. Allergy 2007; 62: 317-24. [Crossref]
6. Stewart MG, Witsell DL, Smith TL, et al. Development and validation of the Nasal Obstruction Symptom Evaluation (NOSE) scale. Otolaryngol Head Neck Surg 2004; 130: 157-63. [Crossref]
7. Kısmalı E, Göde S, Turhal G, et al. A new insight for evaluation of the inferior turbinate with ultrasound elastography. J Ultrasound Med 2015; 34: 777-82. [Crossref]
8. Turhal G, Göde S, Tunakan Dalgıç C, et al. Evaluation of Inferior Turbinate Stroma with Ultrasound Elastography in Allergic Rhinitis Patients. Balkan Med J 2017; 34: 318-22. [Crossref]
9. Onerci Celebi O, Araz Server E, Yigit O, et al. Adaptation and validation of the Turkish version of the Nasal Obstruction Symptom Evaluation scale. Int Forum Allergy Rhinol 2018; 8: 72-6. [Crossref]
10. Bousquet J, Khaltaev N, Cruz AA, et al. Allergic Rhinitis and its Impact on Asthma (ARIA) 2008 update (in collaboration with the World Health Organization, GA(2)LEN and AllerGen). Allergy 2008; 63: 8-160. [Crossref]
11. Clement PA, Gordts F; Standardisation Committee on Objective Assessment of the Nasal Airway, IRS, and ERS. Consensus report on acoustic rhinometry and rhinomanometry. Rhinology 2005; 43: 169-79.
12. Zapletal A, Chalupová J. Nasal airflow and resistance measured by active anterior rhinomanometry in healthy children and adolescents. Pediatr Pulmonol 2002; 33: 174-80. [Crossref]
13. Corey J, Pallanch J. Evaluation of nasal breathing function with objective airway testing. In: Flint PW, Cummings CW, (eds). Cummings Otolaryngology: Head and Neck Surgery. 5th ed. Philadelphia, PA: Elsevier Mosby; 2010: 640-56. [Crossref]
14. Bousquet PJ, Combescure C, Neukirch F, et al. Visual analog scales can assess the severity of rhinitis graded according to ARIA guidelines. Allergy 2007; 62: 367-72. [Crossref]
15. Leger D, Bonnefoy B, Pigearias B, et al. Poor sleep is highly associated with house dust mite allergic rhinitis in adults and children Allergy Asthma Clin Immunol 2017; 13: 36. [Crossref]
16. Hsu HC, Tan CD, Chang CW, et al. Evaluation of nasal patency by visual analogue scale/nasal obstruction symptom evaluation questionnaires and anterior active rhinomanometry after septoplasty: a retrospective one-year follow-up cohort study. Clin Otolaryngol 2017; 42: 53-9. [Crossref]
17. Menger DJ, Swart KM, Nolst Trenité GJ, et al. Surgery of the external nasal valve: the correlation between subjective and objective measurements. Clin Otolaryngol 2014; 39: 150-5. [Crossref]
18. Mohan S, Fuller JC, Ford SF, et al. Diagnostic and Therapeutic Management of Nasal Airway Obstruction: Advances in Diagnosis and Treatment. JAMA Facial Plast Surg 2018; 20: 409-18. [Crossref]
19. Li GY, Cao Y. Mechanics of ultrasound elastography. Proc Math Phys Eng Sci 2017; 473: 20160841. [Crossref]