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ORIGINAL ARTICLE

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# Correlation of three variables describing nasal patency (HD, MCA, NOSE score) in healthy subjects

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## Abstract

Rhinoresistometry and acoustic rhinometry are two established apparative methods to objectify the respiratory function of the nose. Both methods use different variables to describe nasal patency: "hydraulic diameter", HD, in rhinoresistometry, and "minimal cross-sectional area", MCA1 (nasal isthmus) and MCA2 (head of the inferior turbinate and cavernous body of the nasal septum), in acoustic rhinometry.

**Objective:** This study analyzes the mutual correlation of HD and MCA as a pilot study in patients without nasal pathologies. Additionally, we investigated if these objective variables correlate with the NOSE score, a validated tool to measure subjective perception of nasal patency.

**Method:** Planned data collection in a collective of 24 healthy subjects without nasal pathologies.

**Results:** Statistically significant, weak to moderate correlations were found between HD and MCA2 before decongestion. A moderate correlation was found between both HD and MCA2 and the NOSE score on the narrower side.

**Conclusion:** In the assessment of nasal patency, it seems advisable to determine HD, MCA1 and MCA2, but also a subjective variable such as the NOSE score, which all seem to be not fully redundant variables. In further studies, the correlation of the variables should be assessed in patients with nasal pathologies.

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## INTRODUCTION

Objective apparative methods to assess the respiratory function of the nose can be used in preoperative diagnostics before functional or aesthetic rhinosurgery and as a postoperative quality control[1]. Flow resistance and dynamics can be measured by rhinomanometry and rhinoresistometry, while acoustic rhinometry describes the geometry of the nasal flow channel[1,2].

In rhinomanometry, nasal resistance is the most important parameter to describe nasal patency; in rhinoresistometry, which is basically the calculation of additional variables from rhinomanometry by laws of fluid dynamics, but with the same setup, the variable "hydraulic diameter", HD, is used to describe nasal patency[1]. HD is the diameter of an imaginary round pipe with the same flow resistance as the nose of the measured subject. It gives information about energy loss due to flow-induced friction and is strongly influenced by the narrowest area of the nose. While no internationally accepted normal values are yet established, Mlynski recommends to consider a HD < 5.5 mm as too narrow and > 6.5 mm as too wide, while normal nasal patency is thought to lie between these cut-off values[3,4].

Other variables calculated by rhinoresistometry include the friction coefficient, which informs about tendency of the inner nose to produce a turbular instead of a laminar flow. Acoustic rhinometry analyzes the reflexion of acoustical signals to receive information about the geometry of the inner nose. MCA1 and MCA2 are the minimal cross-sectional areas at the typical two narrowest locations, the nasal isthmus and the head of the inferior turbinate and cavernous body of the nasal septum, respectively. Mlynski reports that after decongestion, a normal MCA1 should not be below 0.5 $cm^2$, and a normal MCA2 not below 1.5 $cm^2$ [3,4], while internationally accepted reference values are not yet published.

Both HD and MCA can therefore be used to describe nasal patency in a SI (Système international d'unités) unit. The first aim of this study was to analyze the mutual correlation and therefore possible redundancy of HD and MCA, as a pilot study first in healthy subjects without nasal pathologies. The second aim was to study if these objective variables would correlate with subjective perception of nasal patency.

## METHOD

The study was approved by the ethics commission of the medical faculty Ludwig Maximilian University, Munich, Germany (project number 403-10).

In 24 healthy volunteers (12 women, 12 men, mean age 30 years, range 19-58 years, no history of sinunasal diseases or other morbidities including allergies), rhinomanometry, rhinoresistometry and acoustic rhinometry were performed before and after nasal decongestion for both sides. All measurements were conducted with the Rhino-Sys diagnostic system (Happersberger otopront GmbH, Hohenstein, Germany) according to the recommendations of the "International Standardization Committee on the Objective Assessment of the Upper Airways"[2] and by the same experienced examiner (M. R.) to minimize inter-examiner variability. In all subjects, pathologies such as septal deviation, hyperplastic turbinates or polyposis had been ruled out by anterior rhinoscopy and nasal endoscopy.

Subjects received the Nasal Obstruction Symptom Evaluation (NOSE) score, a validated questionnaire to determine subjective perception of nasal patency[5]. NOSE scores can range from 0 (no subjective nasal obstruction) to 100 (extreme subjective nasal obstruction).

Objective (HD, MCA1, MCA2) and subjective (NOSE score) variables were entered into a statistical spreadsheet for further analysis. Descriptive statistics and Pearson correlation coefficients (including the respective level of significance described by *t*-test) were calculated by SPSS v.17.0 (SPSS Inc, Chicago, Illinois/ United States).

## RESULTS

Descriptive statistics of the objective variables of nasal patency for the right and left side before and after decongestion are demonstrated in Table 1. When comparing the left and the right sides, there was no significant difference between HD and MCA1 ($p > 0.05$), but for MCA2 ($p < 0.001$), with the left side being more patent as also shown by the higher mean and median of MCA2 for the left side.

The mean NOSE score was 17.3 (median 15, minimum 0, maximum 45, standard deviation 11.7).

Table 2 shows Pearson correlation coefficients including the respective level of significance for HD, MCA1, MCA2 and the NOSE score for the right and left side before and after decongestion. No significant correlations were found between HD and MCA1 with or without decongestion. Weak to moderate positive correlations were found for HD and MCA2 in the not-decongested state (r = 0.48 for the right and r = 0.34 for the left side), while only one the right sight a level of significance < 0.05 was obtained. After decongestion, HD and MCA2 did not correlate any more on both sides. In the correlation of objective variables and the subjective NOSE score, statistically significant, moderate negative correlations were found for HD (r = -0.50) and MCA2 (r = -0.55) in the not-decongested state, but only for the left side.