Evaluation of Mini Infrared Thermographic Camera as an Objective Tool for Assessment of Nasal Obstruction, A Feasibility Study

Daniel Chai Z C., Eugene Wong H C., Nur Izzati Ishak., Haziyah Hashim., Yong Doh Jeing

Department of Otorhinolaryngology, Faculty of Medicine and Health Sciences, Universiti Malaysia Sabah, Malaysia

DOI: https://doi.org/10.51244/IJRSI.2026.13010246

Received: 06 February 2026; Accepted: 11 February 2026; Published: 20 February 2026

ABSTRACT

Nasal Obstruction (NO) is a common symptom for a wide range of pathologies, to date there are no universally accepted methods to determine the severity of NO. Nasal Obstruction can be evaluated subjectively by means of questionnaires such as Nasal Obstruction Symptom Evaluation (NOSE) and Visual Analog Scale (VAS). Objective methods of evaluation include Anterior-Posterior Rhinomanometry, acoustic rhinometry, Peak Nasal inspiratory Flow and 3D CT reconstruction flow modeling. This study explores a novel method of NO severity evaluation, by means of Mini Infrared (IR) Thermographic Camera. Inspired air has a cooling effect on nasal vestibule skin while expired air conversely warms up the skin. The cooling and warming process emits Infrared wavelengths at different intensities hence an Infrared camera can be used to indirectly measure the temperature fluctuation without direct contact. This study primarily compares Nasal Vestibule temperature fluctuation range detected on mini IR thermographic camera to NOSE questionnaire score in subjects with the symptom of Nasal Obstruction. Secondarily, this study compares IR thermography results to standard measurement of Active Anterior Rhinomanometry. 34 Subjects with Nasal Obstruction complaints were recruited from the outpatient clinic. All subjects are required to complete the survey via NOSE questionnaire, then to undergo IR thermography evaluation and Anterior Rhinomanometry in the same setting. All subjects are above the age of 18 and well consented. Exclusion criteria includes underlying lung disease, local nasal skin inflammatory condition, septal perforation and recent nasal surgeries. Result wise there is a moderately strong correlation found ($R^2 = 0.713$), between NOSE score and Nasal Vestibule Temperature Fluctuation Means ; On the other hand, Correlation between Nasal Vestibule Temperature Fluctuation and Anterior Rhinomanometry is weak ($R^2 = 0.001 - 0.008$). In conclusion Infrared camera is a potentially useful tool for evaluation of Nasal blockage, demonstrated by moderate correlation to the subjective NOSE score, however further study with larger sample size is needed for validation.

Keywords: Nasal, Obstruction, Infrared, Rhinomanometry, Thermography

INTRODUCTION

Nasal Obstruction can be loosely defined as subjective perception of inadequate air passing through the nasal passage, it is an exceedingly common symptom for various diseases, affecting up to one-third of the global population on a daily basis. To date, stratification of NO according to severity has been mostly done subjectively via questionnaires and perception charts, however when NO is persistent or refractory to medical management, particularly when Otorhinolaryngologist (ORL) clinicians are involved, there is an unmet expectation of objective assessment in any form to be done. Current objective techniques for quantifying nasal airflow and anatomy, such as rhinomanometry, acoustic rhinometry, and peak nasal inspiratory flow, are tedious to use and mostly utilized only in academic research settings to demonstrate improved nasal patency post-surgery [2]. In view of high caseload and current complicated methods of objective assessments, there is a dire need for simple and quick objective diagnostic tools to guide the treatment [1]. This study aims to look into thermographic cameras as a novel solution to objectively assess NO, with the added advantage of being simple, quick and contactless.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue I January 2026

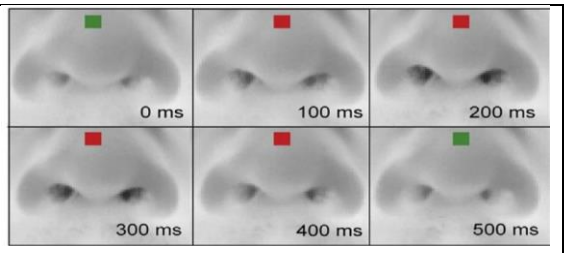
Infrared is an electromagnetic radiation that is invisible to the naked eye, any object above the absolute zero temperature radiates infrared, the wavelength of which is inversely proportional to the temperature of the object, this phenomenon is otherwise known as Wien's displacement Law. Application of infrared associated technology is wide, ranging from military use such as missile targeting, night visions and espionage surveillance, or even home appliances such as television remote control. Infrared thermography cameras have been demonstrated to possess the capability to detect breathing patterns by the mean of temperature gradients resulting from airflow [3]. Therefore, hypothetically as inspired cooler air from surrounding cools and warmer expired air from the body warms the skin of the nostrils, such temperature fluctuation can be used as surrogate marker for volume of airflow passing through, therefore with similar theoretical deduction, the range of temperature reduction should demonstrate degree of obstruction, which was the main principle of this study, to test if this theory holds true. Nasal vestibule skin temperature fluctuation was demonstrated by mini IR Thermography camera while correlation between severity of NO was demonstrated by NOSE questionnaire. Taking advantage of this study, statistical correlation between measurement of active anterior rhinomanometry and Nasal vestibule skin temperature fluctuation was also explored.

MATERIALS AND METHODS

Materials

(1) Mini Infrared Thermographic Camera

The Infrared assessment setup consisted of a non-scientific grade generic brand mini mobile camera connected via USB to a window laptop, infrared images was rendered by using IRImage Tools software suited for windows provided by the manufacturer, the camera originally designed as a smartphone based Infrared + color paired camera with the resolutions of 160x120 pixels for heat seeking infrared camera and 640 x 480 pixels for standard visual color camera. According to claims in the user manual provided by the manufacturer, the ability to capture scene temperature ranges from -20 to 120°C, distance of infrared capture was claimed by the manufacturer to be as close as 15cm up to an infinite distance. For the purpose of standardization and improvement of interpretation accuracy, the mini thermographic camera used a longer USB cable and it was mounted onto a generic camera tripod at a fixed angle. As far as measuring method from the software suite, temperature at the region of interest is obtained by placing the "口" caliper at the mentioned region i.e the nasal vestibule as visualized on the imaging software, temperature reading of 1 decimal point will be shown and recorded. The mini thermographic imaging software can be customized to display images in typical IR false colors or monochrome to guide the placement of calipers.



*** for illustration purpose only**

Fig 1. Mini thermographic camera setup

(2) Nasal Obstruction Symptom Evaluation (NOSE) scale questionnaire

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue I January 2026

All subjects are required to complete the NOSE scale as honestly possible on visit. NOSE scale is a readily validated and reliable questionnaire used in multiple studies to enable subjective numerical quantification of nasal obstruction. Five specific problem scenarios pertaining to nasal obstruction symptoms are being presented to patients, severity of each is being graded from 0 to 4. Sum of answers are multiplied by five to scale the final score out of 100. Interpretation recommended as following, mild (range, 5-25), moderate (range, 30-50), severe (range, 55-75), or extreme (range, 80-100)

Over the past 1 month how much of a problem were the following conditions for you ? Please mark the most correct response					
	Not a problem	Very mild problem	Moderate problem	Fairly bad problem	Severe problem
Nose stuffiness	0	1	2	3	4
Nose obstruction	0	1	2	3	4
Trouble breathing through my nose	0	1	2	3	4
Trouble sleeping	0	1	2	3	4
Unable to get enough air through my nose during exercise	0	1	2	3	4

Table 1. Questionnaire of NOSE Scale

(3) Visual Analog Scale for nasal obstruction

Visual Analog scale is a simple validated and quick tool that enables patients to give a quick impression of Nasal severity in general. Patients are to be instructed to grade a point on the scale of 1 to 10 that best describe their nasal obstruction symptom, whereby a higher score indicates a worse degree of obstruction. Points selected by the patient are to be multiplied by 10 to scale the final score out of 100, for the purpose of statistical analysis

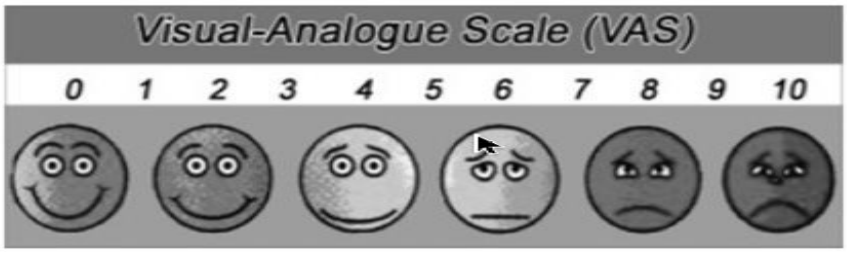


Fig 2. Standard Generic Visual Analog Scale

(4) Active Anterior Rhinomanometry

Rhinomanometry is an objective measurement of nasal airway resistance, this project employs anterior rhinomanometry for each nasal cavity investigated as an additional objective assessment tool for comparison. MERZ Rhino is a compact rhinomanometry system originating from Germany, main component of which is a flow sensor connected to a flow-pressure reader console via pvc tubings, the device incorporated highly sensitive pressure sensors based on CMOS technology. Data interpretation is done via evidENT^{tm} software executable using Windows system, MERZ Rhino system is connected to windows system computers via GDT USB interface. In individuals free from signs of nasal disease, mean total resistance is approximately 0.23 Pa/cm3/s, with a range from 0.15 to 0.39 Pa/cm3/s. For a routine screening procedure, a total nasal resistance to airflow of 0.3 Pa/cm3/s may be considered as the upper limit of the normal range

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue I January 2026

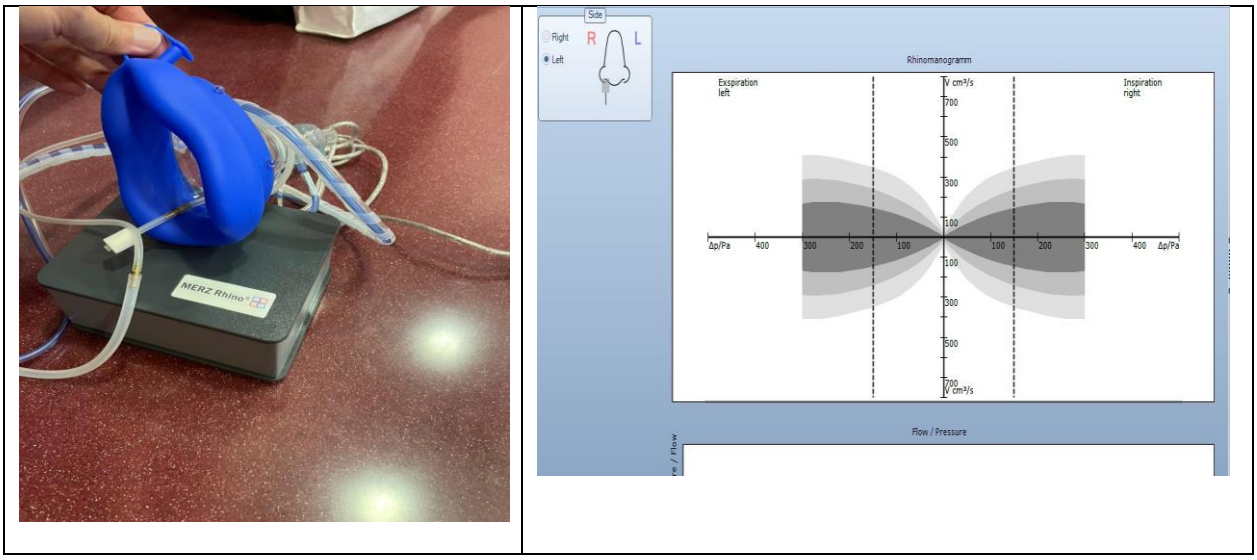


Fig 3. Rhinomanometry

METHODS

Upon recruitment, consenting patients that fall within the inclusion criteria are recruited as study subjects. Written consents for participation in the study are obtained. Medical history reviewed

Patients were handed a proforma sheet containing NOSE score and Visual analog Scale of nasal obstruction, to be given ample time for appropriate response, while an arbitrary subject number is assigned to each subject.Subjects are to spend 30 minutes acclimatizing to room air.

For Infrared temperature reading of each nostrils, subjects are seated upright on a chair facing the Infrared thermal camera placed at a distance of approximately 15cm. Subjects are then instructed to complete 3 deep breathing cycles following an initial 1 minute of quiet breathing. Temperature readings of each nasal vestibule are taken via mini thermal camera software. Nasal vestibule skin temperatures are measured at the end of inspiration and at the end of expiration through the nose, peak inspiratory temperature (T_{Insp}) and peak expiratory temperature (T_{Exp}) recorded, Temperature fluctuation range $\mathbf{\Delta}T = (T_{Exp} - T_{Insp})$ calculated

Anterior rhinomanometry readings are to be taken at the same setting for each nasal cavity. Procedures of Rhinomanometry measurement are as described in MerzRhino^{TM} Instructional manual.

Inclusion Criteria of subjects recruitment included, (i) New patient who come to ENT clinic with nasal obstruction as chief complaint, (ii) Willing and consenting adults aged above 18 years old

Exclusion Criteria were mainly conditions that may cause measurement error and those that cause discomfort to the patient during the course of study, which includes acute inflammatory/ Infective skin disease on the nasal region,Severe Underlying pulmonary disease (Asthma/COAD in exacerbation, bronchiectasis, lung fibrosis, post COVID lung sequelae, pleural effusion and cystic fibrosis). Other conditions considered to be points to exclude a subject included, recent nasal surgeries, ongoing active Rhinorrhea or purulent nasal discharge, uncontrolled Co-morbidity such as hypertension, diabetes and ischemic heart disease. Lastly, patients with active malignancies and the presence of Septal perforation were also conditions that voids a subject eligibility to participate in this study.

Sample Size Derivation

Population size ~ 150 (estimated number of patient with Nasal block presenting to clinic in 6 months) ; Confidence level - 95 % ; Response distribution - 50 %

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue I January 2026

Margin of error to be accepted - 15 % (based on previous nasal temperature profile Versus flow study by Lindemann & Keck 2007 [6]) ; Calculation by Raosoft® sample calculator software (Cohort study type design). Final study sample size for realistic study determined to be 34 subjects

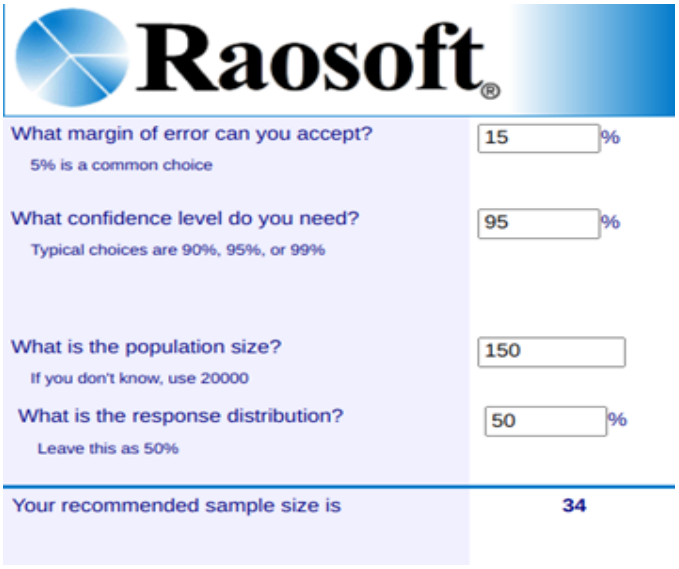


Fig 4. Raosoft sample size calculator software

Data Analysis

Raw data are separated into the following sets of 2 and plotted on X vs Y axis scatter plot chart

- NOSE vs **Δ**T - Worse Obstruction side
- NOSE vs **Δ**T - Less Obstruction side
- NOSE vs μ**Δ**T (mean of right & left reading)
- Right Thermography (**Δ**T) vs Rhinomanometry (Pa/cm3/s)
- Left Thermography (**Δ**T) vs Rhinomanometry (Pa/cm3/s)

Both R^2 regression analysis and Spearman Rho's test are used to find correlation coefficients for the above mentioned 5 sets of data. Two tailed paired Student's t-tests are also used to check validity of the analysis by determining the P value, taking $P < 0.05$ as a proof of significance hence rejection or acceptance of the hypothesis stated.

IBM licensed SPSS software (for social sciences) utilized for data analysis

Ethical Approval

Ethical approval for this study was obtained from Malaysian National Medical Research Registry (NMRR)

Privacy and Confidentiality

Subject's names were kept in a password-protected database and linked only with a study identification number for this research. Other patients' identifiable data (phone numbers, identity number) were collected in a separate patients' ID list locked away from the rest of study data. The identification number instead of patient identifiers were used on subject data sheets. All data was entered into a computer that is password protected.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue I January 2026

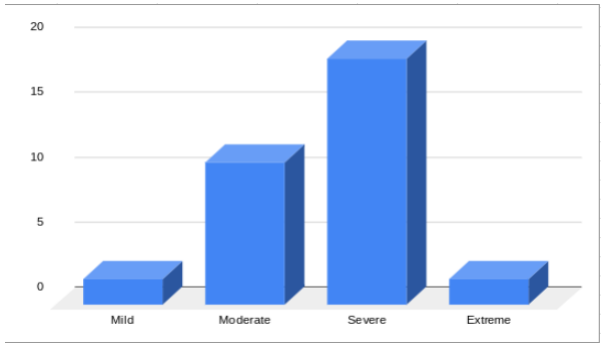
RESULTS

We identified 34 patients who met the inclusion criteria, their age ranged from 18 to 84 years (Mean 47.2 years). 22 (64.7%) were females, and 12 (35.3%) were males. Highest number, 19 subjects reported severe class on a NOSE scale, followed by moderate class 11 (32.4%), while mild and extreme classes reported 2 subjects (5.9%) each. In terms of laterality of the symptom, 19 subjects (55.9%) graded the left nose to experience worse obstruction, while the other 15 (44.1%) graded the right nose to be worse at the point when this study was conducted.

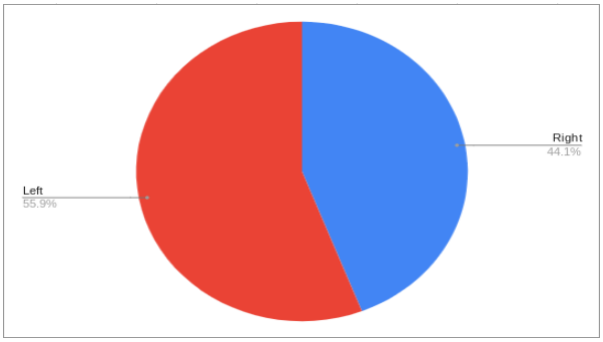
(1) Simple demographic & nasal obstruction distribution

		Number	%
Gender	Female	22	64.7
	Male	12	35.3
Worse side of blocked nose	Right	15	44.1
	Left	19	55.9
NOSE Severity class	Mild	2	5.9
	Moderate	11	32.4
	Severe	19	55.9
	Extreme	2	5.9

Table 2. Demographic analysis



Distribution by NOSE severity score



Distribution of laterality of worse nasal obstruction

Fig 5. Graphic representation of nasal obstruction distribution

(2) NOSE Score Vs μ**Δ**T

	Mean	Std. Deviation
NOSE Score /100	57.21	16.84
ΔT (T-Exp - T-Insp) °C	0.89	0.43

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue I January 2026

Spearman's rho		**Δ**T (T-Exp - T-Insp) °C
NOSE Score /100	Correlation Coefficient	-.788**
	Sig. (2-tailed)	.000
	N	34

Table 3 - spearman rho analysis Nose Vs μ**Δ**T

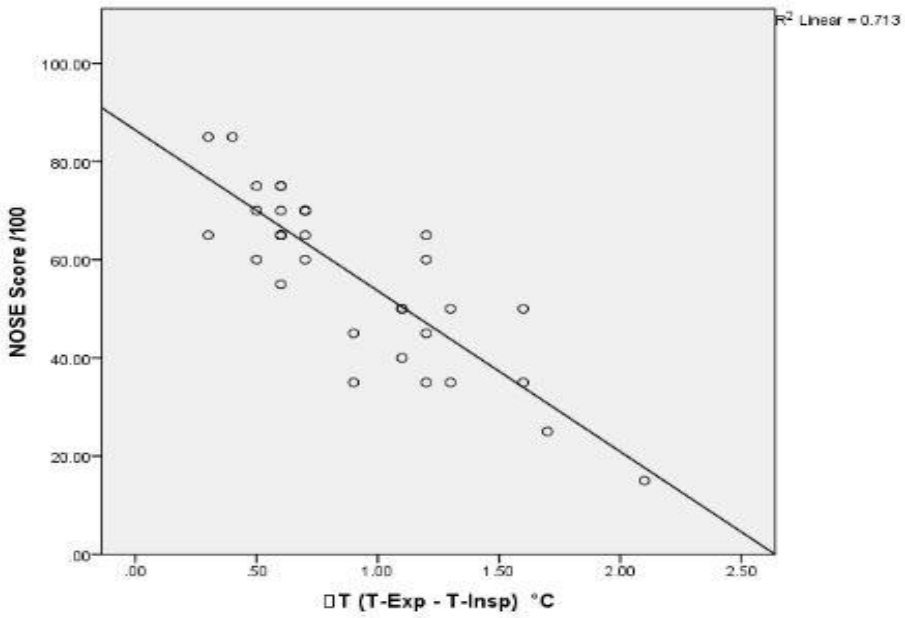


Fig 6. Scatter plot NOSE score vs **Δ**T

Other Comparison done:

NOSE VS **Δ**T of Worse Obstruction Side : $R^2 = 0.535$; Spearman rho coefficient = - 0.739 ($P < 0.05$)

NOSE VS **Δ**T of Less Obstruction Side : $R^2 = 0.739$; Spearman rho coefficient = - 0.809 ($P < 0.05$)

NOSE VS **Δ**T of All Right Side : $R^2 = 0.530$; Spearman rho coefficient = - 0.721 ($P < 0.05$)

NOSE VS **Δ**T of All Left Side : $R^2 = 0.802$; Spearman rho coefficient = - 0.822 ($P < 0.05$)

	NOSE severity class							
	Mild (n=2)		Moderate (n=11)		Severe (n=19)		Extreme (n=2)	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
NOSE Score /100	20.00	7.07	42.73	6.84	66.58	5.54	85.00	0.00
ΔT (T-Exp - T-Insp) °C	1.90	.28	1.21	.23	.66	.21	.35	.07

Table 4 - Mean & SD for each NOSE severity class

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue I January 2026

(3) IR Thermography (**Δ**T) Vs Active Anterior Rhinomanometry (Pa/cm3/s)

	Mean	Standard Deviation
ΔT (T-Exp - T-Insp) °C	.89	.43
ΔT (T-Exp - T-Insp) °C	.92	.39
Right - Ant Rhinomanometry (Pa/cm3/s)	.23	.06
Left - Ant Rhinomanometry (Pa/cm3/s)	.24	.07

			ΔT (T-Exp - T-Insp) °C
Spearman's rho	Right - Ant Rhinomanometry (Pa/cm3/s)	Correlation Coefficient	.088
		Sig. (2-tailed)	.619
		N	34

			ΔT (T-Exp - T-Insp) °C
Spearman's rho	Left - Ant Rhinomanometry (Pa/cm3/s)	Correlation Coefficient	.169
		Sig. (2-tailed)	**.338**
		N	34

Table 5. Correlation analysis for **Δ**T vs Anterior Active rhinomanometry

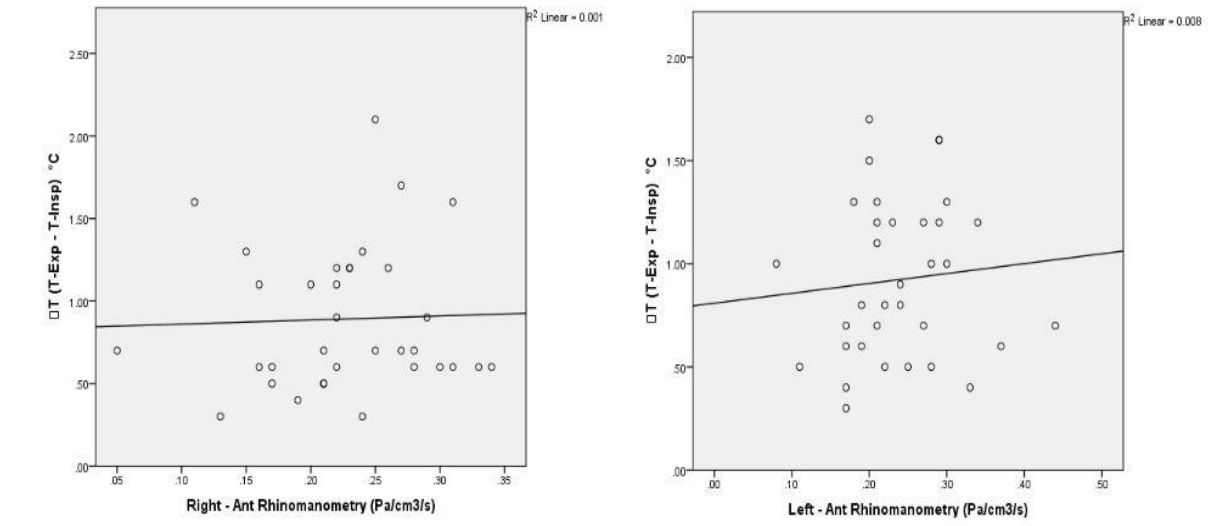


Fig 7. Scatter plot **Δ**T vs Anterior Rhinomanometry

DISCUSSION

In relation to the stated objective of this paper, there are two main findings. First, there is a significant statistical correlation found between the subjective NOSE score and objective mean nasal vestibule temperature fluctuation range (**Δ**T). By treating the NOSE score as a continuous data, plotted against **Δ**T on a Scatter plot and analyzed using R^2 linear regression model, a coefficient of -0.713 is derived (> 0.5 indicate correlation exists). Due to

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue I January 2026

the considerable small sample size, Spearman rho correlation coefficient has been derived as well, showing 0.788 (> 0.6 is indicative of strong correlation), two tailed t-tests meanwhile showed a good validity by demonstrating p - value < 0.05, thereby proving the hypothesis of correlationship existence between nasal vestibule temperature fluctuation and NO severity could not be rejected. In order to eliminate the doubt of laterality of symptoms affecting the overall correlation, additional R^2 linear regression model and Spearman rho correlation coefficient for worse obstruction side, less obstruction side, all right side and all left side versus the NOSE score, no significant deviation from overall correlation coefficient value noted.

Secondly, a similar R^2 linear regression model and Spearman rho coefficient model performed on right and left **Δ**T versus Anterior Rhinomanometry measurement, poor correlation demonstrated, right 0.088 and left 0.169, two tailed t-tests derived p - value much larger than 0.05, thereby hypothesis of correlationship existence between nasal vestibule temperature fluctuation and objective nasal resistance from rhinomanometry is rejected. Poor statistical correlation found between nasal vestibule temperature fluctuation and anterior rhinomanometry in the setting of symptomatic subjects.

Oddly, this study found Visual Analog score (VAS) grading for nasal obstruction to be unreliable, for instance a subject of severe obstruction graded by NOSE score would mark VAS score of 5, similar to a subject with mild obstruction as per NOSE score, vice versa observed as well. We have no clear explanation for this odd finding, as previous studies had demonstrated VAS to be comparable to NOSE score or rhinomanometry in terms of reliability [10] [11].

The concept of Nasal temperature fluctuation as means of demonstrating NO is not new, as a previous systematic review has determined the relationship between various nasal mucosa temperature measurements with perceived nasal patency indeed exist, the research question however is, whether quantification of this correlation is possible [4]. Our study has shown quantification of NO by temperature fluctuation is indeed possible, however a larger study is needed for validation of method, standardization technique and maybe even instrumental calibration. In another previous scientific study of nasal temperature profile, nasal vestibule, nasal valve, anterior head of middle turbinate and nasopharynx were observed to increase in local temperature in a logarithmic pattern when warm air is inspired, nasal valve and head of middle turbinate were shown to be most significant [5]. Due to the low power sensitivity nature of our commercial (recreational) IR camera, we opted to measure the temperature of the nasal vestibule instead, though we were aware that being external part of the nose, a myriad of confounding factors such as ambient temperature, basal body temperature, and various skin conditions may influence our findings, hence our study methodology and criteria of subject selection was designed to minimize the influence of the above mentioned factors. Nevertheless, according to one prior study, the consistency of temperature fluctuation at the nasal vestibule has been demonstrated to be adequate for qualitative study using infrared thermography [9].

As to explain the reason for the poor correlation between mini IR camera and rhinomanometry measurements in our study, we propose a few factors that may have caused this phenomenon. To note, rhinomanometry itself is a proven and reliable method of nasal obstruction assessment, as in a previous study with nearly similar sample size and concept, negative correlation between nasal mucosa temperatures and nasal resistance from rhinomanometry were found [6]. The rhinomanometer used in this study was from an older generation of diagnostic equipment, as from the information we can muster, it is no longer in production, though it is not specifically mentioned in the manufacturer manual, we believe it is a single flow sensor type in nature. The inconsistency of single sensor rhinomanometry was attributed to a complex of phenomena known as “interference”, which is the reason behind the redesigning of the recent generation of rhinomanometers based on multisensor fusion of pressure and flow model [7] [8]. Other factors such as poor quality of nostril seal, incompatible power supply and outdated software-hardware package of our MERZ Rhinomanometer system may have confounded our measurements.

CONCLUSION

Infrared camera is a potentially useful tool for evaluation of Nasal blockage, demonstrated by moderate correlation to the subjective NOSE score, however further study with larger sample size is needed for validation.

Infrared camera and Anterior Active Rhinomanometry are not equivalent tools for the assessment of nasal blockage, demonstrated by weak correlation between measurement results, possibly due to both tools measuring different aspects of nasal obstruction, hence both tools are to be used as complementary to each other.

REFERENCES

1. ESHNR 2023 Book of Abstracts. (2023). Insights into Imaging, 14.
2. Ottaviano, G. (2023). NASAL PATENCY MEASUREMENT. STATE OF THE ART OF ACOUSTIC RHINOMETRY. Facial Plastic Surgery, 40(3), 304.
3. Telson, Y. C., Furlan, R. M. M. M., Porto, M. P., Ferreira, R. A. M., & Motta, A. R. (2023). Evaluation of the Breathing Mode by Infrared Thermography. Research Square (Research Square).
4. Tjahjono, R., & Singh, N. (2021). Correlation between nasal mucosal temperature change and the perception of nasal patency: a literature review. The Journal of Laryngology & Otology, 135(2), 104-109.
5. Keck, T., Leiacker, R., Riechelmann, H., & Rettinger, G. (2000). Temperature profile in the nasal cavity. The Laryngoscope, 110(4), 651-654.
6. Lindemann, J., Keck, T., Scheithauer, M. O., Leiacker, R., & Wiesmiller, K. (2007). Nasal mucosal temperature in relation to nasal airflow as measured by rhinomanometry. American journal of rhinology, 21(1), 46-49
7. Lian, X., Ma, G., Gao, C., Liu, C., Wu, Y., & Guan, W. (2025). A Nasal Resistance Measurement System Based on Multi-Sensor Fusion of Pressure and Flow. Micromachines, 16(8), 886.
8. Clement, P.A.; Gordts, F. Consensus report on acoustic rhinometry and rhinomanometry. Rhinology 2005, 43, 169–179.
9. Kastl KG, Wiesmiller KM, Lindemann J. Dynamic infrared thermography of the nasal vestibules: a new method. Rhinology. 2009 Mar;47(1):89-92
10. Ciprandi, G., Mora, F., Cassano, M., Gallina, A. M., & Mora, R. (2009). Visual analog scale (VAS) and nasal obstruction in persistent allergic rhinitis. Otolaryngology—Head and Neck Surgery, 141(4), 52
11. Shukla, R. H., Nemade, S. V., & Shinde, K. J. (2020). Comparison of visual analogue scale (VAS) and the Nasal Obstruction Symptom Evaluation (NOSE) score in evaluation of post septoplasty patients. World journal of otorhinolaryngolo*gy-head and neck surgery*, *6*(01), 53-58