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Nasal Valve Area in Iranians, an Imaging Based Study

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Abstract

Background and Aim: The internal nasal valve is the narrowest area of nasal airway bounded by the nasal septum, the caudal edge of upper lateral cartilage and the anterior head of the inferior turbinate. Knowledge about this area is of utmost importance for every nasal surgeon.
This study was done to evaluate the internal nasal valve angle and cross sectional area in Iranians.

methods:
This is a retrospective study done using data from cross sectional imagings available from patients who underwent image guided endoscopic skull base surgery between 2013 and 2017. An image navigation software [Osiri- x: 8.5.2] was used for display of the multidimensional images.

Results: Collectively 43 cases (i.e. 86 nasal passages) including 24 males and 19 females in the age range 21 – 74 years (48 ± 13.6) participated in the study. The internal nasal valve angle of naval cavities of the 86 subjects was averaged and the mean value of 17.70º (±3.72) was obtained. Mean value for cross sectional area was of 1.40 cm^2(±0.38).
There was not a statistically significant difference between males and females in terms of the nasal valve angle and nasal valve cross sectional area.

Conclusion: We found some differences between the nasal valve angle and cross sectional area between Iranians and values of Asians / Japanese and Caucasians reported in previous studies. Despite these findings, reaching a conclusion needs further large sample studies in different ethnic groups paying special attention to similar case selection and study design.

Conflicts of Interest: The authors declare no conflicts of interest.
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Introduction

The internal nasal valve is the narrowest area of the nasal airway (1), first described by Mink in 1903; its anatomic boundaries are the dorsal nasal septum, the caudal edge of upper lateral cartilage and the anterior head of the inferior turbinate (2).

The cross sectional area (CSA) of the valve is 55 – 60 mm^2 and the angle formed by the upper lateral cartilage and the septum is 10–15 (3) which is known as “the internal nasal valve angle”.

Poiseuille’s law states that flow is directly proportional to the fourth power of radius. So a minimal decrease in the radius results in a significant decrease in flow (4).

In the same way any reduction in the nasal valve area will lead to a greater effect on the resistance to the nasal airflow. This indicates the importance of the valve area dimensions as the more resistant part of the nasal airway.

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A collapsing valve or a valve with less than a 10 degree angle may require surgical intervention. Therefore, knowledge about this area and accurate estimation of its angle and cross section is critical for every nasal surgeon.

This study was done to evaluate the internal nasal valve angle and cross sectional area in Iranians.

Methods

We conducted this retrospective study with the aim of evaluating the internal nasal valve angle and cross sectional area in Iranians and comparing them with other ethnical groups.

The study was carried out in the department of otolaryngology of a university hospital in Tehran/Iran. This study was approved by the institutional review board of Chronic Respiratory Diseases Research Center of Masih Daneshvari Hospital-Shahid Beheshti University of medical sciences. Informed consent was obtained from all individual participants included in the study. All the participants gave us their permission to use their data for research.

The data were collected from cross sectional imagings available from patients who underwent image guided endoscopic skull base surgery between 2013 and 2017.

Patients under 18, with a history of significant facial trauma or previous nasal surgery and cases with nasal obstruction, were excluded.

Initially, an axial CT scan was obtained from each patient from the superior part of the frontal sinus to the lower border of mandible using a 16 channel multislice CT scanner with the slice thickness at 0.625 mm in bone algorithm (Somatom, Siemens, Erlangen, Germany). Then, axial data were processed and coronal and sagittal reconstructed views were obtained. An image navigation software [Osiri- x: 8.5.2] was used for display of the multidimensional images.

We followed the protocol suggested by Poetker (5) for nasal valve angle calculation. The acoustic axis was estimated on sagittal view. An acoustic axis is considered to be the imaginary line passing through the middle of nasal passage as proposed by Cakmak (6).

Using Osiri-X we moved on the acoustic axis on sagittal view, and the reformatted coronal cut corresponding to the point just anterior to inferior turbinate was selected (figure 1).

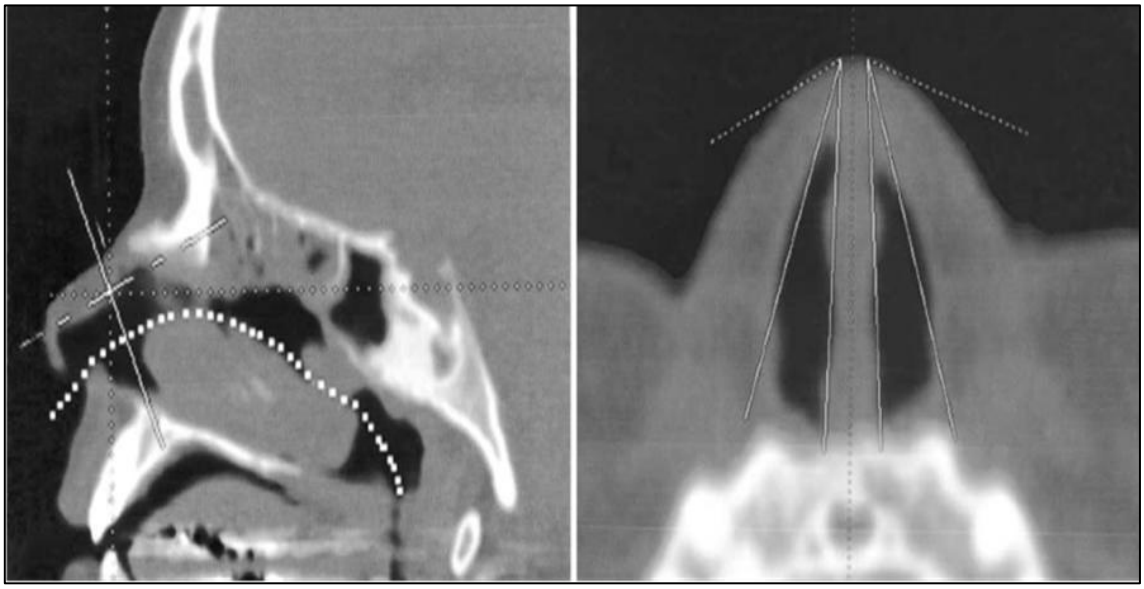

Figure 1: Estimation of the plane perpendicular to acoustic axis on sagittal view.

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Then we focused on base view match up with this level, using 3 points (anterior limit of skin, a point along the upper lateral cartilage and a point on the septal cartilage), we then measured the internal nasal valve angle on each side for every case. (Figure 2)

The surface of the triangular shaped area outlined in this level of axial images was calculated and reported as CSA of internal nasal valve.

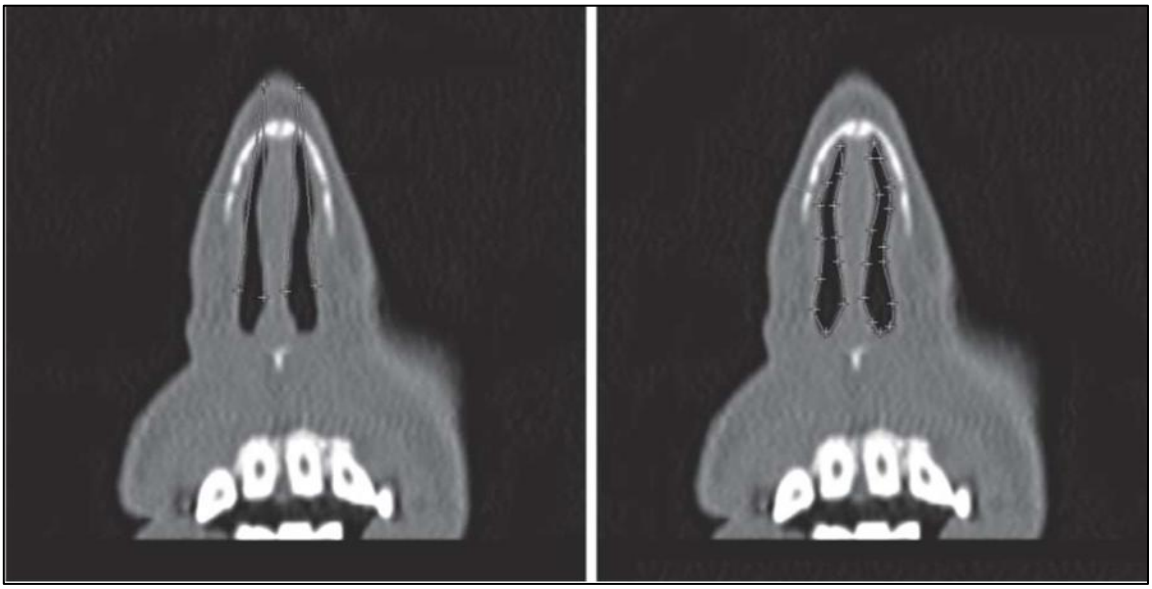

Figure 2: Nasal valve angle measurement (left) and cross sectional area calculation (right) on base view images.

Data were analyzed using SPSS 21. Variables were tested by t-test to compare the means, and Pearson's correlation coefficient test to examine the correlations between them.

Results

Collectively 43 cases (i.e. 86 nasal passages) including 24 males and 19 females in the age range 21 to 74 years (48 ± 13.6) were entered in this study.

The internal nasal valve angle of naval cavities of the 86 subjects was averaged and the mean value of 17.70º (±3.72) was obtained. When considering females and males separately, the angle was 17.4º (±3.76) and 18.15º (±3.60), respectively.

No statistically significant difference was found between the two (p: 0.35).

Values obtained from CSA calculation showed the mean value of 1.40 cm^2 (±0.38). It was 1.32 (±0.32) in females and 1.42 (±0.43) in males; however the difference between the values did not reach a significant level. (p:0.23)

Discussion

The nasal valve first described by Mink (7), who suggested that the area of greatest resistance was at the junction of the upper lateral and alar cartilages and introduced the term nasal valve for this region (8).

He also suggested that the internal nasal valve angle, between the upper lateral cartilage and the septum is about 10 – 15° in normal subjects (9).

Internal nasal valve evaluation has been done in different ways. Nasal endoscopy is the routine accepted method for examining the nasal valve area. Although equipment such as acoustic rhinometry exists to evaluate the CSA of the nasal valve, many surgeons do not have such equipment.

Ichimura and Ishizuka in 1997 (10) measured the nasal valve angle and CSA at the nasal valve area in Japanese subjects by endoscopic

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recorded images and acoustic rhinometry respectively. The mean NV angle was 28.9 and CSA at I notch was 0.95 cm^2. No relation was found between the NV Angle and CSA around the valve.

Application of imaging modalities for the evaluation of the nasal valve has been previously studied many times. Although the American Academy of otolaryngology head and neck surgery consensus panel stated that radiographic studies are not useful for evaluating nasal valve compromise (11). There is a significant correlation between CSA in the anterior part of the nasal cavity in imaging modalities and AR (12, 13) and CT scans have been proposed as an objective tool to measure the internal nasal valve anatomy.

Before Cakmak's study almost all studies used CT sections perpendicular to the floor of the nose.

Cakmak compared nasal valve area measured by acoustic rhinometry with measurements from CT sections taken in 2 different coronal planes: perpendicular to the nasal floor and perpendicular to the acoustic axis. They found a significant correlation between nasal valve area in acoustic rhinometry and CT when imaging was obtained perpendicular to the acoustic axis.

Poetker compared nasal valve values measured by traditional coronal CT scans with those obtained using the nasal base view. Their results showed an angle of 8.3° by coronal plane CT scans and 11.4° by nasal base view scans. They concluded that traditional coronal scans underestimate the true nasal valve angle. (5)

Bloom (14) measured the area of internal nasal valve in the traditional coronal plane and the angled reformatted plane perpendicular to a line along the patient's bony dorsum. The nasal valve angle in this study performed on patients (not normal subjects) was 10.28° and 9.71° for left and right side respectively. Mean values for nasal valve CSA were reported as 82.84 mm^2 and 85.50 mm^2 for left and right side respectively. Our method of measurement was similar to the study done by Suh and collegues (15) who used reformatted images perpendicular to acoustic axis for nasal valve angle calculation in Asians and concluded that the angle (21.6° ± 4.5°) is significantly larger than that of Caucasians (reported in the Poetker study)

Although the Poetker study was conducted in a US state, they did not mention the ethnicity of the participants; furthermore, they did not exclude specific sinonasal disorders from the study group.

The above mentioned studies suggested that the nasal valve area may be better estimated when CT scans are reformatted to a plane perpendicular to estimated acoustic axis.

Englhard (16) evaluated the internal nasal valve of healthy subjects by optical coherence tomography imaging.

The results showed the internal nasal valve angle to be 18.3°± 3.1°. They also reported the CSA of 0.65 cm^2.

Comparing the results of OCT images with images recorded by flexible endoscope, they concluded that there is no statistically significant difference between endoscopy and OCT concerning the mean INV angle.

Given the different study group and design, caution needs to be taken when comparing their results.

Table 1 summarizes the results of similar studies. It also shows p values for comparison of means with our study.

Conclusion

Knowledge of anatomy is obviously of utmost importance for rhinologists when performing a perfect surgical intervention and the nasal valve area is one of most critical issues to which surgeons should pay extra attention to, before and during the intervention. Correction of the internal nasal valve angle is one of primary goals in every

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functional nasal surgery. This angle differs between ethnic groups and it should be considered when planning modifications in rhinoplasties.

Surgeons who operate on people of different ethnicities known to have narrow nasal valves should be cautious about applying techniques which compromise the valve area and should consider the lower threshold in performing corrective measures like specific grafts or suture techniques.

The comparison of mean values showed some differences between nasal valve angle and CSA found in our Iranian samples and the values of Asians / Japanese and Caucasians reported in previous studies. Despite these findings we believe that this is not a definite result on which we can rely. Reaching such a conclusion needs further large sample studies in different ethnic groups paying special attention to similar case selection and study design.

Table 1: summary of results of similar studies

Study (year)	Sample	Method	Results	p-value*
Ichimura[10] **(1997)**	116 healthy adult Japanese	• Endoscopic recorded images for NVA • AR for CSA	NVA: 28.9° ± 6.3°	p<0.0001
			CSA: 0.95±0.16cm^2	p<0.0001
Poetker[5] **(2004)**	30 scans obtained for image guided sinus surgery (60 nasal valve) Randomly selected Ethnicity: not mentioned	NVA in nasal base view CT scan	NVA: 11.4°±2.6°	p<0.0001
Suh[15] **(2008)**	19 patients(38 nostrils) minimal or no sinonasal problems Asians	Reformatted images perpendicular to estimated acoustic axis	NVA: 21.6°±4.6°	p<0.0001
Bloom[14] **(2012)**	46 patients with nasal airway obstruction New York Ethnicity: not mentioned	Reformatted CT (perpendicular to acoustic axis)	NVA Left: 10.28°±2.94° Right: 9.71°±3.54°	
			CSA Left: 82.84±26.08mm^2 Right: 85.5±35.97mm^2	
Englhard[16] **(2015)**	16 healthy subjects (32 data sets) 8 Asian and 8 Caucasian subpopulations	Optical coherence tomography	NVA Asians: 21.8°±2.9° Caucasians: 14.2°±3.2°	p= 0.0004 p=0.0006
			CSA: 0.65±0.23cm^2	p<0.0001
Our study (2019)	43 subjects without nasal obstruction	Reformatted CT perpendicular to acoustic axis	NVA: Left: 17.82°±3.81° Right: 17.65°±3.6° Total: 17.7°±3.72°	
			CSA: Left: 1.40±0.38 Right: 1.40±0.46 Total: 1.38±0.41	

NVA: nasal valve angle, CSA: cross sectional area.

* Comparison of mean values with present study.

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Conflicts of Interest

The authors declare no conflicts of interest.

Ethics:

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