Otolaryngology: Open Access
ISSN: 2161-119X

Narayanan, Otolaryngol (Sunnyvale) 2022, 12:1

Review Article Open Access

Dimensions of the Internal Nasal Valve Using Computed Tomography Scan: A Systematic Review

Ahmad Bogari[1]*, Ibrahim Al Awadh[2], Mohammed Al Karzae[3], Turki Al Drees[4], Raad Al Nassar[5], Faisal Abohelaibah[6] and Ahmed Al Arfaj[7]

[1]*Otorhinolaryngology-Head and Neck Surgery Resident, Ministry of Health, Riyadh, Saudi Arabia*
[2]*Otorhinolaryngology-Head and Neck Surgery Consultant & Facial Plastic Fellow, Ministry of Health, Riyadh, Saudi Arabia*
[3]*Department of Otorhinolaryngology-Head and Neck Surgery, Security Forces Hospital, Riyadh, Saudi Arabia*
[4]*Department of Otolaryngology-Head and Neck Surgery, College of Medicine, Prince Sattam Bin Abdulaziz University, Alkharj, 11942, Saudi Arabia*
[5]*Department of Otorhinolaryngology-Head and Neck Surgery, AlHabib Hospital, Riyadh, Saudi Arabia*
[6]*College of Medicine, Shaqra University, Riyadh, Saudi Arabia*
[7]*Department of Otorhinolaryngology-Head and Neck, College of Medicine, King Saud University, Riyadh, Saudi Arabia*

Abstract

Computed tomography (CT) is a promising modality for measuring the dimensions of the internal nasal valve (INV). A systematic review was performed by collecting medical literature from Medline, Ovid, PubMed, and Embase databases to determine original research articles that evaluated the usefulness of CT in measuring INV dimensions. Of the eight articles selected, two case-control studies could not confirm whether CT had clinical application as a criterion for septoplasty. Three prospective studies also showed non-promising estimation results of the INV using CT in rhinoplasties. Of the three retrospective studies, one suggested that axial CT is useful to assess narrow-valved INV with high sensitivity, one corroborated the benefit of using CT to assess the INV radiographically, but one showed that CT was inferior to other techniques for this purpose. Therefore, current evidence shows that CT may be effective but not sufficient to accurately measure INV dimensions.

Keywords: Internal nasal valve; Narrowing; Radiographic imaging; Rhinoplasty

Introduction

The internal nasal valve (INV) is the valve situated in the middle of the nasal septal wall, upper lateral cartilage, and anterior head of the inferior turbinate and nasal floor. It has been known to play an important role in different procedures, especially in septoplasty and rhinoplasty performed by nasal surgeons [1,2]. The narrowing of the INV has been proposed to be the most common factor that contributes to nasal obstruction, particularly in patients who have undergone a prior rhinoplasty [3].

Rhinoplasty operations, such as osteotomies and hump resections, have been reported to result in several complications as a result of the reduction in the size of the INV and a subsequent reduction in the airflow through the nose [4, 5]. Hence, some interventions have been proposed to reduce the incidence of INV narrowing. These interventions include cartilage bending, spreader graft placement, and other procedures aimed at preventing the occurrence of any form of nasal obstruction [7].

It has been suggested that computed tomography (CT) is an effective and accurate modality that can be used to measure the dimensions of the INV and evaluate the extent of any narrowing [8]. Additionally, over the past two decades, studies have explored different CT techniques for measuring the dimensions of the INV yet the evidence of its clinical significance remains controversial [9, 10]. We reviewed the literature published in the past two decades to elucidate the conflicts associated with the use of CT in measuring the dimensions of the INV and assess the clinical significance of using CT for this purpose.

Methods

The methodology of this systematic review was performed in compliance with the Preferred Reporting Items for Systematic Review and Meta-analysis Protocols 2015 [11].

Eligibility Criteria

Studies were included if three of the authors agreed on the following inclusion criteria: (a) articles that included sufficient data on the description of the radiological investigation, (b) articles that elaborated the indication for radiographic imaging, (c) articles published in the English language, (d) studies that included adult patients only, and (e) available full-text articles. The exclusion criteria were as follows: (a) in vitro studies, (b) cadaveric or animal studies, (c) studies with overlapping or incomplete data, (d) studies with unavailable full-text articles, (e) studies with inappropriate study design, (f) non-English studies, and (g) non-peer-reviewed studies.

Information Sources

Literature search strategies were developed using Medical Subject Headings (MeSH) and text words related to CT and INV. A thorough literature search was performed using four large electronic databases (Medline, Ovid, PubMed, and Embase) up to April 2020. The electronic database search was supplemented by searching for trial protocols through Meta Register.

Search Strategy

The search strategy was using keywords, MeSH terms, and truncation and wildcard symbols. Using the Boolean operators, the

***Corresponding author:** Bogari A, Otorhinolaryngology-Head and Neck Surgery Resident, Ministry of Health, Riyadh, Saudi Arabia, Tel: +966504667551; E-mail: ahmadBogari@hotmail.com

Received: 23-Dec-2021, Manuscript No.ocr-21-46895; **Editor assigned:** 25-Dec-2021, PreQC No. ocr-21-46895 (PQ); **Reviewed:** 11-Jan-2022, QC No. ocr-21-46895; **Revised:** 17-Jan-2022, Manuscript No. ocr-21-46895 (R); **Published:** 25-Jan-2022, DOI: 10.4172/2161-119X.1000442

Citation: Bogari A, Al Awadh I, Al Karzae M, Al Drees T, Al Nassar R, et al. (2022) Dimensions of the Internal Nasal Valve Using Computed Tomography Scan: A Systematic Review. Otolaryngol (Sunnyvale) 12: 442.

following strategy was used: (a) computed tomography OR CT scan OR imag* study OR radiographic imag*; (b) internal nasal valve OR INV OR internal nasal valve narrow*; and (c) a AND b. summarizes the results of the search strategy (**Table 1**).

Study Selection

According to perceived relevance, two authors (MK, FA) independently screened the titles and abstracts of retrieved studies that have terms from the search strategy (c). The relevant studies' full-text articles were then reviewed by two independent authors (TD, RN). A third author (AA) was assigned to solve any disagreements. Studies were included if they met the inclusion criteria.

All the titles and abstracts were evaluated thoroughly so that none of the eligible articles were missed. Works of the literature were then refined to select only original research articles that evaluated the usefulness of CT in measuring the dimensions of the INV. Furthermore, it was ensured that the selected trials outlined the indications for radiographic imaging. All study designs from different countries were considered. Afterward, the inclusion criteria for choosing articles to be examined in the systematic review were determined. Abstracts were manually assessed to select appropriate abstracts for consideration. Moreover, the references from the selected trials were examined to identify any related articles. Finally, required data sets were extracted from the final list of eligible articles and were subsequently summarized. Subsequently, selected eligible studies were critically appraised using the Newcastle–Ottawa Quality Assessment Scale that is used to assess case-control and cohort studies. Complete details on the search strategy are presented in **Figure 1**.

Table 1: Summary of search strategy.

Stage	Search	Result
1	computed tomography OR CT scan OR imag* study OR radiographic imag*	3,061,695
2	internal nasal valve OR INV OR internal nasal valve narrow*	14,474
3	1 AND 2	1,978

Data Review and Analysis

The first step involved a preliminary review: a predesigned excel sheet was used for data extraction. Subsequently, filtered data from the eligible articles were revised through the excel sheet. Any published studies that were conducted by a single research group and that examined similar variables were reviewed for any possible duplication. In addition to the previously mentioned assessment tool of quality, Cochrane's quality assessment tool was also used to evaluate the quality and risk of bias of the included clinical studies [12]. Important points of the included articles were summarized and were formulated to our own opinion on the subject matter. The merits and highlights of each article were pointed out and presented in the Results section and discussed.

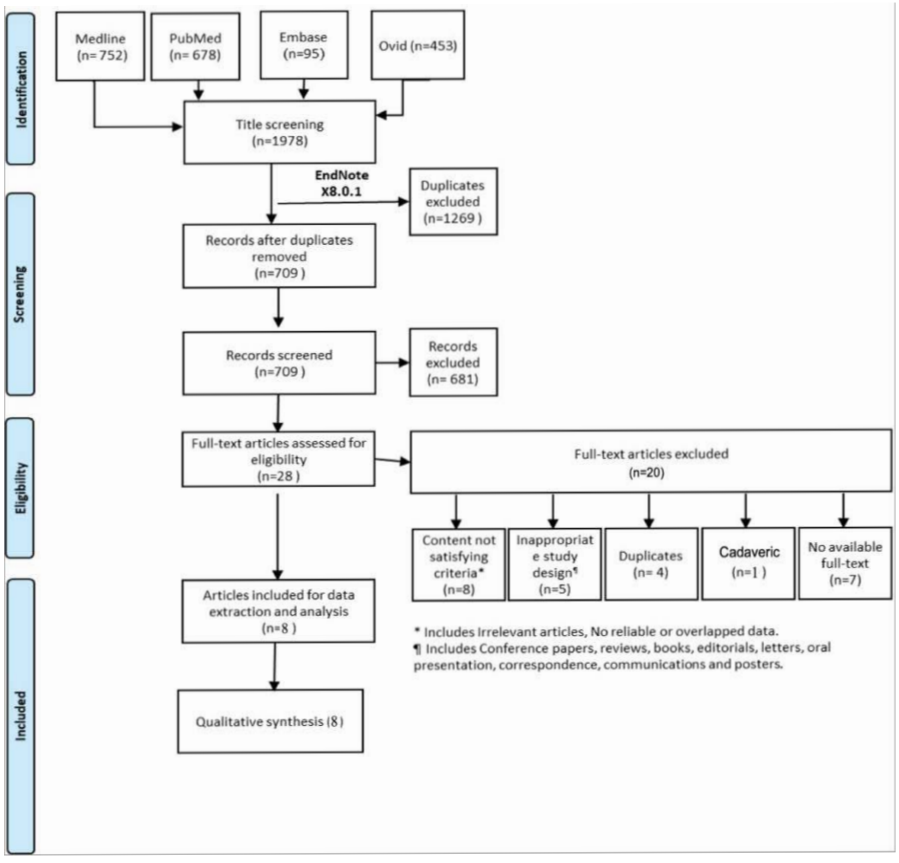

Figure 1: Search strategy and results.

There was no need to obtain informed consent as the study did not involve any interventions on patients.

Results

A total of 1978 articles were retrieved, and after the exclusion, 48 articles were considered for final inclusion. A total of eight articles published between 2000 and 2020 with different indications for CT were selected as eligible. These included 821 patients who underwent a CT scan for varying indications that led to nasal obstruction. Out of the eight studies, two were case-control studies, three were retrospective studies and three were prospective and observational studies. One study performed CT scans on patients undergoing septoplasty, three studies performed CT scans on patients undergoing rhinoplasty, two studies performed CT scans to examine nasal obstructions resulting from nasal surgery and one study performed CT scans on healthy individuals [13-19].

According to the extracted results, the indication for CT in all the trials was considered as the requirement to measure the dimensions of the INV. The included trials are summarized in **Table 2**.

The two case-control studies showed no conclusive advantage of using the CT scan technique. We're not able to confirm whether the CT scan technique has clinical application as a criterion for septoplasty since the sectional areas on the nasal tomography had different values. He has similarly concluded that the CT scan of the INV was not able to facilitate an objective evaluation of the level of nasal discomfort among patients with deviated nasal septum who underwent a septoplasty. The three prospective studies also showed non-promising estimation results of the INV using CT scan imaging among patients with rhinoplasty and nasal obstruction. He have suggested that CT scan (NBV technique) can be used for the accurate measurement of the nasal and paranasal areas, but the conventional coronal CT scan has little value for the measurement of the nasal valve angle alone, considering its cost and side effects [13-18]. The three retrospective studies, however, showed contrasting results. Two of these retrospective studies showed a significant value of tomographic imaging to radiographically assess the INV. have suggested that the conventional axial CT scan can radiographically assess the narrow valved-INV with high sensitivity and specificity among patients with sinusitis and nasal airway obstruction. Although Bloom et al. have suggested that a CT scan that is reformatted may provide improved anatomical data, they have emphasized that surgeons should not only rely on the CT scan measurements solely but also consider the patient's symptoms. The other retrospective study that had findings similar to those of where they suggested that the NBV technique has a more accurate estimation of the nasal valve than the conventional CT scan technique [16-19].

Discussion

Nasal obstruction is one of the complications that affect patient

Table 2: Characteristics of the included literature.

Authors	Year	Study design	Population	Indication	Significant findings
Yazici et al. [13]	2019	Case-control	600	Septoplasty	- 64% of the patients had a left nasal septal deviation; 36% had a right nasal septal deviation. - The mean INV angle in the left septoplasty group was significantly lower than the control group. - Significant statistical difference between the values of the right septoplasty group than the control group. - Sectional areas on the nasal tomography illustrations may have different values
Shafik et al. [14]	2018	Prospective	20	Rhinoplasty	- Non-significant association between CT scan results of the INV before and after rhinoplasty - Non-significant association between CT scan results of the INV and the NOSE score before and after rhinoplasty.
Shafik et al. [15]	2019	Prospective	20	Rhinoplasty	- Non-significant relationship between the pre- and post-CT scan results of the INV angle and NOSE scores - Reformatted CT-scan estimations of the INV area were non-significant.
Moche et al. [16]	2013	Retrospective	40	Sinusitis / nasal airway obstruction	- Conventional axial CT imaging may radiographically assess the nasal valve and it has a strong relationship with physical assessment results and patient symptoms. Radiographic valve areas could be used to screen for narrow nasal valves with high specificity and sensitivity.
Bloom et al. [17]	2012	Retrospective	24	Rhinoplasty	- A CT scan that is reformatted in the appropriate plane of the INV can provide the surgeon with improved anatomical data that can aid in evaluating this region.
Veron et al. [18]	2011	Case-control	50	Septoplasty	- The optimal orientation for examining the nasal valve is perpendicular to the axis of nasal airflow. With this reconstruction technique, there is a significant difference in surface values as well as in the minimal surface value. - A CT scan of the nasal valve does not facilitate an objective evaluation of the level of nasal discomfort, and the results should be correlated with other potential causes of nasal obstruction symptoms, such as septal morphology.
Bilgisayarli and Yeri [19]	2010	Prospective	31	Nasal obstruction	- There were statistically significant differences between the endoscopic findings and the classic coronal tomographic measurements and between the classic coronal tomographic results and the nasal basal view CT scan (NBV) results that are acquired in the plane perpendicular to the acoustic axis. - Tomographic images acquired by the NBV technique provide an accurate measurement of the nasal valve angle. This technique may be preferred for the evaluation of nasal and paranasal areas in selected patients. - Conventional coronal tomographic imaging is not an effective method for the measurement of the nasal valve angle alone due to its cost and side effects
Poetker et al. [20]	2004	Retrospective	30	Evaluation of sinonasal cavities	- The conventional coronal computed tomograms of the sinonasal cavities can underestimate the actual nasal valve angle. - NBV may provide a more accurate estimation of the nasal valve because the measured angles of the nasal valve in this plane (10° to 15°) are more compatible with traditional descriptions.

satisfaction following nasal surgeries, such as rhinoplasty and septoplasty [15]. This complication usually arises from the narrowing of the INV [16]. CT has been proposed as a promising tool for the estimation of the dimensions of the INV and detection of any occurrence of INV narrowing [18].

The measurement of the dimensions of the INV has been evaluated based on various aspects. He has revealed that the dimensions of the INV were significantly smaller in patients who had undergone a septoplasty than in patients in the control group [13]. He has demonstrated that as detected by a CT scan, the INV was narrowed with a 40.4% reduction in its dimension and was correlated with the patients' symptoms [15]. Hence, they have concluded that axial CT is a reliable modality for the detection of INV narrowing. Bloom et al. have used a reformatted plane to evaluate the dimensions of the INV that exhibited a significantly narrower angle compared to the angles observed in conventionally oriented CT positions [16]. In contrast, studies including the supported notion that the optimal orientation for a CT examination is the perpendicular position [17]. However, they were not able to arrive at a conclusion that CT scans can provide clinicians with information regarding the level of discomfort that the patient is experiencing [18]. A more straightforward suggestion was reported studies in that the dimensions of the INV did not differ significantly before and after surgery despite the presence of a significant difference in the Nasal Obstruction and Septoplasty Effectiveness scale [14].

Based on the eight studies reviewed, the INV was found to be significantly narrowed in patients who had symptoms of nasal obstruction, especially following different types of nasal surgeries. It has been demonstrated that the value of conventional CT scans in measuring the dimensions of the INV is still inconclusive to some and valuable to others. These findings may be limited by some aspects of the included studies. For one, the sample sizes that were included in each study were small; thus, they might not reliably reflect the entire nasal surgery patient population. Additionally, most of the included studies were conducted only in one center, which may have a negative influence on external validity. The INV was found to be significantly narrowed in patients who had symptoms of nasal obstruction, especially following different types of nasal surgeries. In conclusion, CT may be an effective radiological intervention for measuring the dimensions of the INV, but surgeons should more closely investigate their patients' symptoms rather than solely relying on CT scan results. It is recommended that future studies, such as randomized controlled trials that have more robust study designs, multicenter studies, and larger sample-sized studies, should be considered.

In conclusion, although CT is one of the proposed modalities to measure INV dimensions, the existing evidence suggesting this technique's usefulness for this purpose is conflicting. Our review showed that CT can be effective in measuring the dimensions of the nasal valve; however, surgeons should pay more attention to performing a physical examination of the patient and assessing his/her symptoms.

Acknowledgments

This publication was supported by the Deanship of Scientific Research at Prince Sattam Bin Abdulaziz University, Al-Kharj, Saudi Arabia.

References

1. Wang T, Chen D, Wang PH, Chen J and Deng J (2016) Investigation on the nasal airflow characteristics of anterior nasal cavity stenosis. Braz J Med Biol Res 49:e5182.
2. Englhard AS, Wiedmann M, Ledderose GJ, Lemieux B, Badran A, et al. (2016) Imaging of the internal nasal valve using long-range Fourier domain optical coherence tomography. Laryngoscope 126:97-102.
3. Hsu DW, Suh JD (2018) Anatomy and physiology of nasal obstruction. Otolaryngol Clin North Am 5:853-865.
4. Sedaghat AR, Kieff DA, Bergmark RW, Cunnane ME and Busaba NY (2015) Radiographic evaluation of nasal septal deviation from computed tomography correlates poorly with physical exam findings. Int Forum Allergy Rhinol 5:258-262.
5. Ardeshirpour F, McCarn KE, McKinney AM, Odland RM, Yueh B, et al. (2016) Computed tomography scan does not correlate with patient experience of nasal obstruction. Laryngoscope 126:820-825.
6. Ismail A, Hussein W, Elwany S (2018) Combining spreader grafts with suture suspension for management of narrow internal nasal valve angles. Turk Arch Otorhinolaryngol 56:25-29.
7. Moche JA, Palmer O (2012) Surgical management of nasal obstruction. Oral Maxillofac Surg Clin North Am 24:229-237.
8. Englhard AS, Wiedmann M, Ledderose GJ, Lemieux B, Badran A, et al. (2018) In vivo imaging of the internal nasal valve during different conditions using optical coherence tomography. Laryngoscope 128:105-110.
9. Shafik AG, Rabie TM, Alkady HA, Mohamed AM (2018) Evaluation of the internal nasal valve using computed tomography pre and post rhinoplasty and its correlation to symptomatic improvement. Egypt J Hosp Med 72:4486-4489.
10. Shafik AG, Alkady HA, Tawfik GM, Mohamed AM, Rabie TM, et al. (2020) Computed tomography evaluation of internal nasal valve angle and area and its correlation with NOSE scale for symptomatic improvement in rhinoplasty. Braz J Otorhinolaryngol 86:343-350.
11. Shamseer L, Moher D, Clarke M, Ghersi D, Liberati A, et al. (2015) Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. BMJ 350: 7647.
12. Higgins JPT, Altman DG, Gøtzsche PC, Jüni P, Moher D, et al. (2011) The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ 343:5928.
13. Yazici A, Er HC (2019) The correlation of computed tomography in the evaluation of septoplasty patients. Niger J Clin Prac 22:1196.
14. Shafik AG, Alkady HA, Tawfik GM, Mohamed AM, Rabie TM, et.al. (2020) Computed tomography (CT) evaluation of internal nasal valve angle and area and its correlation with NOSE scale for symptomatic improvement in rhinoplasty. Braz J Otorhinolaryngol 86:343-350.
15. Moche JA, Cohen JC, Pearlman SJ (2013) Axial computed tomography evaluation of the internal nasal valve correlates with clinical valve narrowing and patient complaint. Int Forum Allergy Rhinol 3:592-597.
16. Bloom JD, Sridharan S, Hagiwara M, Babb JS, White WM, et al. (2012) Reformatted computed tomography to assess the internal nasal valve and association with physical examination. Arch Facial Plast Surg 14:331-335.
17. Veron A, Bocquet J, Clareton V, Tourdias T, Molinier S, et al. (2011) Value of CT scan measures of the nasal valve for predicting clinical nasal obstruction. Age 30:0-5.
18. Beriat KG, Demet K, Sina mn K (2010) The value of computed tomography in evaluation of internal nasal valve angle. Trakya Univ Tip Fak Derg 27:270-274.
19. Poetker DM, Rhee JS, Mocan BO, Michel MA (2004) Computed tomography technique for evaluation of the nasal valve. Arch Facial Plast Surg 6:240-243.