The Laryngoscope

Computed Tomography Scan Does Not Correlate With Patient Experience of Nasal Obstruction

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Objectives/Hypothesis: Third-party payors have begun to demand imaging studies to document septal deviation prior to authorizing septoplasties. This study aims to determine whether septal deviation findings on computed tomography (CT) correlate with symptoms of nasal obstruction as determined by the Nasal Obstruction Symptom Evaluation (NOSE) scale.

Study Design: Prospective and retrospective chart review.

Methods: Patients 18 years or older undergoing CT scans, which included the nasal septum, were asked to complete a NOSE scale survey and report the laterality of any possible obstruction. Coronal CT images of subjects were graded by two blinded otolaryngologists and two blinded neuroradiologists using a grading system devised by the authors.

Results: Seventy-three subjects met inclusion/exclusion criteria. Interobserver reliability about the degree of septal deviation on CT scans was moderately good to substantial (κ values, 0.43 to 0.72). There was poor correlation between NOSE scores and degree of deviation on CT scans (Kendall's τ, 0.031 to 0.045; P values all $>.05$). There was poor concordance between the side of symptoms that patients reported and the side that observers thought was most deviated on CT.

Conclusions: There is little correlation between septal deviation findings on CT scans and symptoms of nasal obstruction. The results do not support a role for CT scans as either a clinically meaningful or necessary test to investigate uncomplicated nasal obstruction.

Key Words: Nasal obstruction, computed tomography, septal deviation, septoplasty, rhinoplasty, nose, radiology, nasal reconstruction.

Level of Evidence: 4

***Laryngoscope*, 126:820–825, 2016**

INTRODUCTION

Nasal obstruction is a common problem seen in primary care and otolaryngology practices.[1,2] It can be caused by several factors including mucosal congestion, turbinate hypertrophy, and adenoid hypertrophy.[3] Framework deformities, including septal deviation, are also a cause of nasal obstruction. Septoplasty, the definitive treatment of septal deviation, is the name of the procedure in which the surgeon straightens the nasal septum.[1,4,5]

For years investigators have sought ways to objectively predict symptomatic nasal obstruction. To date, the literature has not shown whether imaging studies can accurately confirm or not confirm nasal obstructive symptoms. There is no standard method for measuring septal deviation on imaging studies. Despite the lack of evidence, third-party payors have begun to demand imaging studies to document nasal obstruction prior to authorizing septoplasty.

In 2004, Stewart et al.[3] developed a validated instrument, called the Nasal Obstruction Symptom Evaluation (NOSE) scale, to measure nasal obstruction. Extensive testing of this instrument demonstrates that its scores reflect the degree of patient symptomatic burden. Higher NOSE scores correspond to more troublesome nasal obstruction, and measurements have been shown to be reliable over time.

The objective of this study was to determine whether septal deviation findings on computed tomography (CT) scans correlate with symptoms of nasal obstruction as determined by the NOSE scale. We hypothesized that septal deviation findings on CT scans would poorly correlate with symptoms of nasal obstruction as determined by the NOSE scale.

MATERIALS AND METHODS

The institutional review board at Hennepin County Medical Center, Minneapolis, Minnesota approved this combined prospective and retrospective chart review. The Department of Radiology requested that all patients receiving head or neck CT scans complete the NOSE survey (Fig. 1A) immediately before their scan. Additional questions, such as laterality of symptoms and surgical history, were also asked on the survey

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Editor's Note: This Manuscript was accepted for publication October 7, 2015.

The authors have no funding, financial relationships, or conflicts of interest to disclose.

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DOI: 10.1002/lary.25784

A Over the past 1 month, how much of a problem were the following conditions for you?

(Please circle the most correct response)

	Not a Problem	Very Mild Problem	Moderate Problem	Fairly Bad Problem	Severe Problem
Nasal congestion or stuffiness	0	1	2	3	4
Nasal blockage or 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 or exertion	0	1	2	3	4

B

On which side do you have more difficulty breathing through your nose? Left Right Both Equally Not Applicable

Have you ever had surgery inside or outside of your nose? Yes No

Have you ever had sinus surgery? Yes No

Fig. 1. (A) Survey questions from the Nasal Obstruction Symptom Evaluation scale.[3] (B) Additional survey questions.

(Fig. 1B). Inclusion criteria included any patient 18 years older who was to have a CT scan that included the nasal septum. The types of CT scans performed were of the head, sinuses, and facial bones (Table I). Exclusion criteria included patients with any history of nasal surgery, sinus surgery, acute sinonasal trauma, radiation treatment to the face, craniofacial disorders, autoimmune disorders, those who were pregnant, or any scan that did not include the entire height and length of the nasal septum.

Reviewers were trained to use our grading system by reviewing examples of each degree of deviation at a specific coronal section (Fig. 2). Two trained otolaryngologists and two trained neuroradiologists reviewed 73 coronal CT scans, in bony windows, of patients who met the above criteria. Reviewers, blinded to each other and unaware of subjects' NOSE scores, recorded the degree of deviation (0, 1, or 2) and the side of the deviation (right, left, or midline) in each given section. Reviewers scored the deviation as 0 if no deviation was seen, as 1 if there was mild to moderate deviation, and as a 2 if the deviation was severe. Reviewers graded the scans based on the characteristic of the septum, not the turbinates or any other nasal structures. The thickness of the septum (mucosa, cartilage, bone) did not affect the degree of deviation. If a patient had deviations on both sides, the reviewers recorded the side with more significant deviation.

We evaluated the septum in three separate areas. The first was the section anterior to the head of the inferior turbinates (anterior), the second was a single slice through the head of the inferior turbinates (middle), and the third was the area posterior to head of the inferior turbinates (posterior) (Fig. 2). Reviewers also recorded the section that they perceived to be maximally deviated among all the sections.

Inter-rater variability was measured by the kappa statistic (κ). We interpreted κ using the criteria of Fleiss,[6] which rates κ values as: "poor" (<0.4), "fair to good" (0.4–0.74), "excellent" (≥ 0.75). Correlations between NOSE scores and degrees of septal deviation based on CT scans were measured by Kendall's tau (τ), which is the nonparametric analog of the Pearson correlation coefficient (r). We used a nonparametric measure such as τ because our rating system was ordinal, rather than truly dimensional. The τ values can be interpreted in a similar manner as the correlation coefficient, where the scores range from 0.0 (none) to 1.0 (strongest). Like the Pearson correlation coefficient, meaningful relationships are seen beginning at 0.3. P values less than 0.05 were considered

TABLE I.
Demographics Data, Types of CT Scans, and Indications for CT Scans.

	N	%
Age, yr		
Average	47	
Range	18–90	
Gender		
Male	38	52
Female	35	48
Race		
White	37	51
African American	27	37
Hispanic	6	8
Other	3	4
Scan type		
Head	48	66
Sinus	16	22
Face	6	8
Other	3	4
Indications		
Head trauma	25	34
Altered mental status	16	22
Headache	15	21
Rule out sinusitis	14	19
Mass	3	4

CT = computed tomography.

statistically significant. Calculations were made using Stata/SE 10 Data Analysis and Statistical Software (StataCorp, College Station, TX).

RESULTS

One hundred thirty surveys were collected during this study, of which 73 subjects met inclusion and exclusion criteria. Table I shows demographic data, types of CT scans performed, and the indications for the CT scans. The average age for men was 44 years (range, 19–90 years) and for women was 50 years (range, 18–89 years).

Interobserver variability about CT interpretation was measured by using κ to measure inter-rater reliability (Table II). κ values comparing the degree of deviation at each section of the CT among all four reviewers demonstrated "fair to good" agreement,[6] ranging from 0.434 to 0.723. There was good agreement on the interpretation of CTs across and within specialties. Table III shows that there was "poor" concordance between the side patients reported as being more symptomatic and the side that observers perceived to be most deviated.[6]

Table IV shows the correlation between the degree of maximum observed septal deviation across all sections of the septum on CT and NOSE scores. τ values calculated from the different parts of the septum (anterior, middle, posterior) were all very small (0.015 to 0.031, P values all $>.05$), suggesting almost no correlation between NOSE scores and degree of deviation on CT.

DISCUSSION

Our study shows that there is lack of correlation between the degree of septal deviation seen on CT scans and nasal symptoms measured by NOSE scores. The observer-rated nasal obstruction, reflected by interpretation of CT data, had high inter-rater reliability. There was poor concordance between the more symptomatic side of the nose and the side perceived to have greater septal deviation on the CT scan. This study suggests that objective CT scans poorly reflect a patient's subjective description of nasal obstruction.

The finding that objective data do not necessarily correlate with patient subjective data is not novel. The poor correlation between objective and subjective data has been shown in other otolaryngologic diseases such as rhinosinusitis.[7] Imaging studies have been shown not to correlate with patient paranasal sinus symptoms.[8,9] Although not measured in this study, we would anticipate similar findings with "objective" measures such as acoustic rhinometry and rhinomanometry, which are not readily available to practitioners. Patient-based assessments are important, and reliance on only objective data to make inference of subjective patient symptoms is problematic. Symptom-based instruments like the NOSE scale are important in quantifying aspects of disease not detected in objective testing. Outcomes studies, systematic reviews, and meta-analyses have shown septoplasty to be an effective treatment for nasal obstruction due to septal deviation.[1,4,5]

It is possible that our rating system inaccurately reflected the severity of septal deviations. The medical literature does not have a standard system for evaluating septal deviation clinically or radiographically.[2] Reitzen et al. suggested measuring tortuosity on CT and magnetic resonance imaging scans defined by the length of the straight line from the cribriform plate to the hard palate divided by the length of the deviated septum.[2] Mamikoglu et al. described a system that grades the degree of deviation from 1 to 4 on coronal CT scans at points corresponding to three characteristic cross-sectional area points used in acoustic rhinometry.[10] We selected our rating system due to its simplicity and practicality in radiographically evaluating the nasal airway.

In this study, we proposed a simple and practical grading system for otolaryngologists and radiologists that divides the septum into coronal sections in bony CT windows (Fig. 2). The middle section is a single CT slice, which represents the area of the internal nasal valve, the location of greatest airway resistance. The anterior and posterior sections consist of multiple CT slices. Reviewers occasionally expressed some difficulty grading the scans because of medialized or enlarged turbinates, narrow lateral nasal walls or nasal bones, concha bullosa, multilateral deviations, and widened septums. Overall, the grading system was successful and showed good inter-rater reliability between and among otolaryngologists and neuroradiologists. Other factors that are difficult to quantify include S-shaped deviations and spurs or buckles that might be vertical, horizontal, or sloping. Determining the length of deviation, angle of

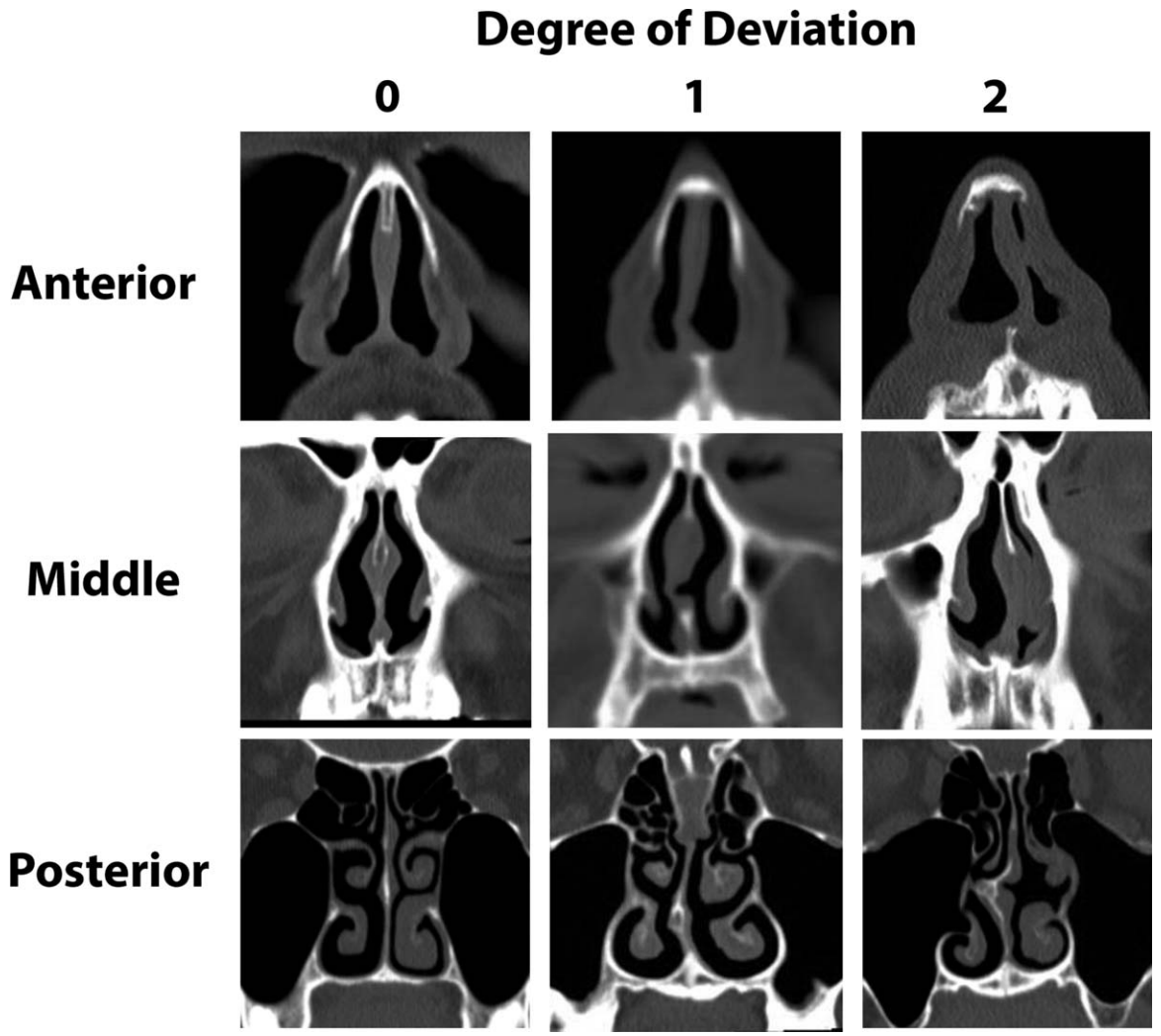

Fig. 2. CT grading system. Anterior: the septum anterior to the head of the inferior turbinates. Middle: a single coronal slice through the head of the inferior turbinates, which likely represents the internal nasal valve. Posterior: the septum posterior to head of the inferior turbinate.

deviation, and volumetric analysis was beyond the scope of this study and are not measurements routinely performed by otolaryngologists or radiologists.

The subjects enrolled in this study had unknown symptomology with no observer-based descriptions of septal deviation. The subject sample should represent a cross-section of the normal or unbiased population; however, it should be noted that 19% of the CT scans were ordered to rule out sinusitis (Table I). Although any patient that exhibited sinus disease on CT was excluded, patients receiving scans to rule out sinusitis are more likely to have higher NOSE scores.

In addition to septal deviation as visualized on a CT scan, there are multiple factors that can lead to nasal obstruction, such as the nasal cycle and rhinitis. These physical and physiologic factors cannot be assessed from radiologic studies, so development of complex algorithms for volumetric analysis of nasal anatomy seems ill advised given the costs and risk of CT scans. Future studies with physical examinations could strengthen the experiment; however, the NOSE scale remains the most important factor for patients. Providing the physical exam findings could help augment the lack of correlation between CT findings and nose scores. In this study, we examined a normal unbiased population that provided a wide range of NOSE scores and CT findings. Logistically, it would have been difficult to perform anterior rhinoscopy, with or without nasal endoscopy, in the radiology suite for patients who were having CT scans for nonotolaryngologic concerns.

In recent years, third-party payors have begun to request CT scans prior to authorizing septoplasties for septal deformities. Our study brings in to question the rationale for obtaining a CT scan as a screening tool for septal deformities. The current standard of care for the diagnostic work up of nasal obstruction is a history and physical exam, with possible nasal endoscopy. Ancillary diagnostic tests, such as CT scans or rhinomanometry, for nasal obstruction and deviated septum are not routinely indicated in uncomplicated cases and are available

TABLE II.
Inter-rater Reliability of CT Scans (κ Values).

	ENT 1	ENT 2	Rad 1	Rad 2
Septum, anterior to valve				
ENT 1	—	0.558	0.529	0.667
ENT 2	—	—	0.408	0.561
Rad 1	—	—	—	0.608
Rad 2	—	—	—	—
Septum, at valve				
ENT 1	—	0.645	0.636	0.602
ENT 2	—	—	0.588	0.578
Rad 1	—	—	—	0.624
Rad 2	—	—	—	—
Septum, posterior to valve				
ENT 1	—	0.561	0.447	0.529
ENT 2	—	—	0.458	0.539
Rad 1	—	—	—	0.463
Rad 2	—	—	—	—
Section of maximal deviation				
ENT 1	—	0.518	0.469	0.482
ENT 2	—	—	0.496	0.511
Rad 1	—	—	—	0.507
Rad 2	—	—	—	—

ENT represents the otolaryngologist reviewer, and Rad represents the neuroradiologist reviewer. Section of maximal deviation is section of the septum that the reviewer perceived to be the most deviated of all the sections. κ values are defined in the Materials and Methods section of the article.

CT = computed tomography.

only at a few academic centers. The ordering of unnecessary tests to appease third-party payors forces the physician to practice beyond the standard of care, which is inappropriate and potentially exposes the surgeon to medicolegal risks.

Adding CT scans to the diagnostic workup of a patient with symptomatic septal deviation is an unnecessary use of patient time, delays treatment, exposes the patient to radiation,[11] and has not been shown to improve outcomes. Incidental findings of septal deviation on CT scans in patients without symptoms may encourage unnecessary surgery and decrease patient satisfaction. Furthermore, the ordering of unnecessary tests adds costs to the healthcare system. In Minneapolis, Minnesota the typical total cost for performing and interpreting a CT scan of the face without contrast (Current Procedural Terminology [CPT] 70486) is $462.[12]

TABLE III.
Concordance Between Side of Reported Obstruction and Maximum Side of Deviation on CT.

Degree of Deviation	ENT 1	ENT 2	Rad 2	Rad 2
κ	0.249	0.257	0.248	0.256

ENT represents the otolaryngologist reviewer, and Rad represents the neuroradiologist reviewer.

CT = computed tomography.

TABLE IV.
Correlation Between Degree of Maximum Deviation on CT Across All Septal Sections and NOSE Scores.

	ENT 1		ENT 2		Rad 1		Rad 2	
Degree of Deviation	Mean NOSE Score	N	Mean NOSE Score	N	Mean NOSE Score	N	Mean NOSE Score	N
0	17.9	17	20.3	15	35.0	5	27.0	10
1	13.6	34	11.5	35	14.1	41	13.3	42
2	16.3	22	18.2	23	13.8	27	14.2	21
τ	0.032		0.031		0.045		0.015	
P value	.637		.643		.483		.812	

The table shows the mean NOSE value and sample size for each grade of deviation that reviewers observed. The data represent the section that reviewers thought was the most deviated across all sections of the septum. It demonstrates a lack of any correlation between septal deviation on CT scans and NOSE scores. ENT represents the otolaryngologist reviewer, and Rad represents the neuroradiologist reviewer.

CT = computed tomography; NOSE = Nasal Obstruction Symptom Evaluation.

The cost of the CT scan is about 11% that of a septoplasty (CPT 30520), which costs about $4,238 in total (facility fee $2,306, surgeon fee $1,173, anesthesia fee $759 for average time of 105 minutes).[13] If third-party payors deny preauthorization for a septoplasty after a CT scan, they would save a considerable amount of money. However, this practice is unjustified because of the lack of correlation between CT scans and symptomatic septal deviations.

CONCLUSION

Our study found almost no correlation between septal deviation findings on CT scans and symptoms of nasal obstruction. The results of our study do not support a role for CT scans as either a clinically meaningful or necessary test to investigate uncomplicated nasal obstruction.

Acknowledgments

The authors thank Christopher S. Palmer, MD, of the Department of Radiology at Hennepin County Medical Center who helped perform analysis of the article data. The authors also thank the CT radiology technologists at Hennepin County Medical Center who collected the surveys for this study.

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