Computed Tomography Technique for Evaluation of the Nasal Valve

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Objective: To compare measurements of the nasal valve on computed tomographic images obtained in the traditional coronal imaging plane with those obtained using the Nasal Base View (NBV) for evaluation of the sinonasal cavities.

Methods: Thirty computed tomograms of the sinuses were evaluated retrospectively. Coronal re-formations were performed in a plane perpendicular to the hard palate at the most anterior aspect of the nasal bones at the nasal dorsum. Re-formations of the NBV were performed in a plane perpendicular to the anterior aspect of the estimated acoustic axis. Measurements of the nasal valve angle were performed for both imaging planes in each patient.

Results: Nasal valve angles measured in the traditional, coronal plane were found to have an angle of 8.3°±2.0° (mean±SD). Nasal valve angles measured in the NBV had an angle of 11.4°±2.6°. A significant difference was demonstrated (P<.001).

Conclusions: The traditional coronal computed tomograms of the sinonasal cavities may underestimate the true nasal valve angle. The NBV may provide a more accurate assessment of the nasal valve, as the measured angles of the nasal valve in this plane were found to be more consistent with classic descriptions of 10° to 15°.

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Computed Tomography (CT) has been proposed to be an objective test that can be used to measure the nasal valve and airway. However, it has not gained universal acceptance in terms of clinical usefulness. It can provide needed anatomical information, but the traditional coronal scanning plane is not at an optimal angle for accurate assessment of the nasal valve (Figure 1). Depending on the scan plane and the specific image chosen for measurement, the nasal valve can be poorly estimated. These images not only have the potential for misleading rhinologists and facial plastic surgeons, they also correlate poorly with the anterior rhinoscopy performed on clinical examination.

Cakmak et al3 established a nasal airway model to study the acoustic axis of the nasal airway and applied this to coronal CT images of the nasal passage. The acoustic axis represents an arc in the middle of the nasal passage, corresponding to the pathway of nasal airflow as measured by acoustic rhinometry. This arc represents the natural physiologic airflow through the nasal vault. Air enters at the level of the nares and gently arcs superiorly above the head of the inferior turbinate, with the main flow of air traversing the area of the middle meatus (Figure 2). Cakmak and colleagues’ study demonstrated that CT images obtained in a plane perpendicular to the acoustic axis showed a higher correlation between the findings of acoustic rhinometry and the nasal valve area than images obtained in a plane perpendicular to the floor of the nasal cavity (hard palate).

The objectives of our study were to further evaluate this method of assessing the nasal valve using a CT scan plane perpendicular to the acoustic axis of the nasal passage, referred to as the Nasal Base View (NBV), and then to compare measurements of the nasal valve angle obtained in that plane with those obtained using the traditional coronal scan plane.

METHODS

Thirty high-resolution axial CT studies (60 nasal valves) of the sinonasal cavities obtained for image-guided sinus surgery were retrospectively reviewed. The axial CT studies were obtained with late-generation, 16-channel, multislice CT scanners (LightSpeed; General Electric Medical Systems, Milwaukee, Wis) at a slice thickness of 1 to 1.25 mm in bone algorithm. Axial slices were obtained from the top of the frontal sinuses to the bottom of max-
illary incisors. The studies were chosen randomly, and no correlation to diagnosis or indication was made. Patients with significant prior facial trauma were excluded from the study.

The axial data were transferred for postprocessing to a commercially available workstation (General Electric Medical Systems). Reformatted images in the standard coronal plane and in the NBV were made at 1-mm intervals and at a slice thickness of 0.5 mm. The standard coronal reformatted images were obtained perpendicular to the hard palate (Figure 1A). The acoustic axis was then estimated on a sagittal reformatted image based on the results of Cakmak et al,3 who showed that the axis passes through the center of the nasal passage in an arc (Figure 2A). The reformatted images of the NBV were obtained perpendicular to the anterior aspect of the estimated acoustic axis (Figure 2).

Once the appropriate plane and location of the nasal valve were identified on sagittal images, attention was turned to the coronal reformatted images. Measurements of the nasal valve angle were made from the anterior-most edge of the soft tissue on the image, through the nasal airway, averaging the irregularities in the medial and lateral soft tissues (Figures 1B and 2B). Two of us (D.M.P. and B.O.M.) reviewed each image simultaneously for each nasal valve.

A paired t test was performed to compare the mean values of the nasal valve angles obtained in the NBV with those in the traditional coronal plane.

RESULTS

The data were reviewed and compiled, with comparison of the traditional coronal plane and the NBV. Nasal valve angles measured in the traditional coronal plane were found to have a range of 3.8° to 15.8°, with an angle of 8.3°±2.0° (mean±SD). Nasal valve angles measured in the NBV had a range of 5.6° to 16.5°, with an angle of 11.4°±2.6°. A significant difference between the nasal valve angles obtained from the 2 imaging planes was demonstrated using a paired t test (10.04; P<.001).

Scans obtained using the NBV demonstrated imaging features that more closely approximated the view obtained on anterior rhinoscopy (Figure 3). Qualitatively, the NBV offered a sharper image of the nasal valve region, with less soft tissue distortion due to volume-averaging effects.

COMMENT

The nasal valve area represents the most narrow segment of the nasal airway. It is defined as the area bounded

Figure 1. A, Sagittal computed tomographic view of the nasal cavity. The asterisk indicates the re-formation plane of traditional coronal images. B, Representative traditional coronal view of the nasal valve and its angle measurement.

Figure 2. A, Sagittal computed tomographic view of the nasal cavity. A indicates the estimated acoustic axis and physiologic nasal airflow; asterisk, re-formation plane of the Nasal Base View images. B, Representative Nasal Base View of the nasal valve and its angle measurement.
the traditional coronal CT plane is used, the true nasal
on the specific image that is chosen in a study in which
the imaging plane on the acoustic wave.3,6 Depending
however, there have been other studies that have based
corononal plane that is perpendicular to the hard palate; the imaging plane that is most commonly referred to is a
imaging have been performed to validate other objec-
tive test results, not to aid in clinical decision making.3,6,7 These studies have used various imaging param-
eters with no universal standardization of either the
plane of the image or the landmarks that are used as
anterior and posterior guides. Of those studies that
specify the anatomical landmarks that are used to stan-
dardize the imaging, the most commonly referenced are
the anterior nasal spine and the tip of the nose.3 The
imaging plane that is most commonly referred to is a
coronal plane that is perpendicular to the hard palate;
however, there have been other studies that have based
the imaging plane on the acoustic wave.3,6 Depending
on the specific image that is chosen in a study in which
the traditional coronal CT plane is used, the true nasal
valve angle may be underestimated because of the plane
in which the image is obtained. These images not only
have the potential for misleading rhinologists and facial
plastic surgeons, they also correlate poorly with the
anterior rhinoscopy findings. In contrast, the NBV is
especially a representative image of the nasal valve
region taken perpendicular to the view that is obtained
during anterior rhinoscopy with the patient’s head posi-
tioned as during photography of the nasal base (Figure
3). Anatomical information presented in this image
plane may be more familiar and clinically useful to the
surgeon. Interestingly, the studies that have used CT
images obtained perpendicular to the estimated or cal-
culated acoustic wave rather than the traditional coro-
nal plane show a higher correlation with objective mea-
sures such as acoustic rhinometry.3,6,7

We believe that the NBV may provide a more accu-
rate assessment of the nasal valve, as, in the present
study, the measured angles of the nasal valve in the
NBV were found to be more consistent with the classic
anatomical descriptions of 10° to 15°. Computed to-
mography is a safe, noninvasive method of imaging the
nasal valve. High-quality reformatted images in any
plane can easily be obtained if the original data are ob-
tained at thin slice thicknesses (0.5-1.25 mm). Accurate
measurements of the nasal valve angle can then be ob-
tained from these re-formations. Also, the NBV pro-
vides a more focused view of the nasal valve, with less
soft tissue artifact, and more closely represents the view
of the nasal valve region that is seen by the examiner in
the clinic and operating room settings.

Limitations of the CT technique include the sub-
jective nature in which angle measurements are taken.
The NBV is based on the subjective approximation of the
acoustic axis. The reproducibility of the NBV has not
yet been addressed and must be established before the
technique can be applied to clinical practice. Also, the
lack of correlation between patient symptoms and
nasal valve measurements currently limits the clinical
applicability of this technique. Another limitation of the
present study is the selection bias that was involved in
the patients who were included in the study. All indi-
viduals were patients of the otolaryngology clinic and

![Figure 3. Nasal base photograph (A) compared with the Nasal Base View image (B). Note similar plane of reference in terms of head and nasal tip position.](image-url)
underwent CT imaging of the sinuses for various indications. This study cohort may not be truly representative of the normal adult population.

Despite these limitations, we believe that the NBV may be a valuable new tool that can be used to evaluate the nasal valve objectively and to provide the clinician with valuable anatomical information. Future studies are needed to correlate the NBV with clinical examination findings, patient symptomatology, and disease-specific quality-of-life scores. Also, longitudinal studies should be carried out in which the NBV would be used as the primary outcome measure for evaluating the ability of various nasal valve surgery techniques (eg, spreader grafts) to alter the nasal valve angle.

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REFERENCES