Validation of a grading system for the attachment of the superior turbinate to the sphenoid face

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Background: **The attachment of the superior turbinate to the sphenoid face may be an important factor in determining the approach for sphenoidotomy. We sought to validate a previously described 4-type grading system for superior turbinate attachment (Type: A, within its medial one-third; B, in its middle one-third; C, to its lateral one-third; and D, directly to the orbit) to the face of the sphenoid sinus and to make recommendations for its use in determining the method of sphenoidotomy (transethmoidal vs transsphenoethmoidal).**

Methods: **Single-slice images through both sphenoid sinus ostia were obtained from axial series of computed tomography (CT) scans. Eighteen (36 ostia) sets of scans were used. Attachment type (A-D) in each image was classified by 10 experienced sinus surgeons and compared against a "gold standard" grading performed by the senior author (A.J.), who was the developer of the grading system.**

Results: **Mean accuracy was 63% (95% confidence interval [CI], 54%-72%) for the 4-type grading system. When Types A + B and Types C + D were grouped together, mean accuracy was 91% (95% CI, 84%-97%). For the 2-group classification system, bootstrap analysis suggested that 97% of physicians attain an accuracy of at least 80%.**

Conclusion: **Accuracy using the 4-type classification is too low to be practically useful. Accuracy using the 2-group system may be sufficiently high to be a useful aid in selecting a surgical approach. We recommend a transethmoid sphenoidotomy for Types A and B and a transsphenoethmoidal approach to the sphenoid for Types C and D.** © 2012 ARS-AAOA, LLC.

Key Words:
Endoscopic sinus surgery; Sinusitis; Superior turbinate; Sphenoid; Sphenoidotomy; Grading

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Endoscopic sinus surgery is generally safe. However, specific components of the surgery have an inherently greater risk of causing skull-base injury, as well as injury to vital neurovascular structures. One of these is sphenoidotomy, a procedure that arguably carries a risk of more severe complications than any other part of this surgery.

These complications include breach of the skull base, leading to a cerebrospinal fluid leak, or worse, injury to the optic nerve or carotid artery. Broadly speaking, there are 2 methods of accessing the sphenoid sinus during surgery for chronic rhinosinusitis (CRS): through the natural ostium (transnasal or transsphenoethmoidal approaches) or by creating a second opening through the posterior ethmoids (transethmoidal approach).

Many suggestions have been made to describe safe techniques of performing this procedure and to reduce the incidence of complications. When adopting the transethmoidal approach, Bolger et al.[1] have described the use of a "parallelogram" to determine entry into the sphenoid sinus. Our Centre has described[2] a system classifying the attachment of the superior turbinate (ST) to the face of the sphenoid into 4 types; these types can be used to grade the ease and safety of this transethmoidal approach.

An ST attachment was classified as Type A if the ST was attached to the sphenoid face within its medial one-third, Type B if attached within its middle one-third, Type C if attached within the lateral one-third, and Type D if attached directly to the orbit (Fig. 1).

Our primary aim for this study was to validate this new 4-type classification system so that anatomical descriptions can be standardized for future discourse within the

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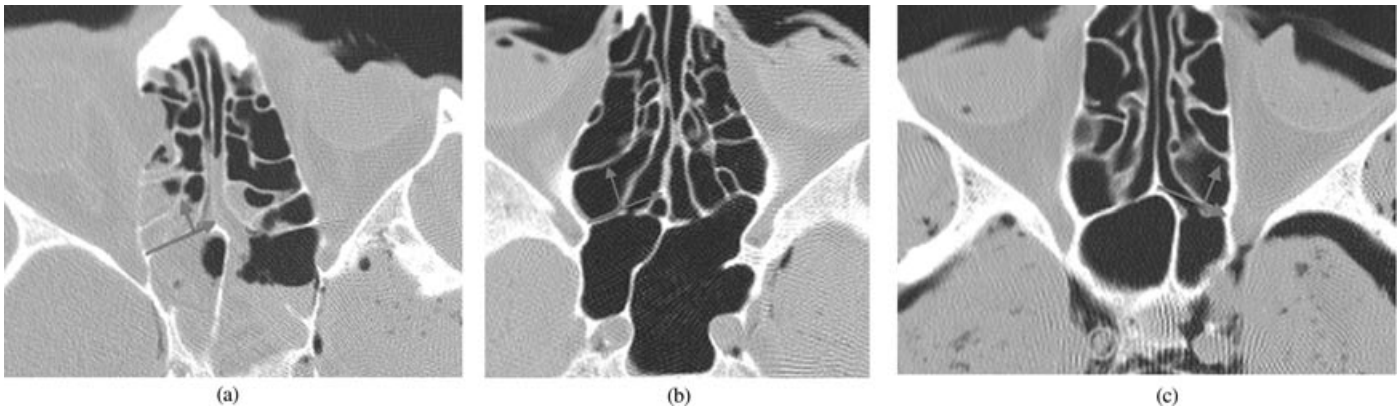

FIGURE 1. (A) Type A attachment. (B) Type B attachment. (C) Type C attachment.

specialty. However, subsequent to learning that the results did not validate the 4-type system, we concluded that the transethmoidal approach would be appropriate with either a Type A or Type B attachment, and so we also sought to evaluate a 2-group classification in which Types A and B are combined (Type I attachment) and Types C and D are combined (Type II attachment), as this classification would be clinically useful for choosing the surgical approach.

To assess the validity of assessments made using each of these classification systems, we determined: (1) the mean and median accuracy across all the surgeons and all the scans; and (2) the proportion of physicians who achieved a specified minimum accuracy (80%, 85%, or 90%)

Materials and methods

We obtained computerized tomography (CT) scans of the paranasal sinuses from 18 cadaver heads, resulting in 36 "sides" from which to analyze the ST attachments to the sphenoid face. We asked 10 fellowship-trained rhinologists to independently examine an axial cut of this attachment at the level of the sphenoid ostia, and to grade it based on the previously described grading system.[2] The accuracy of their classification was judged using the assessment of the same set of images by the senior author (A.J.; the developer of the grading system). This was regarded as the gold standard.

The mean accuracy was calculated as the proportion of images correctly classified by all physicians across all patients. The "bias-corrected" bootstrap was used to calculate a 95% confidence interval (CI) on the mean accuracy. Bootstrap methodology was used because it provides a simple approach to accounting for correlation in outcomes, both within physicians *and* within patients by jointly (ie, as crossed factors) resampling physicians and patients.

The accuracy of each physician was calculated as the proportion of the 36 images that were correctly classified. The distribution of the accuracy from the 10 physicians was summarized using mean, standard deviation, median, and quartiles.

Because the study involved only 10 raters, the calculated proportion of physicians achieving a specified minimum accuracy is limited to values with 10% increments (ie, 10 out of 10, 9 out of 10, 8 out of 10, etc.). This discretization yields estimated proportions that likely are not the best reflections of the true proportion. Hence, we estimated the true proportion by averaging the proportions derived from the bootstrap resamples.

To evaluate the 2-group classification system, the analysis was repeated treating Types A + B as the first category and Types C + D as a second category. Note that results from this analysis should not be interpreted as a validation of this classification system because the rhinologists were not asked to classify patients in this way.

Statistical computations were done using SAS (version 9.2; SAS Institute, Inc., Cary, NC) and R (version 2.12).

Results

The accuracy of the 10 surgeons is shown in Figure 2. As shown, when asked to use the 4-type classification, the accuracy was low, with a median of 67% (interquartile range [IQR], 56%-69%) and a mean of 63% (SD, 8%; 95% CI, 54%-72%). As these results clearly indicated that the accuracies would be too low to be of practical use, there was no value in conducting the analysis for the proportion of physicians achieving specified accuracy cutoffs.

For the 2-group (Type I vs Type II attachment) classification system, substantially better accuracy was obtained (Fig. 3), with a median of 92% (IQR, 89%-94%) and a mean of 91% (SD, 4%; 95% CI, 84%-97%) (Fig. 4). With this system, the bootstrap results suggested that 97% of physicians attain an accuracy of at least 80%, 87% of physicians attain an accuracy of at least 85%, and 62% of physicians attain an accuracy of at least 90% (Table 1).

Discussion

Intraoperative complications of sphenoidotomy include cerebrospinal fluid leak, and internal carotid artery/optic nerve injury.[3] Electing the appropriate approach to the sphenoid sinus should primarily be dependent on the

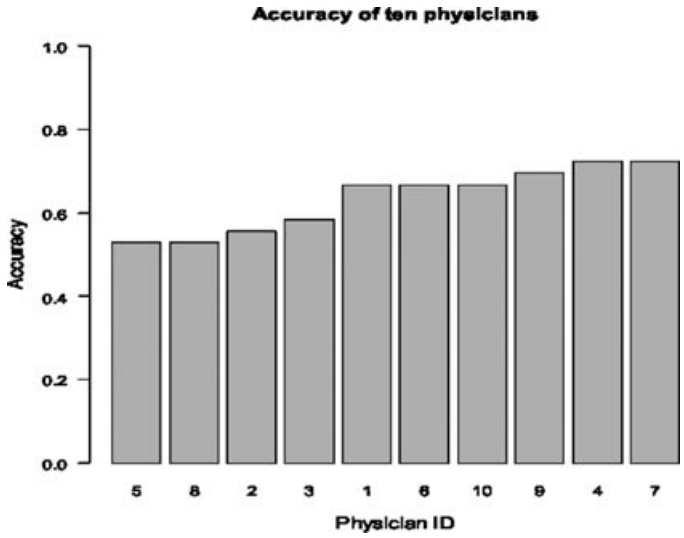

FIGURE 2. Accuracy of the 10 surgeons when using the 4-type classification (ascending order).

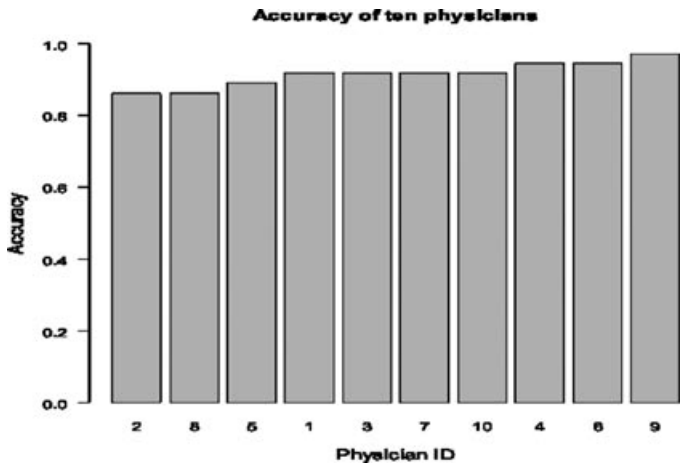

FIGURE 3. Accuracy of the 10 surgeons when the ratings on the 4-type system are aggregated into the 2-group classification (ascending order).

TABLE 1. Estimated proportion of physicians achieving preselected accuracies

Percent accuracy of at least	Proportion of physicians[a]
80%	0.97
85%	0.87
90%	0.62

[a]Obtained by taking the mean of these proportions from 10,000 bootstrapping resamples.

anatomy of the ST, in terms of its attachment to the face of the sphenoid sinus.

Although the transethmoidal approach avoids injury to the ST, a more laterally positioned ST attachment confers greater difficulty and risk in adopting this approach.

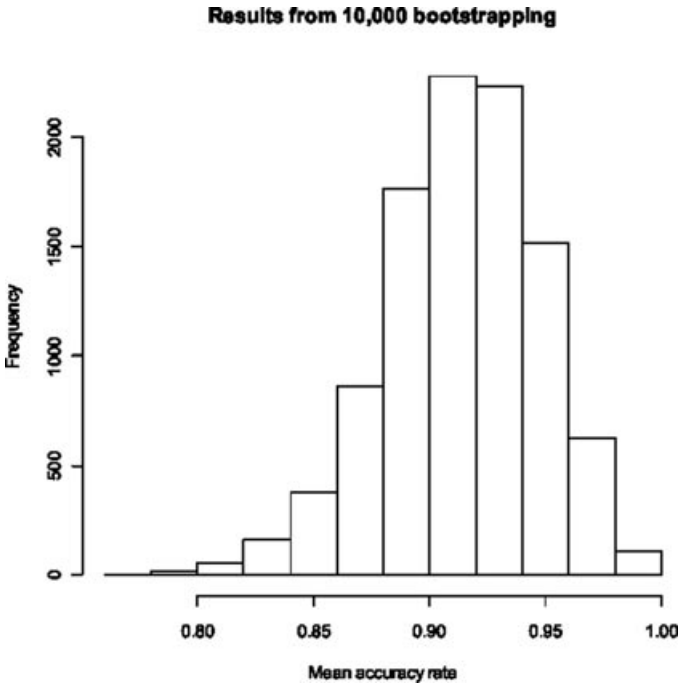

FIGURE 4. Distribution of the mean accuracy estimate for the 2-group classification based on 10,000 bootstrap resamples.

In these situations a transsphenoethmoidal approach may be better advised. However, the theoretical disadvantages of this include destabilization of the middle turbinate[1] and loss of olfactory epithelium.[4]

A previous study from our unit examined the frequency of the 4 different types of ST attachment.[2] The results showed that 81% of STs were Type A or B, and were suitable for transethmoidal approaches (preserving the ST), whereas the smaller or absent parallelogram created in the 19% of STs that demonstrated Type C or D attachments meant that the transsphenoethmoidal approach (partially resecting the ST) was safer.

In this study, accuracy using the 4-type classification system was inadequate for practical use. However, in the 2-group system with Types A and B combined and Types C and D combined, the accuracy was sufficiently high that the assessments could be useful as an aid for selecting a surgical approach. Hence we recommend the use of only 2 descriptors for the attachment of the ST to the sphenoid face (between the nasal septum and orbit): Type I (medial two-thirds of the sphenoid face), and Type II (lateral one-third of the sphenoid face, or the orbit).

Because the gold standard consisted of the subjective rating made by the rating system's developer, it is possible that the accuracies may have been impacted if any of the gold standard ratings were in error. This limitation was unavoidable as there is no other validated method for classifying the attachment type in this system. An additional limitation is that the ratings on the Type I/II system were derived from

the initial 4-type ratings rather being directly chosen by the raters. It is possible that these two sets of ratings would not be perfectly concordant and hence validation of direct Type I/II ratings may be warranted.

Conclusion

We have been unable to demonstrate sufficient accuracy of the 4-type superior turbinate-to-sphenoid attachment classification in this study. However, based on the results, a revised 2-type classification could be a more appropriate grading system. This system would allow the operator to select the most appropriate method of surgical approach to the sphenoid sinus during endoscopic sinus surgery.

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