

Anatomical landmarks for locating the sphenoid ostium during endoscopic endonasal approach: a cadaveric study

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Abstract

Purpose The sphenoid ostium (SO) provides a natural portal for entering the sphenoid sinus and beyond up to the skull base. It is not always easy to locate the ostium during the endoscopic approach. The present study was designed to establish readily identifiable anatomical landmarks for locating the sphenoid ostium.

Methods Cadaveric dissection was performed in 30 hemisections of head and neck and various measurements were taken from fixed anatomical landmarks in the nasal cavity to the sphenoid ostium. The size, shape and position of sphenoid ostium were determined in relation to the anterior wall of the sphenoid sinus and the superior turbinate.

Results The mean distance from the supero-lateral angle of the posterior choana to the SO was found to be 21.21 ± 6.02 mm. The mean distance of the SO from the midline was 4.85 ± 2.89 mm. In all the specimens, the SO was situated within 1 cm of the midline. The mean distance between the inferior end of the SO and the postero-inferior edge of the superior turbinate was 8.03 ± 3.52 mm. The SO was present on an average distance of 55.1 ± 3.54 mm from the limen nasi. In 93.3 % of the specimens, the SO was situated between 5 and 6 cm of the inferior end of the limen nasi. The angle between the anterior nasal spine and the SO was found to be remarkably constant. In 93.3 % of the specimens, it was from 25° to 30° .

Conclusions The sphenoid ostium could be localized medial to the superior turbinate between 1.5 and 3 cm above the supero-lateral angle of the posterior choana,

within 1 cm of the midline and within 1 cm of the postero-inferior edge of the superior turbinate.

Keywords Sphenoid sinus · Superior turbinate · Trans-nasal endoscopy · Limen nasi · Posterior choana

Introduction

The sphenoid sinus situated within the center of the skull base is a passage for surgical treatment of a variety of diseases of the anterior and middle cranial fossa including lesions involving the sellar and parasellar region [7, 9, 12]. Therefore, both neuro and ENT surgeons feel the need to be conversant with the anatomical landmarks necessary for surgical exposure of this area. One of the most consistent and reliable routes for entry into the sphenoid sinus is the sphenoid ostium. Anatomic visualization of this natural opening is therefore a key step during these surgical procedures.

Surgical approach to the sphenoid sinus with the help of an endoscope and an operating microscope has become increasingly popular as it reduces the morbidity of the patients. For surgeons in training and sometimes also for experienced surgeons, it may not be easy to locate the sphenoid ostium. In the present study, we have performed a cadaveric dissection to define the anatomical landmarks which will help in identification of the sphenoid ostium during endoscopic trans-nasal trans-sphenoidal surgery.

Materials and methods

The study was conducted in the anatomy department of PGIMER, Chandigarh. Thirty mid sagittal head and neck

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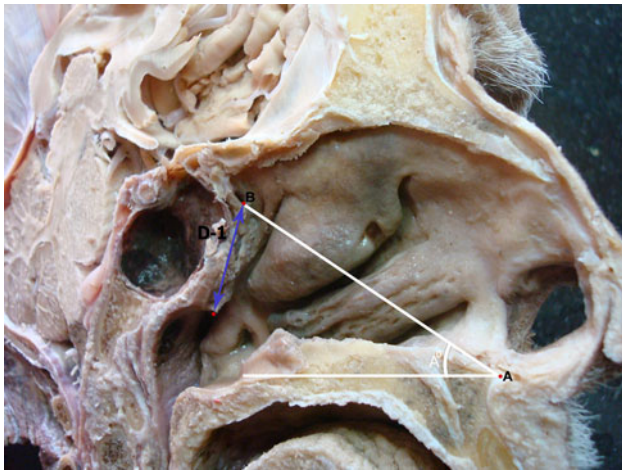


Fig. 1 Depiction of D-1: the distance from the supero-lateral angle of the posterior choana to the inferior end of the sphenoidal opening (SO) and the angle (A°) between the horizontal line passing through the anterior nasal spine (point A) and the line AB (line passing through the anterior nasal spine, point A and inferior end of the SO, point B)

sections of adult male cadavers from north–west Indian population, with intact nasal septum were included in the study. The nasal septum was dissected carefully so as not to disrupt the speno-ethmoidal recess and the anterior wall of the sphenoid sinus. The sphenoid ostium was identified. The measurements were taken from the inferior most edge of the sphenoidal ostium as this would be the first visible point encountered by the surgeon.

1. Distance 1: distance from the supero-lateral angle of the posterior choana (it is an approximately rectangular opening with four corners, the Distance 1 was measured from the superior lateral corner. Hence supero-lateral angle of the choana would be the lateral end of the roof of the choana) to the inferior end of the sphenoidal opening (SO) (Fig. 1)
2. Distance 2: distance of the inferior end of the SO from the midline
3. Distance 3: distance of the inferior end of the SO from the postero-inferior edge of superior turbinate (Fig. 2)
4. Position of the SO in relation to the superior turbinate (Fig. 3)
 - (a) Medial to the superior turbinate
 - (b) Partially covered by the superior turbinate (in line with the posterior end or the inferior turbinate)
 - (c) Lateral to the superior turbinate
5. Distance 4: distance of the inferior end of the SO from the limen nasi. The point where the limen nasi touches the nasal floor was taken for the measurements (Fig. 2)

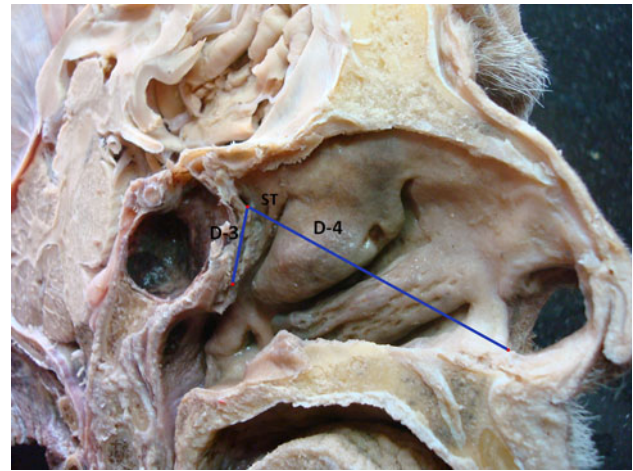


Fig. 2 Depiction of D-3: distance of the inferior end of the SO from the postero-inferior edge of superior turbinate (ST) and D-4: distance of the inferior end of the SO from the limen nasi

6. The angle (A°) between the horizontal line passing through the anterior nasal spine (point A) and the line AB (line passing through the anterior nasal spine, point A and inferior end of the SO, point B) (Fig. 1)
7. Number of sphenoid ostia: single or multiple
8. Position of the SO in relation to the anterior wall of the sphenoid sinus.
 - (a) SO situated in the upper 1/3 of the anterior wall of the sphenoid sinus: 1
 - (b) SO situated in the middle 1/3 of the anterior wall of the sphenoid sinus: 2
 - (c) SO situated in the lower 1/3 of the anterior wall of the sphenoid sinus: 3
9. Distance 5: largest dimension of the SO
10. Shape of the SO

All the measurements were done twice with the help of a digital vernier caliper (Mitutoyo, Japan, accurate up to .02 mm). The angle was measured by a standard goniometer.

Results

Metrical parameters for the sphenoid ostium in relation to fixed anatomical landmarks in the nasal cavity

The mean distance from the supero-lateral angle of the posterior choana to the inferior end of the sphenoid opening (SO) was found to be 21.21 ± 6.02 mm. The SO was present between 1.5 and 2.5 cm above the supero-lateral angle of the posterior choana in 60 % of cases. The minimal distance between the SO and the posterior choana was 1 cm (Fig. 4; Table 1).

Fig. 3 Depiction of the position of the SO in relation to the superior turbinate (superior turbinate is marked by

a Medial to the superior turbinate. **b** Partially covered by the superior turbinate (in line with the posterior end of the superior turbinate). **c** Lateral to the superior turbinate

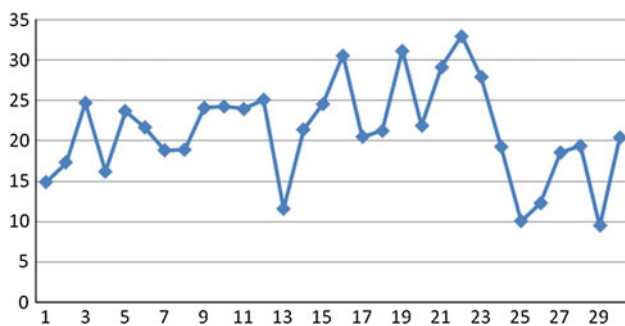
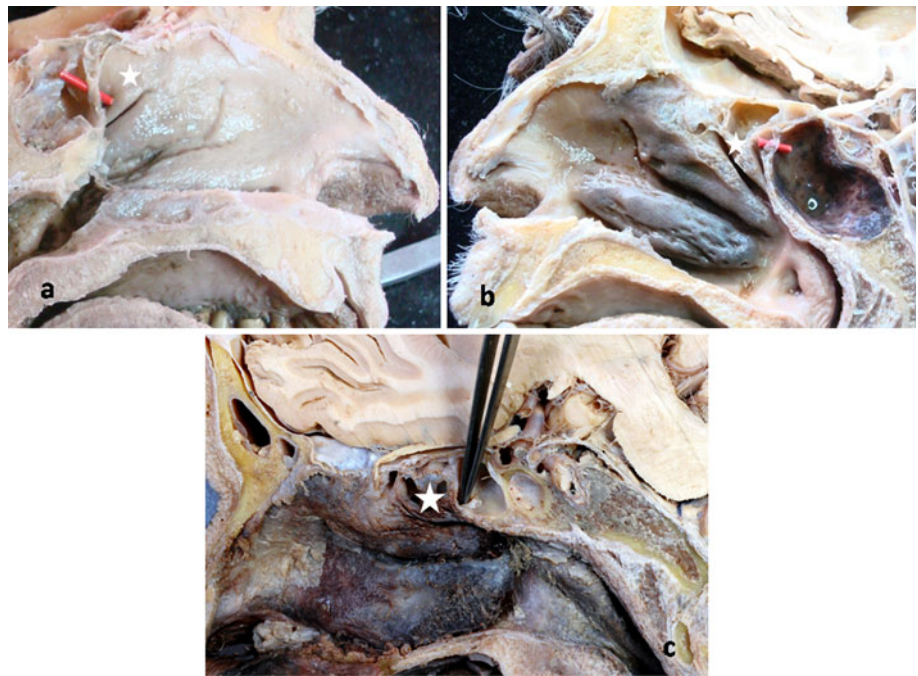


Fig. 4 Chart showing the distance from the supero-lateral angle of the posterior choana to the inferior end of the sphenoidal opening. The y axis depicts each value in mm and number of cases are seen on the x axis

The mean distance of the SO from the midline was 4.85 ± 2.89 mm. In more than half (60 %) of the specimens, this distance was about 4 mm and in all the specimens, the SO was situated within 1 cm of the midline. The distance between the inferior end of the SO and the postero-inferior edge of the superior turbinate was 8.03 ± 3.52 mm. In majority (66.6 %) of the specimens, this distance was not more than 1 cm.

The SO was present on the average distance of 55.1 ± 3.54 mm from the limen nasi, with the range of 51.43–63.56 mm. In 93.3 % of the specimens, the SO was situated between 5 and 6 cm of the inferior end of the limen nasi. The mean value of the angle (A°) was found to be 26.5° ranging from 22° to 36° . The angle (A°) was found to be remarkably constant, lying between 25° and 30° in 93.3 % of the specimens (Fig. 5).

Location, size and shape of the sphenoid ostium

A single sphenoidal opening was found in all the specimens. The sphenoid ostium was found in the upper 1/3 of the anterior wall of the sphenoid sinus in 23 specimens (77 %), it was in the middle 1/3 in 4 cases (13 %) and in the lower 1/3 of the anterior wall in 3 cases (10 %). Out of the total 30 specimens studied, the SO was found to be lying medial to the superior turbinate in 24 cases, lateral to it in four cases; while in two of the specimens, it was partially covered by the superior turbinate.

The mean value for the largest dimension of the SO was 4.29 ± 1.89 mm, while most of the SOs (83.3 %) were between 2 and 5 mm in diameter. All the sphenoidal openings were vertically oval in shape with the exception of one transversally oval, one antero-posteriorly oval and one round opening (Table 1).

Discussion

The sphenoid sinus can be approached through various surgical techniques which include trans-septal, trans-nasal as well as intracranial skull base approaches [8]. In recent years, endonasal endoscopic approach has become popular for entering the sphenoid sinus and for intra-sellar pathologies [12]. This technique gives adequate exposure of the sinus and the sellar region and is associated with lesser morbidity as compared to other procedures [15, 19]. The sphenoid ostium is a natural landmark for gaining access to the sphenoid sinus. Various authors have described

Table 1 Metrical parameters for sphenoid ostium in relation to fixed anatomical landmarks in the nasal cavity

	Distance 1	Distance 2	Distance 3	Distance 4	Angle	Distance 5
Mean	21.21	4.85	8.03	55.1	26.48	4.29
Range	9.47–33.01	0–10.22	3.39–14.07	51.43–63.56	22–36	1.58–9.69
Standard deviation	6.02	2.90	3.52	3.54	2.49	1.89

All distances are shown in millimeter

Distance 1: distance from the supero-lateral angle of the posterior choana to the inferior end of sphenoidal opening (SO)

Distance 2: distance of the inferior end of the SO from the midline

Distance 3: distance of the inferior end of the SO from the postero-inferior edge of superior turbinate

Distance 4: distance of the inferior end of the SO from the limen nasi. The point where the limen nasi touches the nasal floor was taken for the measurements

The angle (A°) between the horizontal line passing through the anterior nasal spine (point A) and the line AB (line passing through the point A and inferior end of the SO, point B)

Distance 5: largest dimension of the SO

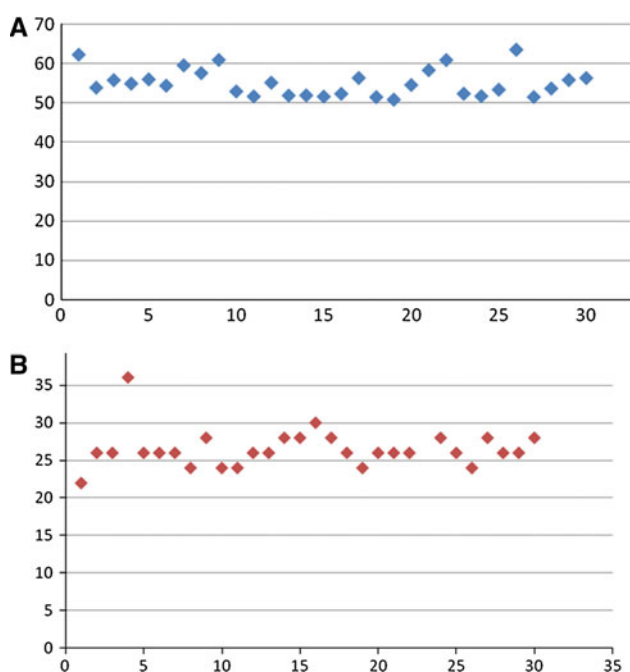


Fig. 5 **a** The distance of the inferior end of the SO from the limen nasi. The y axis shows each value in mm. **b** The angle (A°) between the horizontal line passing through the anterior nasal spine (point A) and the line AB (line passing through the point A and inferior end of the SO, point B). Number of cases are shown on x axis

intra-operative endoscopic landmarks for localization of the sphenoid ostium [2, 4, 7, 9–11, 13, 16–18]. There is no consistency in the landmarks used by different authors. Therefore, the results vary between different studies and also between different population groups. In the present study, we have made an attempt to localize the sphenoid ostium using easily identifiable permanent anatomical landmarks.

Wigand [17] described that the sphenoid ostium could be found 10 mm above the choana and surgeon palpating

the anterior wall of sphenoid sinus with blunt instrument would enter the sphenoid sinus at this height. The sphenoid ostium has been reported to be between 10 and 15 mm from the superior edge of the choana in various studies (Table 2). In the present study, the mean distance of the inferior edge of the sphenoid ostium from the supero-lateral angle of the choana was found to be 21.2 mm. The discrepancy could be because of morphological differences between the skulls of different ethnic populations. The measurements would also differ depending upon whether the study was CT scan based or cadaver based. In addition, the exact point on the choana used for the measurement probably varied in different studies. Most of the studies refer to the roof of the choana rather than a specific point. However, we have used a constant landmark, i.e., the supero-lateral angle of the choana in all the specimens. It is important for the surgeon to be aware of the most probable height of the sphenoid ostium from the choanal roof. If the probing for the localization of sphenoid ostium is done too superiorly, there is danger of perforating the skull base [8]. It is also well known that in many individuals, there can be significant thinning of the bone and therefore blind palpation by an instrument can cause injuries to the vital structures. In our study, in 83 % of the specimens, the distance between sphenoid ostium and the choanal roof was from 1.5 to 3.0 cm (Fig. 4).

The sphenoid ostium was located approximately in the middle of the anterior wall of the sphenoid sinus in most cases [1, 5, 7]. Lang [10] divided the anterior wall of the sphenoid sinus into three parts and found that the centre of the ostium was located in the upper 1/3 in 52 %, middle 1/3 in 34 %, and lower 1/3 in 14 % of cases. Kim et al. [9] discovered that the position of the sphenoid ostium corresponded to the middle region of the anterior wall of the sinus. We found the ostium to be located in upper 1/3 in 77 % the cases, which is more than what has been reported

Table 2 Parameters studied by various authors to localize the sphenoid ostium

Study	Distance from Choana (mm)	Distance from mid line (mm)	Distance from superior turbinate (mm)	Distance from limen nasi (mm)	Angle	Position in relation to superior turbinate	Position in relation to anterior wall of sphenoid sinus
Hidir et al. [7]	10.9 ± 2.3						Middle in 76.5 %
Abuzayed et al. [1]	14.9						All at mid point
Kim et al. [9]			10 in 83 %	56.5	34.3°	Medial, 83.3 %; lateral, 17 %	All in middle 1/3
Enatsu et al. [5]							All at mid point
Millar and Orlandi [13]						Medial, 100 %	
Davis et al. [3]					30°		
Elwanys et al. [4]			5			Medial	
Lang [10]							Upper 1/3, 52 %; middle 1/3, 34 %; lower 1/3, 14 %
Wigand [17]	10–12						
Campero et al. [2]	Right, 2.04; left, 2.18						
Eweiss et al. [6]						Medial 98.6 %	
Present study	21.21 ± 6.01	4.85 ± 2.9	8.02 ± 3.52	55.1 ± 3.54	26.5°	Medial, 80 %; partially covered, 6.7 %; lateral, 13.3 %	Upper 1/3, 77 %; middle 1/3, 13 %; lower 1/3, 10 %

in the earlier studies. This corresponds to the finding that the vertical distance of the sphenoid ostium from the choana was found to be greater in the present study as compared to the values reported in the previous studies (Table 2).

In many of the earlier reports, the distance of the sphenoid ostium was measured from the anterior nasal spine [3, 16]. However, in the endoscopic approach, the limen nasi is considered a more appropriate and practical landmark [9]. We found that the average distance of the sphenoid ostium from the limen nasi was 51.1 mm, which is remarkably similar to the 56.5 mm reported by Kim et al. [9]. In practical terms, if the endoscope has gone beyond 5–6 cm from the limen nasi, it is probable that it is at the sphenoid ostium in more than 90 % of cases (Fig. 5). Similarly, the angle subtended by the endoscopic trajectory to the horizontal plane through the anterior nasal spine was also remarkably consistent (Fig. 5). The mean value of the angle ranges from 26.5° to 34.3° in the different series (Table 2).

The middle turbinate has also been used as a reference mark for entry into the sphenoidal sinus [9, 17]. However, there is the sphenopalatine artery coursing just above the postero-inferior end of the middle turbinate, so it is not a desirable reference point [9]. Because of this, most authors

use the superior turbinate for locating the sphenoid ostium. The sphenoid ostium was situated medial to the superior turbinate in 80 % of the specimens, while in two specimens, the sphenoid ostium was partially covered by the superior turbinate in our study. Kim et al. [9] also found that the sphenoid ostium drains medially in relation to the superior turbinate in 83 % of the cases. However, Millar and Orlandi [13] reported that the sphenoid ostium was located medial to the superior turbinate in all their specimens. They were of the view that the observation reporting the position of the sphenoid ostium position lateral to the superior turbinate may have been caused by stripping of the superior turbinate mucosa before the measurements were taken. The postero-inferior end of the superior turbinate is an appropriate standard point for locating the sphenoid ostium. The distance of the sphenoid ostium from this reference point in our series was comparable to that reported by other authors (Table 2). The sphenoid ostium can be reliably located within 1 cm of the postero-inferior end of the superior turbinate in most of the cases. Another useful landmark for the intraoperative localization of the sphenoid ostium is the midline, as in all the specimens, the opening was situated within 1 cm of the midline. Orhan et al. [14] described an extremely rare condition of absence of sphenoid sinus with corresponding absence of sphenoid

ostium. In such unusual cases, knowledge of these anatomical landmarks might be of help in deciding the site of entry into the sphenoid bone for approaching the sellar pathology.

Based upon the above data, the sphenoid ostium can be confidently localized between 1.5 and 3 cm above the supero-lateral angle of the choana, within 1 cm of the midline and within 1 cm of the postero-inferior edge of the superior turbinate and medial to it. The trajectory of the surgical approach should be at an angle of about 25°–30° from a horizontal passing through the nasal spine. These anatomical landmarks are easily visualized during the endonasal endoscopic approach and thus would be helpful to an endoscopic surgeon.

Conflict of interest The authors declare that they have no conflict of interest.

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