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Endoscopic anatomy of the sphenoid sinus and sella turcica

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Abstract

An endoscopic study of the sphenoid sinus was carried out, on 30 cadavers, to understand the important anatomical relationships of the sphenoid sinus, and the sella turcica. The aim was to study the endoscopic anatomy and the variants, and to determine if endoscopic instrumentation and techniques, could play a beneficial role in endoscopic management of sellar lesions.

The results of this study are discussed, with particular reference to the important surgical anatomical features of the sphenoid sinus. A surgical technique for the endoscopic transsphenoid approach to the sella turcica was developed.

Anatomical variants can be identified endoscopically, and endoscopic techniques have the advantages of improved visualization, magnification, angled vision, and a panoramic perspective of the intrasphenoid anatomy, compared to currently employed methods of pituitary/sellar surgery, using the operating microscope.

Key words: Sphenoid sinus; Pituitary gland; Sella turcica; Endoscopy; Anatomy

Introduction

The asset of improved visualization and magnification, available through endoscopes, has revolutionized the understanding of the pathophysiology of sinusitis, and resulted in better appreciation of the anatomy of the paranasal sinuses. As a result, the use of endoscopes has been applied to the diagnosis and management of sinus pathology. Their minimally invasive role in surgery, has been widely accepted in most communities. In recent years, endoscopes have been used to perform surgery beyond the boundaries of the paranasal sinuses. Diagnosis and repair of CFS fistulas, identification and cauterization of posterior epistaxis, transnasal decompression for dysthyroid orbitopathy, and intranasal laser surgery have all been performed in conjunction with transnasal endoscopic techniques (Wurman *et al.*, 1988; Levine, 1989; Papay *et al.*, 1989; Kennedy *et al.*, 1990; Mattox and Kennedy, 1990).

It was possible that endoscopic surgery could be applied to skull base lesions, particularly that of the sella turcia. To acquire information about the neurovascular relationships of the sphenoid sinus, 30 sphenoid sinuses (in cadavers) were examined endoscopically with particular attention being given to the sella and neurovascular structures in the lateral wall of the sinus.

Material and methods

Endoscopic dissection of the sphenoid sinus was carried out in 30 cadavers (20 males and 10 females). They were all adults with an age range of 30 to 78 years. Twenty-four were Chinese and six were Indian.

A bilateral intranasal endoscopic ethmoidectomy was performed in all specimens. Care was taken to identify the sphenoid ostium, the posterior ethmoidal neurovascular bundle and the anterior sphenoid wall. The entire middle turbinate was trimmed, offering access to the sphenoethmoid recess. Wide sphenoidotomies were made bilaterally, extending, superiorly from the skull base and inferiorly as far as possible, and also laterally to the orbital apex. A transseptal approach was employed to remove the bony nasal septum, sphenoid rostrum, and the entire anterior wall of the sphenoid to gain a wide access and a panoramic view of the sphenoid sinus. The structures within the sinus were then studied with 0°, 30° and 70° telescopes. Important anatomical features such as the pattern of sphenoid pneumatization, intersinus septae, sella turcia, internal carotid arteries, optic nerve, and optic chiasma were studied.

Results

The pattern of sphenoid pneumatization, sphenoid

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TABLE I

SPHENOID PNEUMATIZATION, SPHENOID DOMINANCE AND TERMINATION OF INTERSINUS SEPTAE

Sphenoid pneumatization	n = 30	Percentage
Presellar	8	27
Sellar	22	73
Sphenoid dominance		
Right dominant	8	27
Left dominant	10	33
Termination of intersinus septae on:		
Internal carotid artery	12	40
Optic nerve	2	7

dominance, and the termination of intersinus septae was studied in 30 sphenoid sinuses (Table I).

Sphenoid pneumatization

Sphenoid sinus has been classified into three types, conchal, presellar, and sellar depending on the extent to which the sphenoid bone was pneumatized. In the conchal type the area below the sella is a solid block of bone without an air cavity. In the presellar type the air cavity does not penetrate beyond a plane perpendicular to the sellar wall. The sellar type is the most common and the air cavity extends into the body of the sphenoid below the sella and may extend as far posteriorly as the clivus.

In this study, the presellar type of sinus was found in eight (27 per cent) and the sellar type in 22 (73 per cent) specimens. As the floor of the sinus and the infrasellar regions could be examined with angled telescopes, it was possible to endoscopically differentiate between the sellar and the presellar types.

The conchal type, is very common in children before the age of 12 years, after which pneumatization begins within the sphenoid sinus. As all our specimens were adults, this type was not encountered in our study.

Sphenoid dominance

The dominance of one sphenoid sinus in relation to the other occurred in 18 (60 per cent) of the 30 specimens. The right was dominant in eight (27 per cent) and the left in 10 (33 per cent) specimens. In 12 (40 per cent) specimens the septum was midline anteriorly, but extended posteriorly to end on the anterior wall of the sella in eight. Although one complete septum determined the dominance of the sinus, more than one incomplete septae (accessory septae) were noted in nine (30 per cent) specimens.

Intersinus septae

The intersinus septum terminated on the bulge of the internal carotid artery in 12 (40 per cent) and onto the optic canal in at least two (seven per cent) specimens.

Onodi cell (Figure 1)

An unilateral Onodi cell was noted in three (10 per cent) of the 30 cadaveric specimens. A bilateral Onodi cell was present in two (three per cent).

Sphenoid ostia (see Figure 2 and Table II)

The anterior wall of the sphenoid was identified with certainty prior to the sphenoidotomy. The sphenoid ostium and the posterior ethmoidal neurovascular bundle were used as landmarks (Figure 2). A total of 60 sphenoid ostia were examined, from the 30 cadaveric specimens. Forty-six (77 per cent) ostia could be identified without the removal of the middle turbinate. The manoeuvre of removing the middle turbinate, enabled the identification of the remaining 14 (23 per cent). The sphenoid ostium, in our material, was round in 28 (47 per cent), elliptical in 24 (40 per cent), and a pinhead in eight (13 per cent). Eight (13 per cent) ostia admitted the 4 mm telescope, 12 (20 per cent) the 2.7 mm telescope but not the 4 mm one and 34 (57 per cent) admitted neither.

The posterior ethmoidal neurovascular bundle was identified in 48 (80 per cent) of the 60 sides examined.

TABLE II

SHAPE AND SIZE OF SPHENOID OSTIA, INTERNAL CAROTID ARTERIES, OPTIC CANALS AND MAXILLARY BRANCH OF TRIGEMINAL NERVE

Shape/size of sphenoid ostia	n = 60	Percentage
Round	28	47
Elliptical	24	40
> 4 mm	8	13
< 4 mm, > 2.7 mm	12	20
< 2.7 mm	34	57
Identification of internal carotid artery		
Identifiable	56	93
Small focal bulge	4	7
Serpigenous elevation	2	3
Identification of optic canals		
Identifiable	60	100
Dehiscent	2	3
Optico-carotid recess	48	80
Identification of maxillary branch of trigeminal nerve	18	60

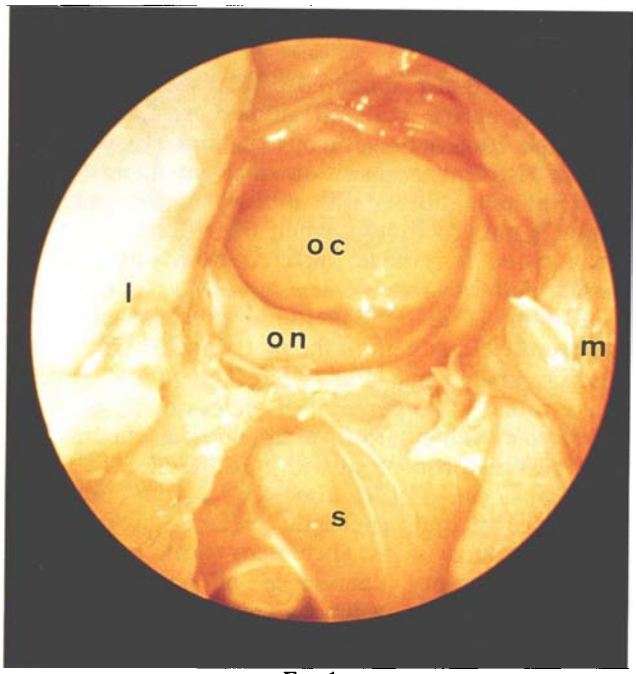

FIG. 1

Endoscopic view (using 0° 4 mm telescope) of an Onodi cell (oc). Note the relationship of the optic nerve (on) with the Onodi cell. s = sphenoid; m = medial; l = lateral.

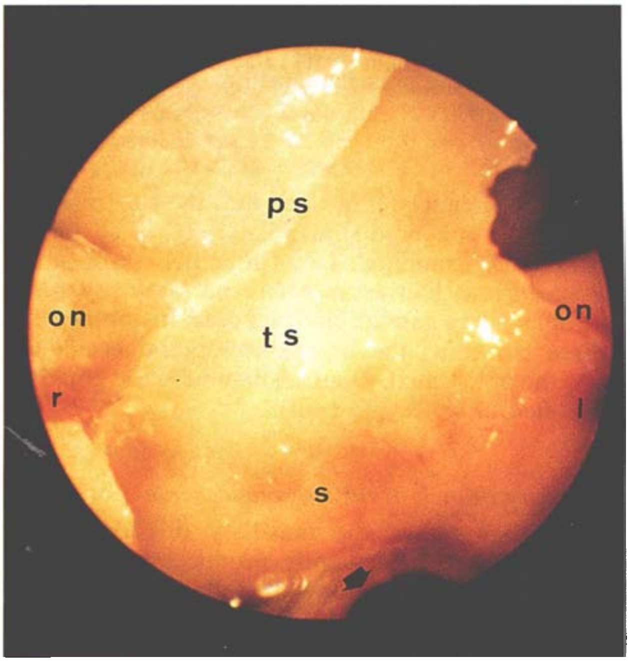

FIG. 3

Endoscopic panoramic view (using a 30° 4 mm telescope) of the planum sphenoidale (ps), tuberculum sella (ts), optic nerves (on), and anterior sellar wall (s). r = right; l = left; arrow indicates post-sellar pneumatization.

Internal carotid arteries

The internal carotid artery is the most medial structure within the cavernous sinus. It rests directly against the lateral surface of the body of the sphenoid and its course is marked by a groove in the bone, the carotid sulcus, which defines the course of the intracavernous portion of the carotid artery. As the sphenoid sinus expands and its walls resorb, the carotid sulcus produces a prominence within the sphenoid sinus. Of the 60 carotid arteries examined in our material, 56 (93 per cent) produced an identifiable prominence on the lateral wall of the sphenoid sinus. This prominence was most pronounced in those specimens with maximal pneumatization of the sphenoid. It varied in size from a small focal bulge in four (seven per cent) specimens to a serpigenous elevation in two (three per cent)

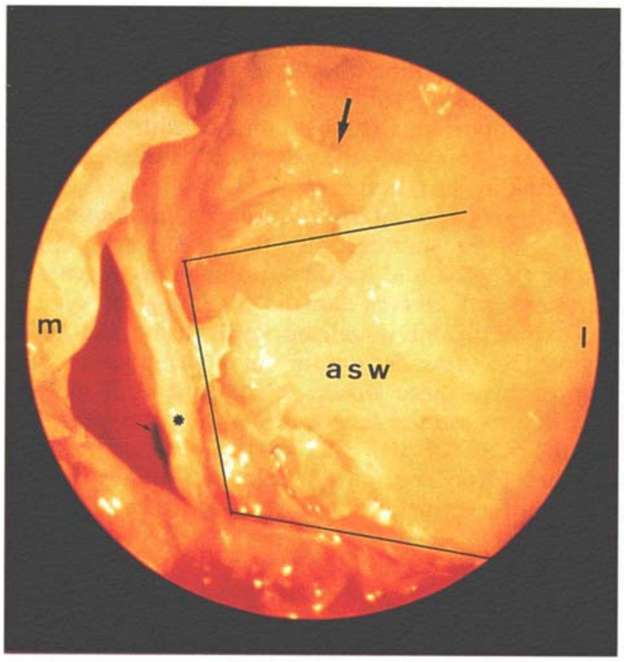

FIG. 2

Endoscopic view (using 0° 4 mm telescope) of the relationship of the sphenoid ostium (small arrow) with the superior turbinate (small asterisk) and the posterior ethmoidal neurovascular bundle (large arrow) with anterior sphenoid wall (asw). m = medial; l = lateral.

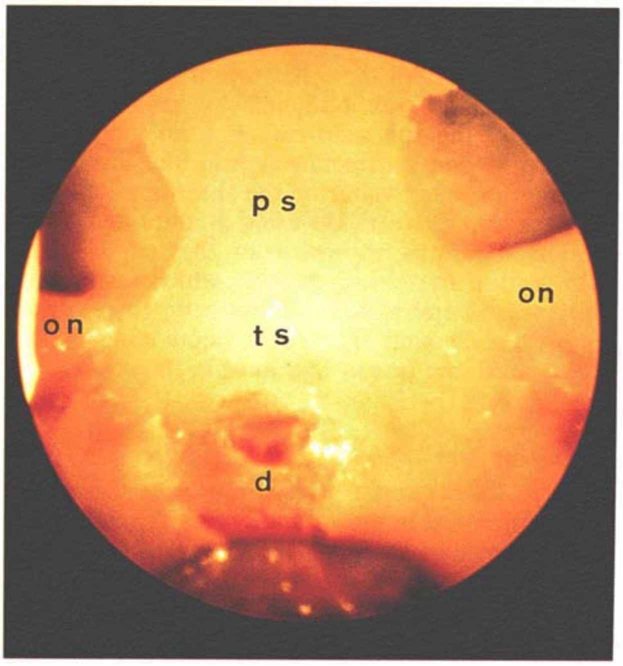

FIG. 4

Endoscopic panoramic view (using a 30° 4 mm telescope). Anterior sellar wall has been removed exposing the dura (d). ts = tuberculum sella; on = optic nerve, ps = planum sphenoidale.

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marking the full course of the carotid artery. In one specimen, carotid arteries on either side were dehiscent, at the presellar portion.

Optic canals

The optic canals, protruded into the superolateral part of the sphenoid sinus bilaterally, in all the 60 optic canals examined. Two (three per cent), of the 60 specimens, had areas where no bone separated the optic nerve and the sinus mucosa. In another two (three per cent) the intersinus septum terminated onto the optic canal. A superiolateral recess could be identified in 48 (80 per cent).

Maxillary branch of the trigeminal nerve

The segment of the maxillary division of the trigeminal nerve frequently produces bulging into the lateral sinus wall below the sella especially if the sinus is well pneumatized. This bulge was best recognized using a 30° telescope with the angle of view directed laterally and inferiorly. It was recognized in 18 (30 per cent) of the 60 sides examined.

Anterior sellar wall (see Figures 3 and 4)

The anterior wall of the sella was recognized by its midline bulge inferior to the tuberculum sella. The appearance of the dura through the thin anterior sellar wall imparts a bluish hue to the sella which aids in its identification.

Sellar depth

The measurement of the depth of the sphenoid sinus, defined as the distance of the closest part of the anterior wall of the sella from the ostium of the sphenoid sinus was obtained by measuring the distance of the sphenoid ostium from the anterior nasal spine and subtracting it from the distance of the anterior sellar wall from the anterior nasal spine. This measurement, made using a calibrated Fraser suction apparatus approximates the length of the path, within the sinus, through which instruments must pass in transsphenoidal surgery, to reach the anterior sellar wall. The sellar depth ranged from 11.0 to 21.0 mm (mean 15.2 mm) in this study.

Discussion

There have been earlier reports on the microscopic anatomy, and the neurovascular relationship of the sphenoid sinus and sella turcica (Renn and Rhoton, 1975; Fujii *et al.*, 1979; Elwany *et al.*, 1983; Lang, 1989). These studies have required sagittal sectioning of cadaver heads or en bloc removal of the sella turcica to study the anatomical details.

The anatomy of the sphenoid sinus and sella turcica were looked at from an endoscopic perspective in this study. The neurovascular anatomy and anatomical relationships were studied from the point of view of the endoscopic surgeon, in an operative setting.

A pinhead size sphenoid ostium was noted in 15 per cent of the material studied by Lang (1989) which is consistent with our findings (13 per cent; Table II). One observation made by Lang (1989), that inflammation of the mucosa of the sphenoid sinus is more common, when the ostium is narrow, than when it is wide, differed from our findings, which did not show a correlation.

Elwany *et al.* (1983) found presellar sphenoid sinuses in 27 per cent of the males and 31 per cent of female specimens. Post-sellar sphenoidal sinuses were found in 73 per cent of males and 79 per cent of females. This pattern of sphenoidal pneumatization was also consistent with our findings (Table I).

Fujii *et al.* (1979) reported a four per cent incidence of optic canal dehiscence. This is similar to our findings of two specimens (three per cent).

Carotid artery dehiscence in our series was observed in four specimens (seven per cent; Table II), similar to the incidence of eight per cent reported by Fujii *et al.* (1979).

The incidence of intersinus septum terminating onto the carotid artery was 40 per cent in our series (Table II) as compared with 32 per cent reported by Renn and Rhoton (1975).

This similarity in observations and in the incidence of anatomical variations, substantiates the fact that, such variations can be recognized intraoperatively, with the help of the endoscope, and the discerning surgeon can alter his approach, technique, and selection of instruments accordingly.

Forty patients with sellar lesions such as pituitary adenomas and craniopharyngiomas have been managed using endoscopic techniques (Sethi and Pillay, 1995). Endoscopes offer the advantages of superior illumination, improved visualization, angled vision, and a panoramic view, thus enabling more precision during surgery. However, it is of paramount importance, to be familiar with the endoscopic anatomy of the sphenoid sinus prior to undertaking such surgery.

The application of the endoscopes, not only to the lesions of the sella but also to the other structures within the sphenoid sinus has potential as the carotid arteries, optic nerves and the trigeminal nerves can be exposed, and visualized easily using the endoscope. The foundation for an alternative surgical approach to these structures is possible. It may be possible to use the length of carotid artery exposed in the wall of the sphenoid sinus for inserting catheters for specialized contrast studies or for obliteration of fistulas and trapping procedures.

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