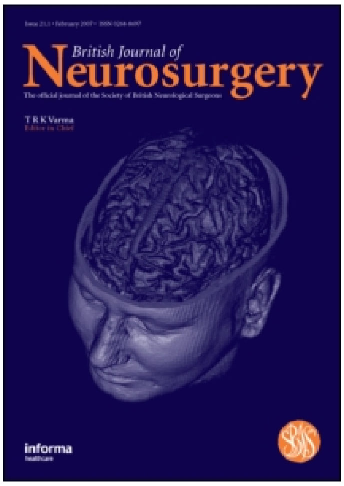

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ORIGINAL ARTICLE

Anatomical landmarks for positioning the head in preparation for the transsphenoidal approach: The spheno-sellar point

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Abstract

The transnasal approach is the most utilized approach to the sellar region. This study was conducted to identify an anatomical landmark on the lateral surface of the head that corresponds to the midpoint of the sellar floor at the level of sphenoidal rostrum. This point, lined up with the nostril, simulates the surgical path and facilitates the transnasal access to the sella turcica. Four adult, formalin-fixed and silicon-injected cadaveric heads, and ten dried skulls were used for laboratory dissection. The heads and skulls were sectioned along the midline; and the spheno-sellar point, corresponding to the midpoint of the sellar floor at the level of sphenoid rostrum, was determined. The spheno-sellar point was plotted on the lateral surface of the skull, and its position measured relative to the external acoustic meatus. Linking the spheno-sellar point with the nostril created the spheno-nostril line. This line represents the surgical path to be taken for direct access to the sphenoid rostrum, and was used to align the cadaveric heads as in surgery.

The endonasal transsphenoidal approach was then utilized in one hundred and two adult patients with sellar lesions, using the spheno-sellar point and the spheno-nostril line as the superficial landmarks to guide the approach. The results of this clinical experience are summarized. The spheno-sellar point was found to be located an average of 40.1 mm (SD $\pm$ 2.9 mm) anterior and 23.3 mm (SD $\pm$ 3.2 mm) superior to the external acoustic meatus. The spheno-nostril line represents the straight surgical path to the sphenoidal rostrum. This landmark was used in 102 correlative transnasal surgeries for sellar lesions of adult patients, and has allowed an easy and straightforward access to the sella. In only 3 cases with poor pneumatisation of the sphenoid sinus (presellar type), the actual location of the surgical instruments had to be confirmed by fluoroscopy. The application of the spheno-sellar point and the spheno-nostril line is a fast, reliable and very simple way to facilitate transsphenoidal surgery, and their use may avoid complications associated with misdirection of this approach. Its use may be limited in cases of poor pneumatisation of the sphenoid sinus, where fluoroscopic guidance could be necessary as a rule.

Key words: *Endonasal transsphenoidal approach, microsurgical anatomy, pituitary adenoma, sphenoid sinus, spheno-sellar point.*

Introduction

The pituitary gland and sella are located below the center of the brain at the middle cranial base.[1] The sellar contents are separated from the sphenoid sinus by a tiny sheath of bone that constitutes the sellar floor, making the transsphenoidal approach the most used surgical route to access intra-sellar lesions. Herman Schloffer, an Austrian rhinologist, was the first in 1907 to successfully operate on a patient with a pituitary tumor using a transnasal approach.[2] Cushing, between others, adopted and popularized it with some modifications.[3] After a period of disuse, caused by its high complication rate due to septic complications of CSF leak and hypo-function of glucocorticoid axis postoperatively, the use of the transsphenoidal approach resurged in the second half of the last century.[4–6]

The endonasal transsphenoidal approach is considered a simple technique by which to access the sphenoid rostrum and sellar contents, as it avoids extensive mucosal dissection, which has been implicated in several surgical complications.[7] One of the pitfalls of this approach is related to the nasal path taken and the positioning of the head prior to surgery. Considering a straight trajectory parallel to the floor of the operating room, when excessive head extension is applied, the surgeon tends to overshoot the trajectory towards the anterior fossa. On the other hand, increasing head flexion favours an inferior

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trajectory, pointing towards the clivus. In any case, misalignment of the surgical pathway during trans-sphenoidal procedures demands prompt correction, increasing the surgical time and possibly resulting in complications like neural damage, bleeding and cerebrospinal fluid fistula. The aim of this study was to determine an external anatomical landmark that could help to simulate the surgical intranasal trajectory, facilitating those procedures that warrant an endonasal transsphenoidal approach.

Methods and materials

Anatomic studies

Four adult, formalin-fixed and silicon-injected cadaveric heads and 10 skulls were used in this study. The heads and skulls were cut along the midline using a circular saw; and a point corresponding to the intersection between a line crossing the sellar floor and another crossing the sphenoid rostrum was marked. This point was called the "spheno-sellar point" (Fig. 1). With the use of an electric drill, the position of the spheno-sellar point was transposed to the lateral surface of the skull. The distance from the external acoustic meatus to the perpendicular projection of the spheno-sellar point over the convexity was measured.

For the anterior-posterior axis, a line passing through the superior edge of the external acoustic meatus and through the inferior border of the orbital ring was used; this line was parallel to the zygomatic arch. For the cranio-caudal axis, a line perpendicular to the anterior-posterior line was used (Fig. 2). The results of these measurements were collected and the mean and the standard deviation of the spheno-sellar point in relation to the external acoustic meatus were calculated. The spheno-nostril line was constructed by linking the spheno-sellar point with the anterior edge of the anterior nasal aperture, simulating the ideal surgical trajectory (Fig. 2). The head then was positioned in such a way that the spheno-nostril line became parallel to the floor of the operating room. With this manoeuvre, both the speculum and surgical microscope were angled parallel to the floor, in a straight path towards the sphenoid rostrum (Figs. 3 and 4).

Clinical studies

From July, 2003 to March 2008, the spheno-sellar point and spheno-nostril line were used to guide head positioning in one hundred and two consecutive surgeries in which the endonasal transsphenoidal approach was used by the first author (AC).

Results

The sphenoid bone, sphenoid sinus and spheno-sellar point

The *sphenoid bone* is located at the center of the skull base, in front of the temporal and occipital bones and posterior to the frontal and ethmoid bones. Its anterior aspect resembles a bat with wings outstretched. It has a body, and paired greater and lesser wings and pterygoid processes. The pituitary gland lies over the sella on the cerebral surface of the body of the sphenoid. The sella protrudes inferiorly into the body, which, in turn, faces anteriorly and superiorly into the nasal cavity. The intimate contact of the body of the sphenoid bone with the nasal cavity below and pituitary gland above has led to the transsphenoidal route being the operative approach of choice for the resection most sellar tumors.

The *sphenoid sinus* is a space created by pneumatisation of the sphenoid body anterior and inferior to the sella. The sphenoid sinus is subject to considerable variation in size, shape and degree of

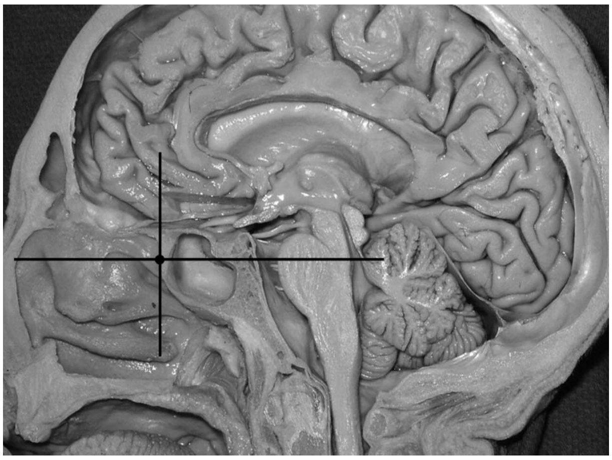

FIG. 1. The spheno-sellar point: This point corresponds to the intersection between a line crossing the sellar floor and another line crossing the sphenoid rostrum.

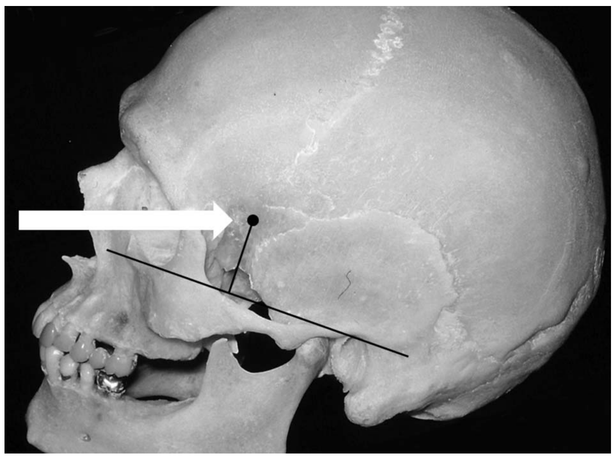

FIG. 2. The position of the spheno-sellar point was transposed to the lateral surface of the skull (black circle), and the distance from the external acoustic meatus to the projection of the spheno-sellar point over the convexity was measured (black lines). The spheno-nostril line was constructed by linking the spheno-sellar point to the anterior edge of the anterior nasal aperture (white arrow).

pneumatisation and, in the adult, can be divided by multiple bony septae, which often are located off of the midline. The ostia for the sinus are located in a superior position related to the floor of the sinus, at each side of the midline, at the level of the posterior portion of the superior concha; and both are used as landmarks during the performance of the endonasal transsphenoidal approach, marking the upper margins of the opening into the sphenoid sinus.

The *spheno-sellar point* corresponds to the intersection between a horizontal line crossing the sellar floor and another vertical line crossing the sphenoid rostrum. This point is represented on the external surface of the skull, a mean of 40.1 mm (SD $\pm$ 2.9 mm) anterior and 23.3 mm (SD $\pm$ 3.2 mm) superior to the external acoustic meatus.

FIG. 3. Patient positions used for the endonasal approach. The patient is positioned in a semi-sitting position, with the head on a head holder positioned so that the spheno-nostril line is aligned parallel to the floor of the operating room.

Use of the spheno-sellar point in surgical practice

As stated above, from July, 2003 to March 2008, the first author of this paper (AC) used the spheno-sellar point and spheno-nostril line to guide the head positioning and the transnasal path in one hundred and two consecutive surgeries performed in adult patients in which the endonasal transsphenoidal approach was adopted. Reoperations were excluded of this series, because post-surgical intranasal scars would limit the utility of the external landmarks to guide the approach.

This series includes 95 pituitary adenomas, and seven non-pituitary lesions (one craneopharyngioma, one central neurocytoma, one breast cancer MTS, one fibrous dysplasia, one Rathke's cleft cist, one empty sella and one sphenoidal mucocele. The spheno-sellar point and the spheno-nostril line were used as external landmarks to position the head and to guide the nasal part of the approach in all 102 surgeries. In order to facilitate this with the patient covered by the surgical sheets, we took care to position the spheno-nostril line exactly parallel to the floor. The position of the surgical microscope was then also oriented parallel to this line and to the floor.

The spheno-sellar point and the spheno-nostril line were the only internal or external landmarks used to access to the sellar content during surgery. In 3 out of 8 presellar type of sphenoid sinus founded in these series, fluoroscopic guidance was required to confirm the location of the sellar floor.

Discussion

Pituitary adenomas comprise 10% of central nervous system tumours, only surpassed by gliomas and meningiomas. Over the last 30 years, the transsphenoidal approach has become the first choice of

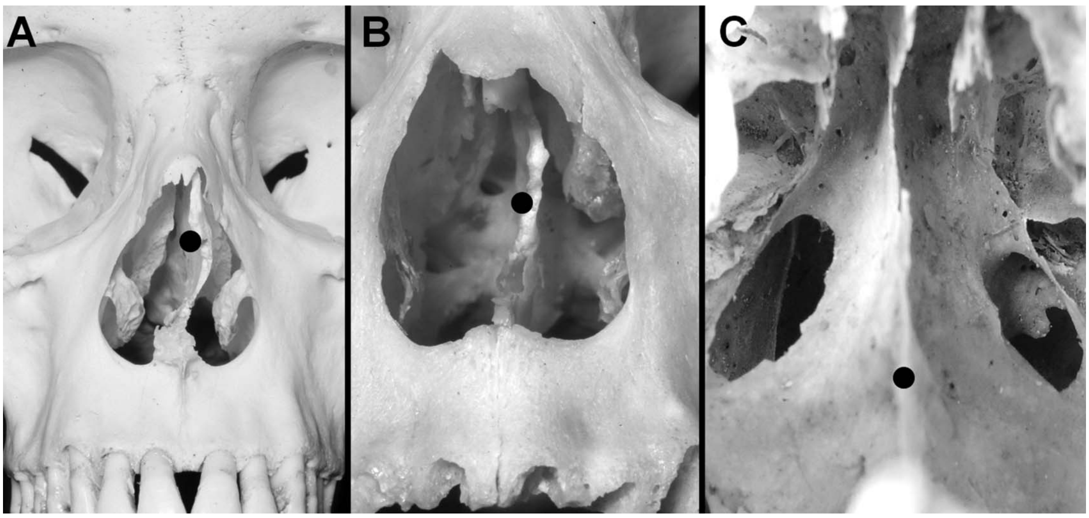

FIG. 4. Anterior view of the nasal cavity and sphenoid sinus. The spheno-sellar point is represented by a black circle. A: the sphenoid rostrum is located at the bottom of the nasal cavity. B: the middle concha on the right side has been removed to expose the sphenoid rostrum. C: all the conchae and the nasal septum have been removed, in order to expose the anterior aspect of the sphenoid body, and the sphenoid ostia.

approach to sellar lesions, not only because the sellar contents are separated from the sphenoidal sinus by a tiny sheath of bone that constitutes the sellar floor, but also because the transsphenoidal route is relatively safe, with a low risk of complications. In major series and experienced hands, death rate was 0.27 in microadenomas and 0.86 for macroadenomas. [8,9] Major morbidity includes optic nerve or carotid artery direct injury, meningitis, and permanent Diabetes Insipida or cranial nerve lesions. Minor morbidity includes transient Diabetes Insipidus, nasal discomfort, CSF leak, SIADH and transient cranial nerve paresis.

In 1987, Griffith and Veerapen described the endonasal approach, which require just minimal mucosal dissection over the rostrum of the sphenoid bone.[10] Over the last several years, the endonasal approach has been adopted for use with endoscopic assistance.[11–15] The transsphenoidal approach can be initiated in three different ways: cutting the mucosa over the alveolar part of the maxilla (sublabial transsphenoidal); cutting along the anterior nasal mucosa adjacent to the columella (transseptal transsphenoidal);[16] and cutting the mucosa over the sphenoid rostrum (endonasal transsphenoidal).[17] The endonasal approach provides a working window similar to the sublabial and transseptal approaches at the sphenoidal and sellar level; but it avoids the extensive dissection of septal mucosa that is required with the other techniques. The endonasal approach, thus, has the potential to avoid complications like sensory disturbances of the upper lip, septal perforation, sinequiae and septal abscesses.[18]

During the first stage of the endonasal transsphenoidal approach, the sphenoid rostrum is reached by inserting a nasal speculum along the nasal cavity, medial to the nasal conchae, and parallel to the nasal septum. When a surgeon is beginning his/her experience with this approach, it is possible to deviate from the ideal pathway by an angled trajectory that may take the surgeon further anterior towards the anterior fossa, or inferior towards the clivus. Although the surgical trajectory can be corrected using fluoroscopic guidance, such a misalignment has the potential to cause bleeding and damage to neural and vascular structures, and results in longer operative times. Surgeons use different patient/surgeon positions to operate on pituitary tumors via the transsphenoidal approach.

Some prefer Cushing's original method, in which the patient is placed in the supine position and the surgeon stands behind the patient's head.[19] Others prefer the semi-sitting position used by Guiot and Hardy.[15,19–22] In the last case, the position of the head is so variable, from almost horizontal to the floor of the operating room to almost vertical. The spheno-sellar point and the spheno-nostril line proved to be a reliable guide to position the head and obtain a straightforward trajectory towards the sella. With the surgical microscope aligned parallel to the spheno-nostril line and, therefore, also parallel to the floor- direct access to the sellar floor was guaranteed without the need of any other internal or external guidance.

As stated before, fluoroscopic guidance was not used routinely during surgery, even thought it was in the operation theatre ready to be utilized in case that, once inside the sphenoid sinus, some doubts still remained about the actual location of the sellar floor. This situation occurred in three cases, in which a presellar type of pneumatisation of the sphenoid sinus difficult anatomical identification of intrasinusal landmarks. Although, a total of 8 patients presented this type of sinus, and in the remaining five, no fluoroscopic guidance was required to access the sella. Nevertheless, it is not the purpose of the present study to conclude that the spheno-sellar point should replace the use of fluoroscopic guidance in transphenoidal surgery. Moreover, we believe that an important role still remains to X-rays specially for inexperienced surgeons or complicated patients.

It is also important to point out that if the surgeon is not used to operate with the microscope parallel to the floor, as described above, the spheno-nostril line can still be used as an external landmark, taking into account to orientate this line parallel to the vision of the microscope.

Regarding our results, there is a slight difference in the relative percentage of presellar-type sphenoidal sinus, when compared with Hamberger (11%)[23] or specially with Renn and Rhoton (20%).[24] We believe that this difference is not important, and probably relates to a different distribution of the age of our patients, with relates directly to the grade of pneumatisation of the sinus. The present work, based in normal cadaveric heads and skulls, may not account for extreme anatomical variations, as for example in acromegalics. More research should be done in the future before extrapolating our results to this subgroup of patients.

Conclusions

According to our experience in the lab, we described a constant relationship between the external skull and the sella turcica in adult patients. These external parameters were called spheno-sellar point and spheno-nostril line. They simulate the surgical trajectory on the surface of the head, as they link the initial point of entry, the nostril, to the sphenoidal rostrum, aiming at the desired sellar level. We used successfully those anatomical landmarks to guide a series of 102 consecutive transphenoidal surgeries. With the help of the spheno-sellar point and the spheno-nostril line, the surgeon can safely position the patient's head, the endonasal speculum, and the microscope parallel to the floor of the operating room, thereby allowing for a straight, direct path to the sellar content.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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