British Journal of Neurosurgery, 2013; Early Online: 1–9
© 2013 The Neurosurgical Foundation
ISSN: 0268-8697 print / ISSN 1360-046X online
DOI: 10.3109/02688697.2013.798862

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REVIEW ARTICLE

Endoscopic transnasal approach to the pituitary – Operative technique and nuances

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Abstract

Background. **The endoscopic transnasal approach is becoming the preferred minimally invasive approach to the pituitary region. We review the key anatomical landmarks, stepwise description of the surgical technique, technical variations, indications, limitations and important aspects of peri-operative management.** ***Technique.*** **The procedure consists of nasal, sphenoidal and sella stages performed using a rigid fibre-optic endoscope. Tumour debulking is undertaken with low-profile ring curettes, suction and/or ultrasonic aspirator. At the end, the pituitary fossa floor is reconstructed in a graded fashion, depending on the extent of the CSF leak through the arachnoidal and dural defects. Important technical variations include the surgeon position relative to the patient, uni- versus binostril approach, two- versus four-handed technique, extent of resection of the middle turbinate and the type of repair of the sella floor. Post-operative management is influenced by the nature of the pathology, involvement of the optic apparatus and changes to the pituitary function. In selected cases, extension of the technique along the sagittal and coronal planes can allow access to the other pathologies in the anterior, middle and posterior skull bases (i.e. the so-called extended approach).** ***Conclusion.*** **The endoscopic approach is becoming the technique of choice for accessing the pituitary region, with reduced nasal trauma, improved access, visualisation and potentially better tumour resection compared to the microscopic technique. However, there is an operative learning curve and some pathologies are more easily approached by this technique than others.**

Keywords: anterior skull base; endoscopy; operative technique; transnasal approach; pituitary

Introduction

The endoscopic transnasal transsphenoidal approach uses the natural air spaces of the nasal cavity to access the pituitary fossa, without the need to dilate the nasal passages using a nasal speculum as necessary with the microscopic approach.[1–3] The introduction of the rigid fibre-optic endoscope in pituitary surgery has been a relatively recent event, with the first endoscopic pituitary operation described in 1992.[1,4]

There are now numerous reports of the technique, with claims of benefits for the surgeon and patient, in terms of reduced nasal trauma, better optics (i.e. better illumination and wider angle of view), and potentially greater tumour removal in comparison to the microscopic technique.[2,3,5–12] The endoscopic transnasal technique has also been used to deal with lesions around the pituitary fossa in the so-called extended approach.[1,11,13]

In this review article, we describe the relevant anatomy of the region, details of the basic operative technique, variations in the technique, potential surgical complications, limitations of the technique and relevant peri-operative management issues.

Relevant surgical anatomy

The natural air spaces leading to the pituitary fossa consist of the nasal cavity and sphenoid sinus (Fig. 1). These structures interface with one another in a modular fashion. It is helpful to consider the surgical approach in terms of the 'nasal,' 'sphenoidal' and 'sella' stages (Figs. 3–5). Recognising a number of important anatomical landmarks during each of these stages is also a key to perform the exposure to the sella region in a safe fashion.

Nasal cavity and sphenoid sinus

The nasal cavity forms the working corridor to the pituitary fossa as it extends from the anterior naris to the sphenoid sinus. It is divided in the midline by the nasal septum, composed of septal cartilage anteriorly and by the bony plate of ethmoid and the vomer posteriorly. The nasal cavity is further segmented in the horizontal plane by the superior, middle and inferior turbinates (aka Chonchae) creating the inferior, middle and superior meatuses below each turbinate (Fig. 1A and D). The anterior wall of the sphenoid sinus is in line with the middle turbinate (Fig. 3A).

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Received for publication 12 February 2013; accepted 14 April 2013

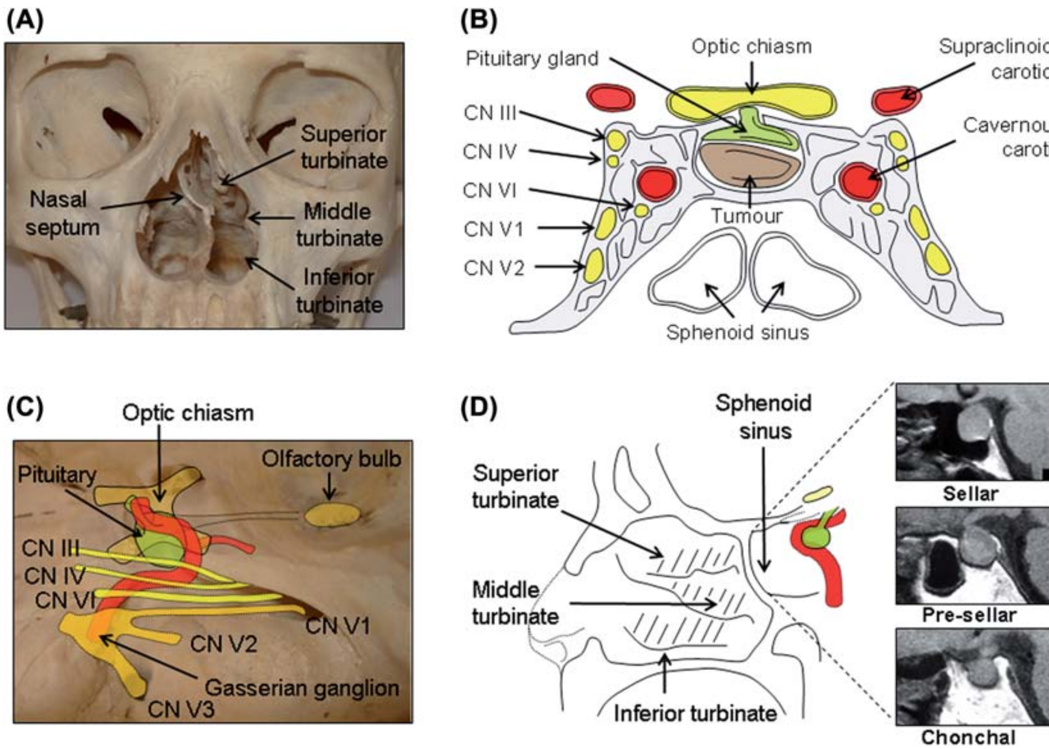

Fig. 1. Relevant surgical anatomy for the transnasal transsphenoidal approach to the pituitary. A) External landmarks on skull. B) Coronal cross section of the cavernous sinus depicting neurovascular relations. C) Oblique lateral view of the sellar/parasellar region. D) Sagittal view of the nasal cavity demonstrating the relationship between the nasal turbinates and the sphenoid sinus. Inset right: Different anatomical configurations of the sphenoid sinus relative to the pituitary fossa.

Located above the superior turbinate is the spheno-ethmoidal recess into which the sphenoid sinus drains via the sphenoid ostium (Figs. 1 and 3). For accessing the pituitary, the sphenoid ostium usually marks the superior limit of the opening into the sphenoid sinus (Fig. 3B and E). The lower limit of the opening into the sphenoid sinus is usually about 1 cm above the Choanae, which is the outline of the posterior orifice of the nasopharynx (Fig. 3B and C).

The sphenopalatine artery provides part of the vascular supply to the nasal septum and nasal mucosa. It enters the region via the sphenopalatine foramen and branches out supero-lateral to the Choanae (Fig. 3B). Its terminal branches may be encountered during submucosal dissection supero-lateral to the Choanae, and adequate coagulation of these arterial branches is important to prevent early post-operative epistaxis (Fig. 3B).

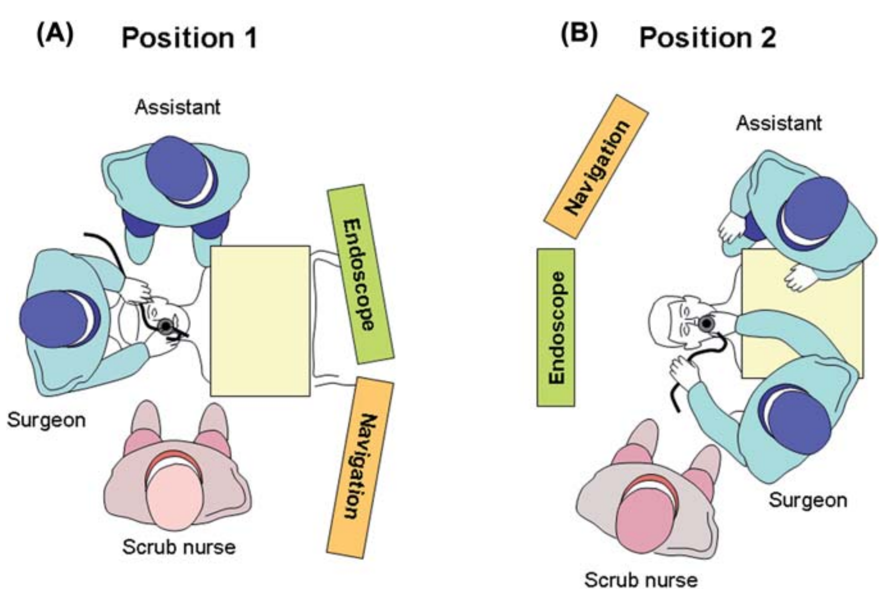

Fig. 2. Schematic diagram depicting the relative position of the patient and surgeon, the latter standing, either at the head end (A – position 1) or at the foot end (B – position 2) of the patient.

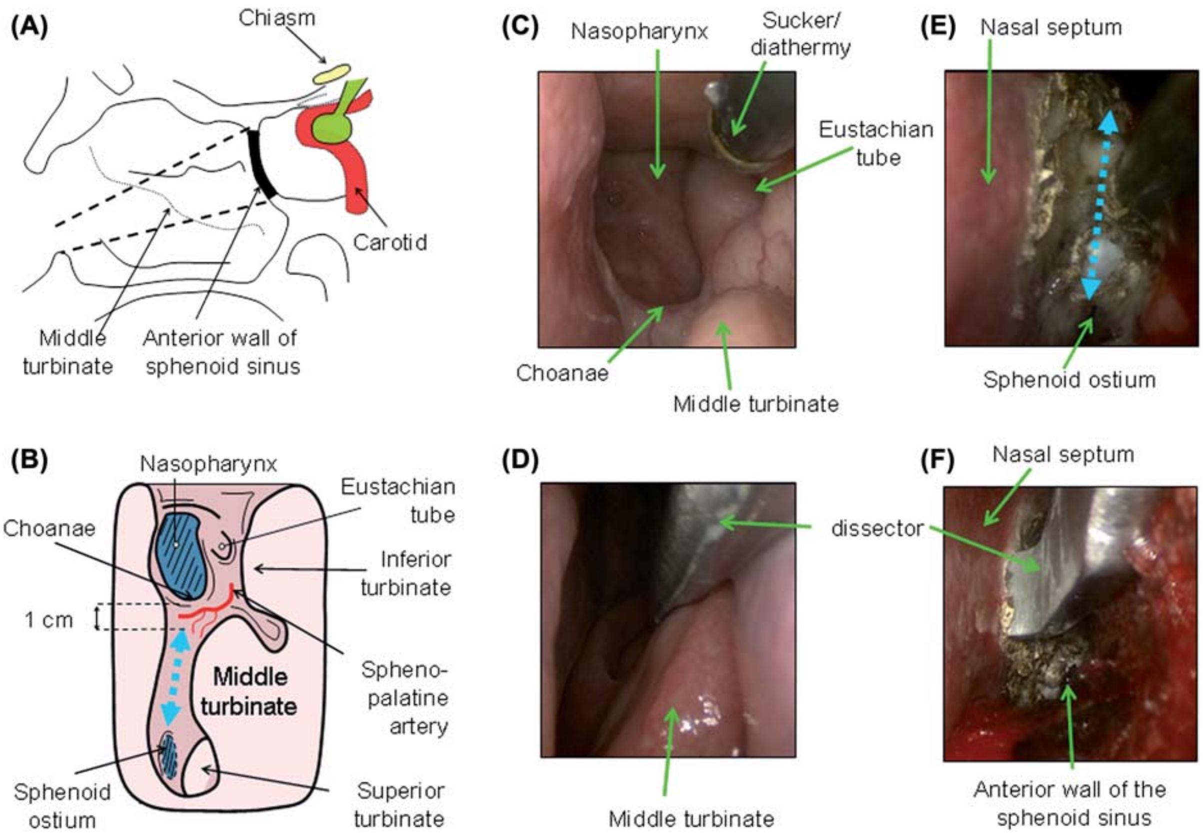

Fig. 3. Nasal stage of the transnasal transsphenoidal approach as viewed from surgeon 'position 1'. A) Surgical trajectory and relationship of the middle turbinate with the anterior wall of sphenoid sinus are shown. B) Schematic depicting the intra-operative view of the key anatomical landmarks on approach to the anterior wall of sphenoid sinus, including the Choanae, Eustachian tube, sphenoid ostium and the nasal turbinates. Mucosal incision is highlighted by the blue line, and note the relationship with the sphenopalatine arterial branches. C) Initial intra-operative view of the nasopharynx with the identification of the Eustachian tube and the Choanae. D) Middle turbinate is displaced laterally, to reveal the anterior wall of the sphenoid sinus and the sphenoid ostium (E). F) Nasal septum is fractured at the base and displaced to the contra-lateral side.

In the vast majority of the patients, on deflecting the middle turbinate laterally, the sphenoid ostia come into view or its bony defect can be palpated with a blunt instrument (Fig. 3B and E). There are various anatomical configurations to the sphenoid sinus termed 'sellar', 'pre-sellar' and 'chonchal variants (Fig. 1D). Of these, the 'sellar' variant is the commonest (approximately 75%), and the 'chonchal' is the least common and is more usually seen in children.[14] The sphenoid sinus usually contains one or more septae within it, which are infrequently not in the midline. Close study of the pre-operative imaging (i.e. axial CT scans and/or the axial and sagittal MR) is important to be pre-warned about the anatomy of the sphenoid sinus in each case.

On opening through the anterior wall of the sphenoid sinus, its posterior wall constituting the pituitary fossa floor is revealed (Fig. 4). Superior to the pituitary fossa, the tuberculum sella and planum sphenoidale, form the continuation of the anterior skull base (Fig. 6D). Inferior to the pituitary fossa, the bony clivus separates the sphenoid sinus from the contents of the posterior fossa (Figs. 4 and 6). In a well-aerated sphenoid sinus, it should be possible to appreciate the bulge of the vertical segment of the petrous carotid arteries, infero-lateral to the pituitary fossa, extending upwards to form the 'C'-shaped cavernous carotid segments, and then intra-cranially the supra-clinoid carotid arteries (Figs. 4 and 6). The bony covering over the petrous and cavernous carotid bulges can be very thin or even deficient in a minority of patients, and care must be taken. The optico-carotid recess is frequently seen as the bony depression on the supero-lateral aspect of the sphenoid sinus that demarcates the optic nerve from the carotid arteries (Fig. 4B and C). It represents the pneumatisation of the anterior clinoid seen intra-cranially (Fig. 1C).

Anatomy of the pituitary fossa

Also known as the 'sella turcica', the pituitary fossa is a bony depression that occupies the centre of the cranial skull base (Fig. 1). Its key relations are the optic chiasm superiorly and the cavernous sinus located laterally, which harbours the cavernous segment of the internal carotid artery, along with the cranial nerves III, IV, V1, V2 and VI (Fig. 1B and C).

The pituitary stalk passes through the dura of the anterior skull base at the sella turcica (Fig. 1B and C). The anterior skull base dura is continuous around the pituitary gland, but the arachnoid envelopes the pituitary stalk and passes over the dome of the pituitary gland and the associated pituitary tumour (Fig. 5F). This part of the arachnoid constitutes the diaphragma sellae that descends into the fossa on removal of the pituitary tumour (Fig. 5E and F). The arachnoid folding in the anterior recess is especially vulnerable to inadvertent opening during durotomy (Fig. 5F).

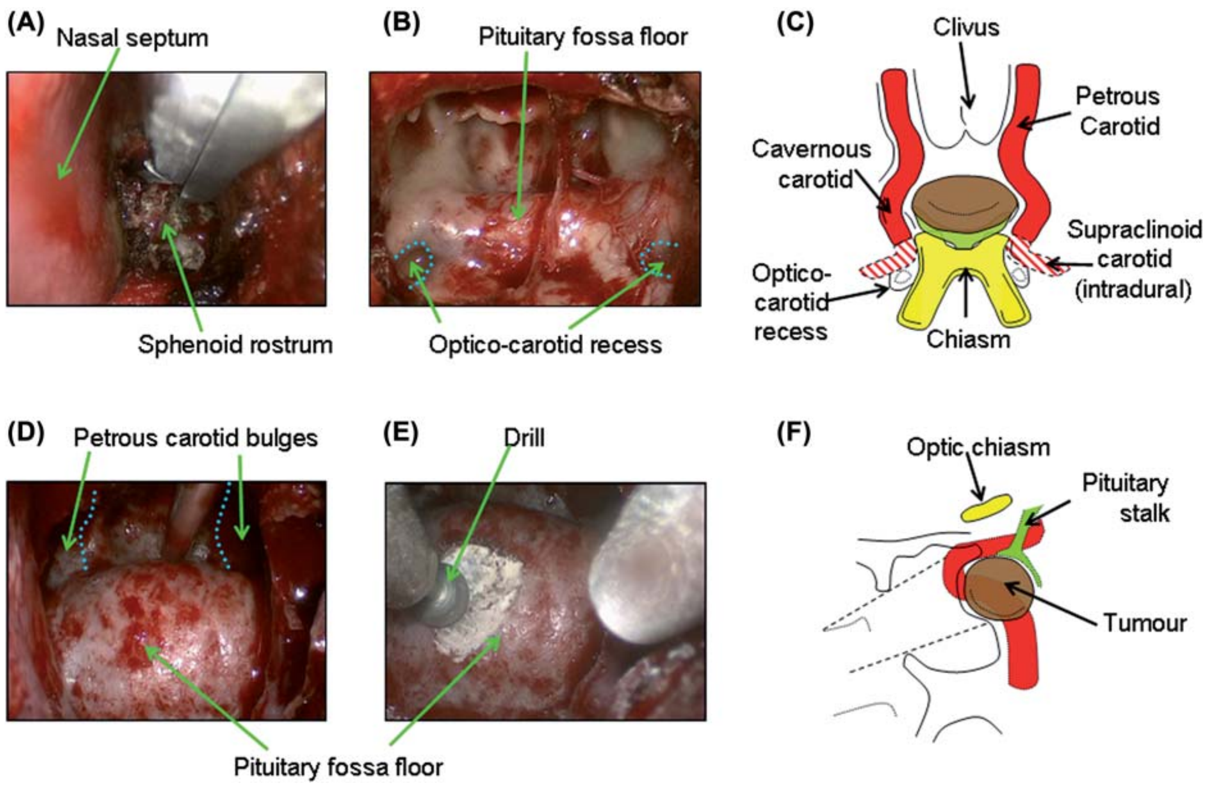

Fig. 4. Sphenoidal stage of the transnasal transsphenoidal approach as viewed from 'position 1'. A) The sphenoid rostrum is removed using a rongeur to create a window to the sphenoid sinus. B) Intra-operative view within the sphenoid sinus and the accompanying schematic (C – inverted coronal view) demonstrate the pituitary fossa and relationship with the petrous and cavernous segments of the carotid arteries, optic chiasm and the optico-carotid recess in between. D) View within the sphenoid sinus reveals an expanded pituitary fossa, the bony wall of which is opened using a diamond drill (E). F) Sagittal schematic view of the pituitary fossa and relationship with cavernous carotid artery and optic chiasm.

Pituitary tumours that extend into the suprasellar space can displace the optic chiasm superiorly (Fig. 5F), anteriorly (i.e. a pre-fixed chiasm) or posteriorly (i.e. a post-fixed chiasm) (Fig. 6A and B). This can usually be deduced from a careful study of the pre-operative MR images in the coronal and sagittal planes. Understanding the relationship between the chiasm and tumour is also of importance in choosing the appropriate surgical approach; for example, a cranial approach for a suprasellar tumour with a pre-fixed chiasm may be challenging as the chiasm in front may obstruct access to the tumour. This may be less so with a transsphenoidal approach in the same case, as this allows for a more direct approach to the tumour from an inferior trajectory (Fig. 6).

Operative technique

Pre-operative planning and positioning of the head

Under general anaesthesia, the patient is positioned supine with the head in a neutral position held on a horseshoe or rigidly in pins if neuronavigation is being used. Frameless CT and/or MR based neuronavigation is essential for re-operations, for extended transsphenoidal procedures and/or if the sphenoid sinus anatomy is not straightforward.[15] Peri-operative steroids (100 mg hydrocortisone) and a single dose of broad spectrum antibiotics (e.g. Cefuroxime and Metrondiazole) are administered.

Methods for nasal preparation vary widely. Peri-operatively, we employ a topical nasal decongestant spray (Cophenylcaine; Aurum Ltd, UK), useful for both its local anaesthesia and vasoconstrictor properties. Given the normal bacterial flora of the nasal passages, we do not washout the nasal passages with anti-septic solutions peri-operatively. However, some surgeons prepare the nasal passage with antiseptics (e.g. aqueous betadine). For a more potent vasoconstriction of the nasal mucosa, some apply patties soaked in relatively concentrated adrenaline solution (1 in 1000) or cocaine paste, but there is a potential for greater cardiac side effects with these measures.

Patient is positioned supine with the trunk elevated by approximately 20° to aid venous return. Patient's head is usually in a neutral position for pathology within the pituitary fossa, slightly extended (10–30°) for pathology of the anterior skull base, and slightly flexed (20–40°) for pathology of the clival region and below.

The primary surgeon can stand at the head of the patient, facing down (i.e. position 1) or be looking up (i.e. position 2) (Fig. 2). There are relative merits with both surgeon positions and it's often a personal choice. With position 1, the operating surgeon can access either nostril with equal ease, and ergonomically, the surgeon's body posture is neutral and potentially more comfortable when undertaking prolonged operations. With the surgeon standing in position 2, for a right-handed surgeon the right nostril is easier to access. Moreover, the operating surgeon's body posture is twisted, unless the patient's head can be rotated towards the surgeon, but this manoeuvre may disadvantage the assistant.

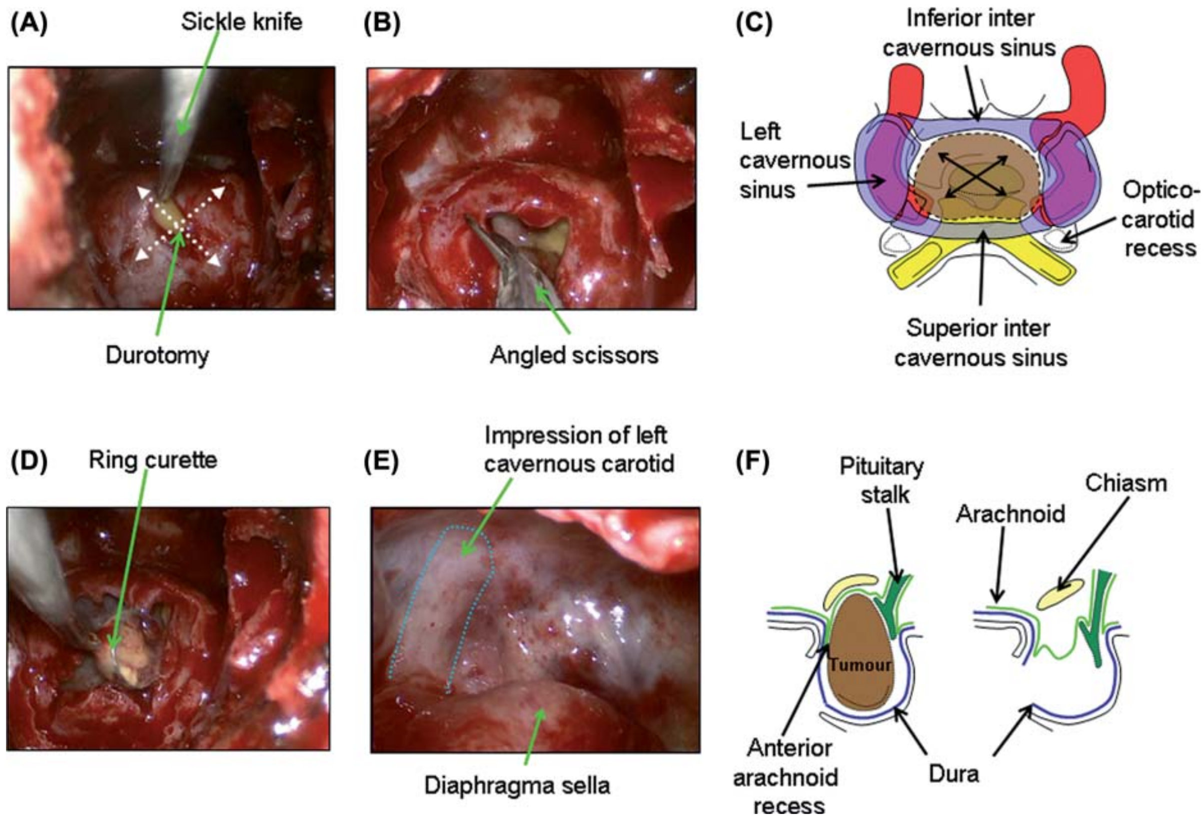

Fig. 5. Sella stage of the transnasal transsphenoidal approach as viewed from 'position 1'. Cruciate durotomy is carried out with a sickle knife (A) and further extended laterally with angled microscissors (B). C) (Inverted coronal) represents the schematic views of the pituitary tumour and relationship with the cavernous sinus laterally and the inter-cavernous venous sinuses, above and below. D) Necrotic tumour is debulked using ring curettes. E) View from within the empty pituitary fossa reveals the descent of the diaphragma sellae and the impression of the left cavernous carotid, deep to the cavernous sinus wall. F) (Sagittal) represents schematic views of the pituitary tumour and relationship with the pituitary gland, dural and arachnoid lining, before (left) and after (right) tumour removal.

However, position 2 may be easier if 2 surgeons are operating simultaneously and there is also a greater scope for elevating the patient's head to help with reducing venous bleeding. The relative positions of the assistant and scrub staff can also be variable, and use of a secondary monitor for the assistant and scrub nurse can help to avoid uncomfortable body positions.

In our practice, most pituitary pathology is operated by a single surgeon standing in position 1, via a uninostril approach (Fig. 2A). For most 'extended approaches' to tackle other anterior skull base pathology (see below), two operating surgeons, standing in position 2, using a binostril approach and a 4-handed technique are preferred (Fig. 2B).

Nasal stage

A zero-degree, 4-mm rigid fibre-optic endoscope (Karl Storz, Germany) is used in a free-hand fashion. For most pituitary lesions, a uni-nostril approach is adequate, and for midline lesions, the nostril that is more capacious (i.e. less obstructed by septal deviation or by an enlarged middle turbinate) is used. Lesions that are lateralised are best approached from the contra-lateral nostril.

The endoscope is initially passed inferiorly along the floor of the nasal passage, to identify the nasopharynx, Eustachian tube, Choanae and the inferior and middle turbinates (Fig. 3B and 3C). To increase the working space, the middle turbinate is gently deflected laterally and use of surgical patties soaked in diluted adrenaline solution (approx 1 in 100,000) can help to minimise the mucosal bleeding at this step (Fig. 3D). Partial or complete middle turbinectomies and a posterior septostomy are only necessary in 'extended approaches' undertaken via a binostril approach. The use of a microdebrider (ENT instrument with a rotating blade and suction) can be very helpful for turbinectomies and posterior septostomy.

To access the pituitary fossa, the mucosa overlying the anterior wall of the sphenoid between the sphenoid osteum and approximately 1 cm above the Choanae is diathermied and stripped laterally (Fig. 3B and E). As the mucosal dissection progresses infero-laterally, branches of the sphenopalatine artery may be encountered and should be coagulated to minimise early post-operative epistaxis (Fig. 3B).

The nasal septum is then fractured across at the base, using a dissector or a high-speed 4-mm diamond drill (Fig. 3F). Working submucosally, the septum is displaced to the contralateral side to enlarge the working space between the middle turbinate and the nasal septum (Fig. 3F). This also allows for the contra-lateral sphenoid ostium to be located.

Sphenoidal stage

The sphenoid rostrum is then resected between the ostia using rongeurs and upcuts (Fig. 4A). Care must be taken while resecting the sphenoid septae within the sinus which can be multiple, off midline and distort the normal anatomy

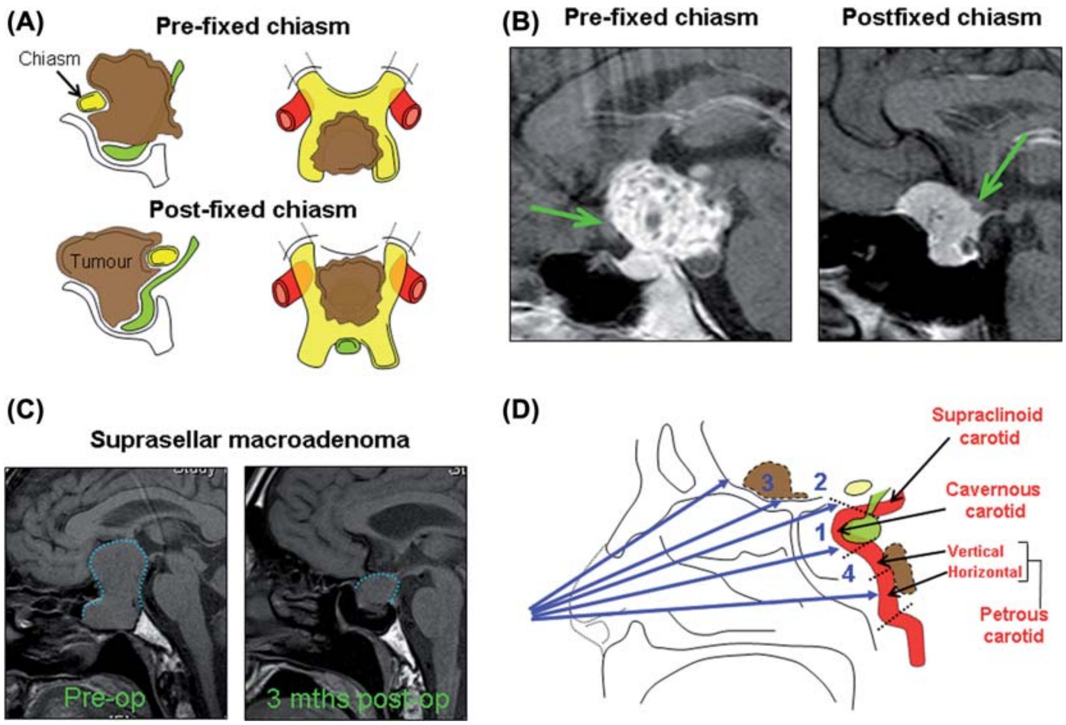

Fig. 6. Schematic diagrams (A) depicting the differences in relationship between the optic chiasm, tumour and the pituitary gland and stalk, in cases of pre- and post-fixed chiasm. B) Sagittal T1-weighted MR scans with contrast reveal a case of pre-fixed chiasm in a suprasellar craniopharyngioma (left) and post-fixed chiasm in a tuberculum sella meningioma (right). The green arrows indicate the position of the chiasm. C) Sagittal T1-weighted MR shows a case of a pituitary macroadenoma with a large suprasellar component (left). Following an initial transsphenoidal attempt, subtotal resection was feasible with gradual descent of the suprasellar component as evident on the 3-month post-operative MR scan. D) Schematic in the sagittal plane showing the areas in the anterior skull base that can be targeted in the 'extended transnasal approaches'. 1 – sella, 2 – Tuberculum sella and planum sphenoidale, 3 – cribriform plate, and 4 – clival.

(Fig. 4). The key factor determining the difficulty in exposing the pituitary fossa within the sphenoid sinus is the configuration of the sinus cavity in terms of 'sellar', 'pre-sellar' and 'chonchal' variants as described above (Fig. 1D). 'Pre-sellar' and more especially 'chonchal' variants necessitate greater amount of 'bone-work' to expose the pituitary fossa, with increasing reliance on use of a high-speed diamond drill and the neuronavigation. The sphenoid mucosa is gently dissected off the pituitary fossa laterally, and the mucosal bleeding is controlled with patties and irrigation. It is generally not advisable to use a microdebrider within the sphenoid sinus to minimise the risk of carotid injury.

At this stage, and in a well-aerated sphenoid sinus, a number of useful anatomical landmarks may be identifiable, including the bulge of the vertical segment of the petrous carotid arteries, clival recess in between, the cavernous carotid bulges and the pituitary fossa in between, and more superiorly the optico-carotid recess, tuberculum sella and the planum sphenoidale (Fig. 4B–F).

The sella floor may be of variable thickness. With large macroadenomas, the bone may be very expanded and thin or even absent, and upcuts are sufficient to resect this (Fig. 4B–E). With microadenomas and/or growth hormone producing adenomas, the pituitary fossa floor can be very thick. A 4-mm diamond burr is very helpful in adequately exposing pituitary fossa dura in such cases (Fig. 4E). The extent of the exposure of the sella dura is in part related to the size and the extent of the pathology; for example, pituitary adenomas with significant suprasellar extension may necessitate exposure of the dura over the tuberculum sella (Fig. 4F).

Sella stage

The durotomy is usually carried out with a sickle or retractable knife in a cruciate fashion, starting in the middle and further cautiously extended with angled micro-scissors. Care is taken to avoid CSF leak from the inadvertent opening of the arachnoid folding in the anterior recess (Fig. 5F).

The configuration of the cavernous sinuses can vary, and with larger adenomas, the superior and inferior intercavernous sinuses are usually displaced and tamponaded by the tumour (Fig. 5C). However, with microadenomas, the superior and inferior intercavernous sinuses may be substantial and troublesome venous bleeding can be encountered on opening the dura (Fig. 5C). Indeed, in some cases, the anterior dural wall of the pituitary fossa may be a venous lake (Fig. 5C). Prior diathermy of dura using angled bipolars and placing collagen sponge extradurally to tamponade the dural sinus can help in this regard.

Given that most adenomas are soft in consistency, tumour removal is usually performed with a variety of ring curettes (blunt and sharp types) and suction (Fig. 5D). Ultrasonic aspirator may also be useful for tougher tumours. Removal of the suprasellar component of the adenoma can be aided by valsalva manoeuvre and/or cautious injection of saline via a lumbar drain placed pre-operatively. Debulking the suprasellar component of the adenoma usually leads to descent of the diaphragma sella into the pituitary fossa (Fig. 5E and F).

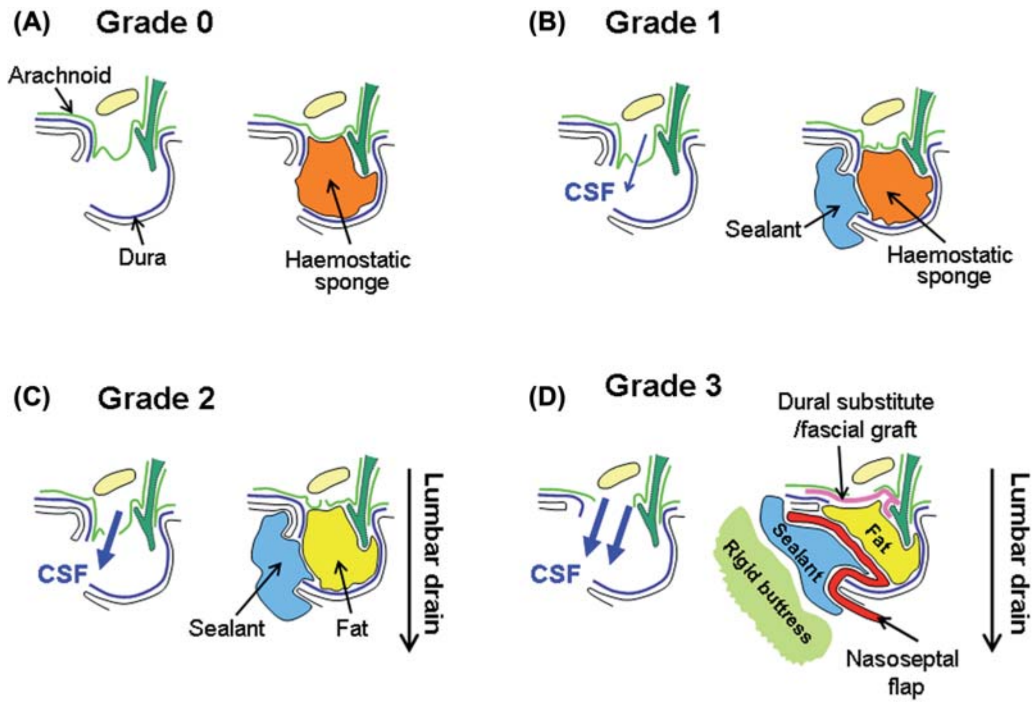

Fig. 7. Schematic diagrams depicting the different grades of CSF leak and the graded repair strategies. A) No CSF leak and intact arachnoid. B) Grade 1 CSF leak (minor leak with no obvious arachnoid defect). C) Moderate Grade 2 CSF leak, with a visible arachnoid defect. D) Large grade 3 CSF leak, with large arachnoid and dural defects usually seen in the cases of extended transsphenoidal procedures.

The descent of the diaphragma sella into the pituitary fossa intra-operatively may not be apparent in cases with very large suprasellar component and with significant suprasellar adhesions. The descent may take place slowly over the subsequent weeks and months, due to CSF pulsations (Fig. 6C).

Final inspection with an angled endoscope (30–70°) can help identify and cautiously remove tumour from hidden corners including laterally within the cavernous carotid loop and into the cavernous sinus (Fig. 5E). Intra-operatively, the cavernous sinus walls may be seen compressed rather than truly invaded by macroadenomas and this can be difficult to establish on the pre-operative MR scan. For tumours extending laterally into the cavernous sinus, cautious intra-tumoural debulking is advised, with a gentle suction and blunt curetting under direct vision. For endocrine active adenomas, resection of the pseudo-capsule of the adenoma, any invaded dura (if possible) and bipolar diathermy of tumour bed is important to achieve disease remission.

Sella floor repair

Following haemostasis of tumour bed, it is useful to test for CSF leaks using a valsalva manoeuvre. The severity of CSF leak can also be graded as Grade 0 (no leak), Grade 1 (small CSF leak or 'weep', without obvious arachnoidal defect), Grade 2 (moderate leak, with arachnoidal defect) and Grade 3 (large arachnoidal/dural defect, usually associated with extended transsphenoidal procedures) (Fig. 7).[16,17]

Numerous techniques have been described to reconstruct the sellar floor, and we utilise a graded method of repair depending on the extent of CSF leak (Fig. 7).[16,17] Overall, most repair methods seem very successful for low-grade CSF leaks (i.e. Grades 1 and 2), but less so for Grade 3 leaks.[16,17] Use of autologous materials (e.g. subcutaneous fat, fascia and vascularised naso-septal flap), rigid supporting buttress and temporary CSF diversion are important when repairing higher-grade CSF leaks.

In the absence of any CSF leak, a haemostatic gelatin sponge is placed within the tumour bed to aid haemostasis and also to support the arachnoid bulge of the diaphragma sella (Fig. 5F; Fig. 7A).[17] For Grade 1 CSF leaks, the above repair is supplemented by a dural sealant applied on top of the haemostatic sponge (e.g. Duraseal or Tisseel) (Fig. 7B). For Grade 2 CSF leaks, autologous fat graft from a peri-umbilical incision and dural sealant are used to tamponade the arachnoidal defect (Fig. 7C). For Grade 3 leaks, the large arachnoidal/dural defect is closed in a multilayered fashion with initially an extradurally placed dural substitute or fascia lata graft (from thigh incision) (Fig. 7D). This is covered with a further layer of autologous fat and/or gelatin sponge, a vascularised naso-septal mucosal flap (hinged on the sphenopalatine vascular pedicle) and a dural sealant. The multilayered repair is held together for 3–5 days by a rigid buttress in the form of absorbable or non-absorbable nasal tampons, a titanium mesh or a Foley balloon catheter (Fig. 7D). For Grade 2 and Grade 3 leaks, the repair can be further supported in high-risk cases by pre-operative placement of a lumbar drain to divert CSF at 5–10ml per hour for 3–5 days (Fig. 7C and D).

At the end of the procedure and after adequate haemostasis of the nasal mucosa, the middle turbinate and the nasal septum are pushed back towards the midline. Nasal packing is not necessary for the vast majority of patients and typically only required in the cases of 'extended approaches' and where a naso-septal flap may have been harvested.

Case example of a necrotic pituitary macroadenoma resected via endonasal transsphenoidal approach (OPERATIVE VIDEO)

Post-operative care

Post-operative nasal care protocols vary, and in our unit, all patients undergoing endoscopic transnasal surgery are instructed to administer saline nasal spray (Sterimar, UK) for up to 2–3 months post-operatively. Post-operative ENT review and out-patient endoscopic nasal examination are warranted for the small minority of patients who complain of recurrent nasal symptoms and those who undergo 'extended transnasal procedures' involving bi-nostril approaches with middle turbinectomies.[12]

Pre- and post-operative endocrine review to address any hormone deficiencies is essential for all patients with pathology in and around the pituitary gland. In those patients with endocrine active adenomas (e.g. Cushing's disease and Acromegaly), early testing of the active hormone levels is undertaken at 2–5 days post-operatively.[8] In patients with persistently raised hormone levels, re-exploratory surgery can be considered at 2–4 weeks post-operatively if there is evidence of residual tumour on an early post-operative MR scan.[8] Early surgical re-exploration can be easier as post-operative scarring is less likely and dissection within the tumour bed potentially more straight forward.[8]

For most non-functioning pituitary adenomas, patients are usually discharged 1–2 days post-surgery, and for functioning adenomas the in-patient stay may be longer (i.e. 3–5 days), primarily to allow for early endocrine assessment. Unless there are post-operative concerns, visual fields and post-operative MR scans are routinely undertaken at 4–6 months post-operatively.

Indications

Pathologies of the pituitary gland, notably of the pituitary adenomas, are the commonest indication for an endoscopic transsphenoidal approach (Table I). Surgery is commonly indicated to address the mass effect on the optic chiasm from a macroadenoma (Table I) and is approximately 80–90% effective at improving visual deficits.[3] Even in the cases of giant macroadenomas with large suprasellar components, an initial transsphenoidal attempt is preferable, given the lower morbidity with this compared to a cranial approach. If the resection was subtotal, a repeat transsphenoidal approach could also be considered 4–8 weeks later, as the tumour residuum may gradually descend down over time, due to CSF pulsations (Fig. 6C). Alternatively, if further resection via a transnasal approach is deemed difficult, then a transcranial approach, such as the eyebrow craniotomy, can be considered.[18]

Endocrine active adenomas tend to be smaller, and surgical success in controlling excess hormone production partly depends on the size and the invasiveness of the adenoma and the relative expertise of the surgeon (Table I).[3]

Cystic or solid craniopharyngiomas are the other common indications. Numerous other pathologies of the pituitary fossa can also be reached transsphenoidally. This approach can also be used in combination with a cranial approach as part of a two-stage procedure (Table I).

Table I. Typical indications for the endoscopic transnasal approach to the pituitary.

Pituitary macroadenomas - For mass effect
- Large sellar/suprasellar pituitary adenoma
- Residual sellar/suprasellar pituitary adenoma*
- Pituitary apoplexy

Pituitary micro/macroadenomas – For hormone secretion
Craniopharyngioma – Sellar and Suprasellar*
Miscellaneous pituitary lesions
- Rathke's cyst
- Pituitary hypophysitis and other inflammatory lesions
- Pituitary mucocoele and abscess
- Pituitary dermoids
- Pituicytoma
- Metastasis to the pituitary

Extended transnasal approaches
- Anterior skull base meningiomas*
- Clival chordomas and chondrosarcomas*
- Meningoencephalocoele and CSF leak repair*
- Tumours of the nasal passages*

*In selected cases an alternative or in combination with a cranial approach.

Extended transnasal approaches

More recently, in the so-called extended approaches the endoscopic transnasal approach has also been utilised to tackle para and supra-sellar lesions along the anterior skull base (Table I and Fig. 6D).[1,11,13] In the sagittal plane, lesions from the frontal sinus to base of clivus may be targeted, and in the coronal plane the cavernous carotids usually demarcate the extent of surgical access. However, there is a significant learning curve with these more complex procedures, with risk of serious complications, including life-threatening arterial bleeds that are difficult to control and failure to satisfactorily repair CSF leaks.[1,11,13] Some lesions (e.g. small central clival chordoma) are more easily tackled by the trans-nasal route than other types of pathologies (e.g. large tuberculum sella meningiomas, with lateral extension beyond the carotid arteries).

A binostril approach with 2 surgeons, standing in position 2 and utilising a 4 handed technique is frequently used in these extended cases. To maximise access, partial or complete middle turbinectomy with posterior septostomy is frequently carried out, with the aid of a microdebrider. Adequate repair of the Grade 3 CSF leaks produced in these cases can be difficult, but the recent use of vascularised naso-septal mucosal flaps has been an important step in dealing with this problem.[11,13]

Table II. Operative complications with endoscopic approach to the pituitary.

Major complications (< 0.1% risk; case dependant)
- Major vascular injury
- Blindness from optic nerve/chiasmal injury
- Death

Other complications (~5–50%; case dependent)
- Infection (sinusitis, mucocoele, meningitis, etc)
- Bleeding (nasal and intracranial)
- Pituitary dysfunction and need for hormone replacement
- Diabetes insipidus and SIADH
- CSF rhinorrhoea and need for repair
- Neurological deficits and fits
- Residual tumour, need for further surgery and adjuvant radiotherapy
- Other medical complications (e.g. respiratory and cardiovascular)

Complications and limitations

A list of most complications associated with the endoscopic transnasal approach to the pituitary are summarised in Table II. The operative risks vary and are largely dependent on the nature, site and size of the pathology and the extent of surgical resection attempted. This is especially so for the 'extended approaches'.

Catastrophic complications, such as carotid injury, are usually due to the surgeon 'getting lost' intra-operatively. The risk of this can be minimised by close study of the nasal and sphenoid anatomy, as revealed by the pre-operative imaging and intra-operatively from the panoramic view provided by the endoscope. Intra-operative use of neuronavigation and doppler ultrasound probe can also prove very helpful in this regard. The reported risks of complications associated with pituitary surgery also reduce with an increase in surgeon's experience.[19]

One of the disadvantages of the endoscopic transnasal approach is the narrow and deep surgical corridor to the site of pathology, with an increase in working distance. This is partly overcome by the use of the fibreoptic endoscope, with a better illumination and a wider angle of view. Specially modified instruments such as suction-diathermy, suction-curette and long low profile ('tube shaft') bipolars and drills are other essential tools.

Another relative disadvantage is the two-dimensional image provided by the current range of endoscopes. The relative movements between instruments give an estimate of the working depth for the surgeon. Newer generation of endoscopes may provide a more 3-dimentional image. Furthermore, periodic clouding of the endoscope lens by blood can be an irritant, but this can be reduced by use of an outer sheath for the endoscope that allows for irrigation and suction. Use of an endoscope holder can be useful to free up both hands for the surgeon. However, this may be at the expense of reduced access for other surgical instruments through the same nostril and the loss of depth perception as described above.

Overall, the endoscopic technique remains a significant departure for the neurosurgeon familiar with the microscopic technique, and there is a well-documented operative learning curve with this approach.[8] Attendance at cadaveric courses, fellowship training in the endoscopic technique and careful selection of more 'straight forward' cases early in the operative learning curve are the important steps to minimize the operative risks.

Conclusions

The endoscopic transnasal approach uses the natural air spaces to safely access the pituitary fossa, in a minimally invasive fashion. The key surgical steps of the procedure consist of the nasal, sphenoidal and sella stages, and are guided by key anatomical landmarks. The procedure is associated with an operative learning curve, and an adequate training is essential.

Supplementary material available online

Supplementary material available online at http://informahealthcare.com/doi/abs/10.3109/02688697.2013.798862

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

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