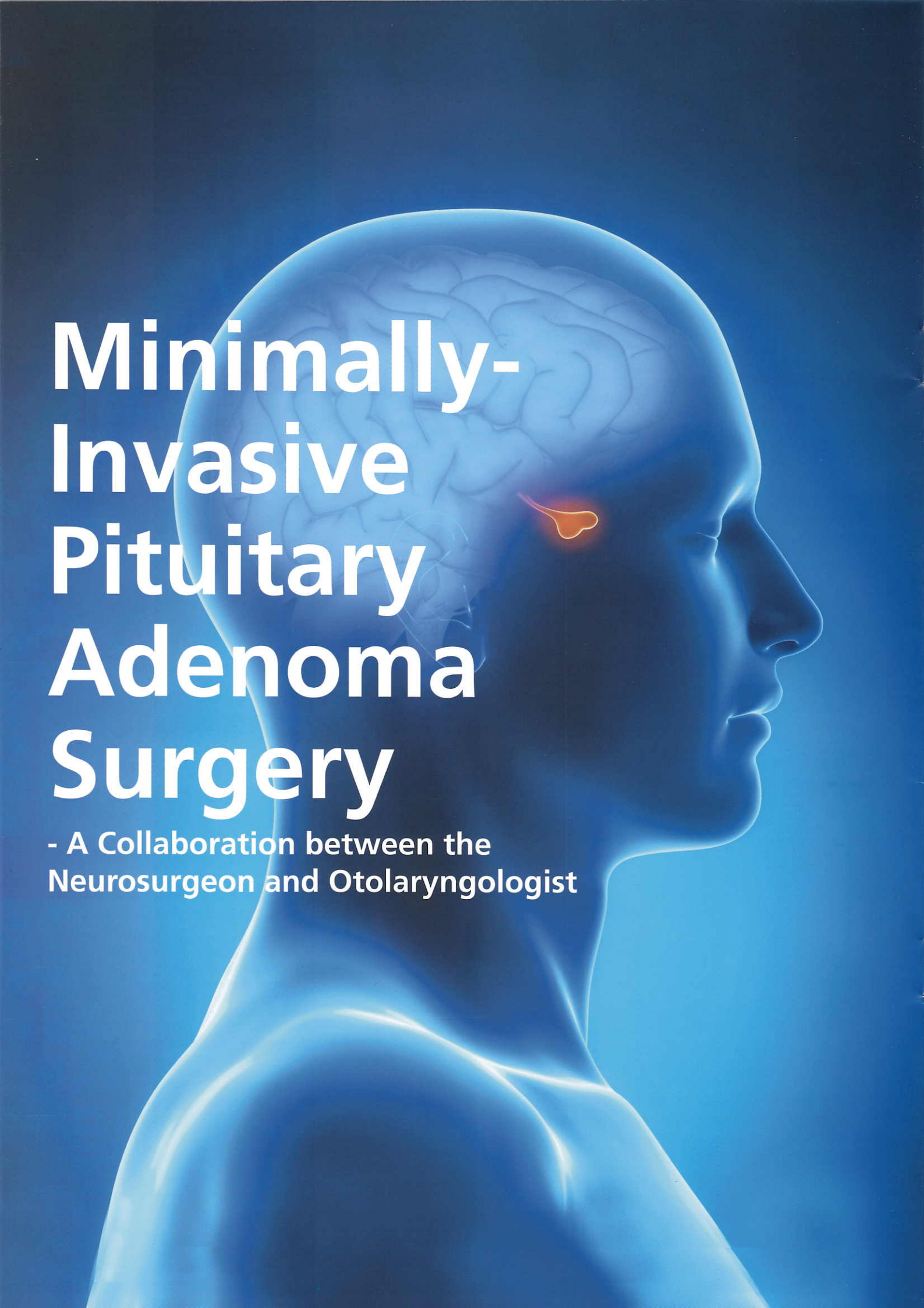

Minimally-Invasive Pituitary Adenoma Surgery

- A Collaboration between the Neurosurgeon and Otolaryngologist

Mr Ng, a 43-year old taxi driver, started noticing three months ago that he was having frequent headaches and nausea, which he attributed to long working hours and lack of sleep. He became concerned when he noticed his vision was becoming cloudy and was occasionally seeing double. A change of glasses did not improve his vision, and it was starting to affect his ability to drive and read.

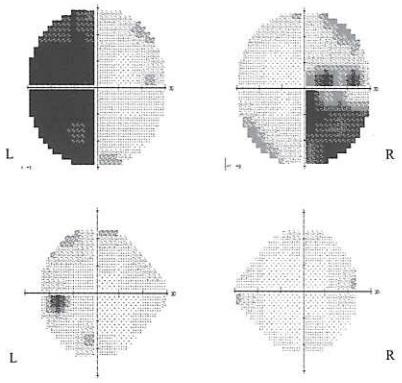

Figure 1: Humphrey visual analyser of Mr Ng. Top row is the pre-operative visual field test showing bitemporal hemianopia. The bottom row is the post-operative visual field test at eight weeks which shows resolution of the bitemporal hemianopia.

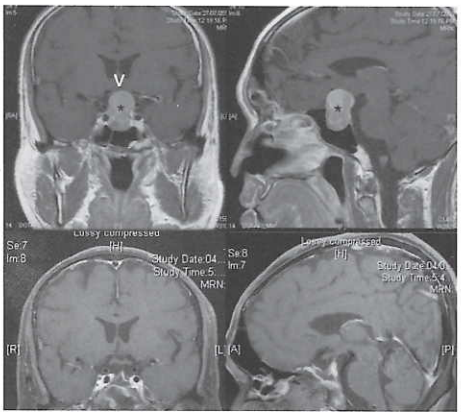

Figure 2: Top row shows the pre-operative MRI coronal and sagittal views of the pituitary tumour (*) compressing on the optic chiasm (V). Bottom row demonstrates complete resection of the tumour.

He finally saw his family doctor, who referred him to an ophthalmologist. Visual field testing showed that he had suffered from bilateral temporal hemianopia (Figure 1). MRI brain revealed a large pituitary tumour that was compressing on the optic chiasm (Figure 2). As he was at risk of permanently losing his vision, he was recommended surgery to remove the tumour.

Pituitary adenomas - symptoms and signs

While many lesions of the pituitary gland exist, this focus is on pituitary adenoma as it is the most common type of pituitary disorders. A pituitary adenoma, despite being a benign tumour, is anything but mild, given its seat in the brain. In fortunate cases, the tumour is small ("small" means less than 1cm in size - also known as a microadenoma), the patient is asymptomatic, and can be managed conservatively. However more often than not, like in Mr Ng's case, a pituitary adenoma grows beyond 1cm (also known as a macroadenoma) and becomes problematic because of compressive effects. The patient can experience headaches (stretching of the dural sheath), bitemporal hemianopia (impingement on the optic chiasm), palsies of the oculomotor, trochlear and abducens nerves (involvement of the cavernous sinus) and partial or complete hypopituitarism (secondary to compression of the pituitary stalk or pituitary gland).

In addition, two-thirds of pituitary adenomas are functional, meaning they secrete hormones in excess. The commonest of these are prolactinomas, which cause amenorrhoea, galactorrhoea and gynaecomastia. Growth-hormone secreting adenomas result in acromegaly, and adrenocorticotropic (ACTH)-secreting adenomas are responsible for Cushing's disease.

Pituitary adenoma can also present as an emergency. Pituitary apoplexy - an acute haemorrhage or infarction of the pituitary gland usually in the presence of a pituitary tumour, can present with sudden onset of severe headache, rapid deterioration in visual acuity and even altered mental state. This is considered a neurosurgical emergency and the patient will require immediate decompression to salvage the vision.

Except for prolactinomas, in which the treatment of choice is typically a dopamine agonist, the first line of management of virtually all symptomatic pituitary adenomas is surgery. Naturally, for most patients, the thought of having to undergo brain surgery can be daunting as it conjures the image of large head scars or having parts of the skull removed. However, with recent innovations in surgical techniques, patients can achieve complete resection of pituitary adenomas without facial incision or prolonged hospitalisation, and ultimately return to their normal, active life.

While the role of the neurosurgeon is obvious, where does the otolaryngologist come in?

Earlier method of approaching the skull base

In the past, pituitary adenomas were excised via the transcranial route - hence the need for craniotomy and brain retraction which can result in significant morbidity. A much more direct way of access to the pituitary tumour is via the sphenoid sinus. Thus the trans-septal trans-sphenoidal approach was conceptualised, whereby the neurosurgeon enters the sella via the nasal septum and sphenoid sinus using a speculum (a funnel-shaped device) and operating microscope. This method has been the workhorse for most neurosurgeons in the past few decades.

While this is significantly less invasive than the transcranial method, the amount of exposure it offered is often limited. The microscope and speculum gives a tunnel vision of the brain - much like looking through the keyhole of a door (Figure 3). In addition, the funnel shape of the speculum limits the range of movement of surgical instruments. Therefore large tumours, especially those with significant lateral or suprasellar extension, are unlikely to achieve complete resection. Patients often require adjuvant gamma-knife therapy for residual tumours.

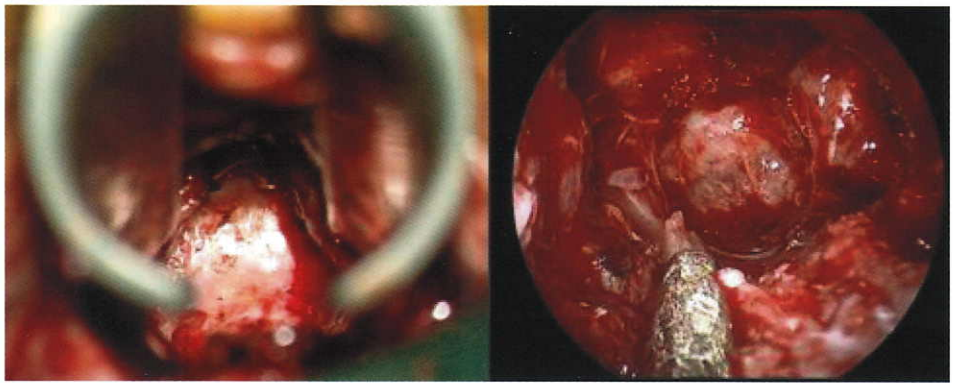

Figure 3: The picture on the left shows the 'keyhole' view via a microscope in the transeptal transsphenoidal approach. In contrast, the picture on the right is the panoramic view offered by the endoscope in the endoscopic transsphenoidal approach.

Endonasal endoscopic pituitary surgery - minimally-invasive surgery

Later on, it was the introduction of rigid endoscopes in sinus surgery performed by the otolaryngologists that hinted at its potential role in pituitary surgery. The endoscope provides distal illumination, enhanced magnification and panoramic (i.e. expanded) views of the sphenoid sinus. This means that while the microscope offers a telescopic view of the operative field, the endoscope brings the surgeon's eye right next to the area of interest instead (Figure 3).

The endonasal endoscopic approach to pituitary tumours was thus popularised and refined over the years with the help of highly-specialised equipment. Currently, each endoscopic pituitary surgery uses high-definition endoscopic cameras and video monitors for magnified, detailed views of the surgical field. Angled 30 degree and 45 degree endoscopes allow visualisation of hidden corners of the skull base. Computer-assisted navigation or image-guided surgery (akin to global positioning satellite (GPS)), provides intra-operative real-time feedback of the location of a surgical instrument based on a MRI scan performed preoperatively. From the days of "maximally invasive" transcranial surgery, complete resection of most pituitary adenomas, including those previously considered inoperable or hard to reach, can now be achieved in a truly minimally-invasive but yet maximal exposure method. In short, the endoscopic endonasal approach has revolutionised the field of skull base surgery.

How is endonasal endoscopic pituitary surgery performed?

The surgery is accomplished by a skull base team comprising a neurosurgeon and otolaryngologist specialised in endoscopic skull base surgery. The otolaryngologist starts the surgery by creating a wide intra-nasal surgical corridor which allows placement of the endoscope and up to three other instruments through both nostrils, thus eliminating the need for facial incisions. A free mucosal graft or vascularised flap (usually from the nasal septum, also known as the nasoseptal flap) is harvested, and the sphenoid sinuses open and widen to expose the sella floor. The

resection of the pituitary adenoma is then carried out by both surgeons working simultaneously using a "2-surgeon, 4-hand" technique, in which the neurosurgeon performs the dissection bi-manually, and the otolaryngologist provides dynamic visualisation (Figure 4). After the resection, the otolaryngologist repairs the resultant defect with the earlier harvested graft or flap.

Figure 4: A routine endoscopic transsphenoidal surgery of a pituitary tumour case involving both authors using a 2-surgeon 4-hand technique.

In Mr Ng's case, complete resection was achieved by this technique. By the first postoperative day, he had noticed some improvement in his vision. He was discharged well from hospital about one week after his operation. By the eighth week, he had recovered his vision fully (Figure 1) and was back at work. His surveillance MRI scan 12 months after surgery showed that he remains disease-free (Figure 2).

Limitations

Tumours that extend lateral to the internal carotid artery (within the lateral cavernous sinus) are not amenable to endoscopic, microscope transseptal or even transcranial resection, as there is a high risk of oculomotor, trochlear and abducens nerve injuries during manipulation of the tumour in this area. In such cases, gamma knife therapy may be the only suitable option to obtain control of the tumour.

While not a limitation per se, there is clearly a learning curve involved in this technique, as with any new surgical approach. Neurosurgeons, by virtue of their training, are more accustomed to using the microscope as well as the binocular vision it provides, in contrast to the endoscopic view and its lack of depth perception. The skull base otolaryngologist, while skilled with the endoscope, is less familiar with the intracranial anatomy. Thus a comfortable cooperation between both surgeons is crucial.

Complications

While pituitary surgery has its usual predictable risks, such as bleeding, cerebrospinal fluid leak, meningitis, hypopituitarism, diabetes insipidus, injury to the optic and other cranial nerves, a novel approach can lead to complications not normally encountered in the traditional transcranial or trans-septal approaches. The creation of the nasal surgical corridor can cause minor complications such as bleeding, crusting, sinusitis or synechae. Hyposmia may also occur as a result of crusting though this is usually temporary and is resolved by the second to third month after regular nasal douching and toilet. By virtue of the fact that a more complete resection can be achieved with the increased exposure and better visualisation, there is always a potential risk of internal carotid artery injury, although this can potentially be avoided by early recognition of the vessel during exposure of the sphenoid sinus.

Conclusion

There is a paradigm shift in the operative approach for pituitary adenomas. The endoscopic approach is a minimally-invasive approach that offers excellent visualisation of the operative field with the ease of bi-manual dissection. This is achieved by a close partnership between the neurosurgeon, which has the expertise to extirpate the tumour, and the otolaryngologist with intimate knowledge of the endoscopic skull base anatomy to adequately expose the sella whilst minimising injury to nasal structures. For the patient, this translates to potentially complete resection of large, hard-to-reach or previously considered "inoperable" pituitary adenomas without the need for extensive or disfiguring external scars.

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Dr Ong Yew Kwang completed his ENT specialist training in 2008 and in 2009 spent a year doing a clinical fellowship in skull base surgery at the University of Pittsburgh Medical Centre in Philadelphia. Following his return, he joined the rhinology service at National University Hospital and helmed the endoscopic skull base service with Dr Sein Lwin from the Division of Neurosurgery. To date, he remains the only endoscopic skull base-trained otolaryngologist in Singapore.

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