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Case Report

Extended Endoscopic Endonasal Surgery Using Three-Dimensional Endoscopy in the Intra-Operative MRI Suite for Supra-Diaphragmatic Ectopic Pituitary Adenoma

Supra-Diyafragmatik Ektopik Hipofiz Adenomu için İntra-Operatif MRG Odasında Üç Boyutlu Endoskopi Kullanılarak Genişletilmiş Endoskopik Endonazal Cerrahi

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ABSTRACT

We describe a supra-diaphragmatic ectopic pituitary adenoma that was safely removed using the extended endoscopic endonasal approach, and discuss the value of three-dimensional (3D) endoscopy and intra-operative magnetic resonance imaging (MRI) to this type of procedure.

A 61-year-old-man with bitemporal hemianopsia was referred to our hospital, where MRI revealed an enhanced suprasellar tumor compressing the optic chiasma. The tumor extended on the planum sphenoidale and partially encased the right internal carotid artery. An endocrinological assessment indicated normal pituitary function. The extended endoscopic endonasal approach was taken using a 3D endoscope in the intra-operative MRI suite. The tumor was located above the diaphragma sellae and separated from the normal pituitary gland. The pathological findings indicated non-functioning pituitary adenoma and thus the tumor was diagnosed as a supra-diaphragmatic ectopic pituitary adenoma. Intra-operative MRI provided useful information to minimize dural opening and the supra-diaphragmatic ectopic pituitary adenoma was removed from the complex neurovascular structure via the extended endoscopic endonasal approach under 3D endoscopic guidance in the intra-operative suite. Safe and effective removal of a supra-diaphragmatic ectopic pituitary adenoma was accomplished via the extended endoscopic endonasal approach with visual information provided by 3D endoscopy and intra-operative MRI.

KEYWORDS: Chiasmatic cistern, Intraoperative MRI, Suprasellar tumor, Tuberculum sellae

ÖZ

Genişletilmiş endoskopik endonazal yaklaşım kullanılarak güvenli bir şekilde çıkartılan bir supra-diyafragmatik ektopik hipofiz adenomu tanımlanmakta ve bu tür işlemde üç boyutlu (3B) endoskopi ve intraoperatif manyetik rezonans görüntülemenin (MRG) değeri tartışılmaktadır.

Bitemporal hemianopsili, 61 yaşında bir erkek hasta hastanemize sevk edildi ve MRG'de optik kiazmayı sıkıştıran, kontrast tutan bir suprasellar tümör görüldü. Tümör, planum sfenoidale üzerine uzanmaktaydı ve sağ internal karotid arteri kısmen çevrelemişti. Endokrin değerlendirme normal pitüiter işlev gösterdi. İntraoperatif manyetik rezonans görüntüleme (MRG) odasında bir 3D endoskop kullanılarak genişletilmiş endoskopik endonazal yaklaşım gerçekleştirildi. Tümör diyafragma sella üzerinde bulunuyordu ve normal hipofiz bezinden ayrılmıştı. Patolojik bulgular işlev görmeyen bir hipofiz adenom düşündürüyordu ve tümöre bu şekilde bir supra-diyafragmatik ektopik hipofiz adenom tanısı konuldu. İntraoperatif MRG dural açıklığı minimuma indirmek için faydalı bilgiler sağladı ve supra-diyafragmatik ektopik hipofiz adenom intraoperatif MRG odasında 3B endoskopi kılavuzluğu altında genişletilmiş endoskopik endonazal yaklaşımla kompleks nörovasküler yapıdan çıkarıldı. Supra-diyafragmatik ektopik hipofiz adenomun güvenli ve etkin bir şekilde çıkarılması 3B endoskopi ve intraoperatif MRG tarafından sağlanan görsel bilgiler ve genişletilmiş endoskopik endonazal yaklaşım yoluyla gerçekleştirildi.

ANAHTAR SÖZCÜKLER: Kiazmatik sistern, İntraoperatif MRG, Suprasellar tümör, Tüberkulum sella

INTRODUCTION

The endoscopic endonasal approach to suprasellar lesions has been extended to provide a direct route through which to visualize the chiasmatic cistern without violating the optic nerves and brain parenchyma (1). This enables the resection of suprasellar tumors including craniopharyngioma, pituitary adenoma and tuberculum sellae meningioma (3, 4, 13). However, the endoscopic view lacks steric sense, and wide opening of the dura mater could result in postoperative cerebrospinal fluid leakage. Recent advances in modalities

can provide useful information to ensure safe operations. Intraoperative MR imaging (iMRI) manifests the degree of tumor removal during surgery (7, 9-11, 14) and three-dimensional (3D) endoscopy offers a steric view that allows the recognition of neurovascular structures around the parasellar area (16).

Here we describe a patient with an ectopic pituitary adenoma extending into the anterior skull base that was safely removed using the extended endoscopic endonasal approach, and discuss the value of 3D endoscopy and iMRI to this type of procedure.

CASE REPORT

A 61-year-old-man was referred to our department with a visual disturbance. A neurological examination revealed bitemporal hemianopsia and MR imaging revealed an enhanced suprasellar tumor compressing the optic chiasma (Figure 1A, B). The tumor extended anteriorly to the planum sphenoidale and partially encased the right internal carotid artery (Figure 1A, B). The pituitary gland was compressed inferiorly and the pituitary stalk was identified on the posterior surface of the tumor (Figure 1B). Endocrinological assessment indicated normal pituitary function (values with normal ranges): adrenocorticotrophic hormone (ACTH) 24.5 (9 - 40) pg/mL, cortisol 11.8 (3.0 - 15.2) µg/dL, thyroid-stimulating hormone (TSH) 1.31 (0.2 - 5.0) µIU/mL, free T3 3.65 (2.0 - 6.0) pg/mL, free T4 0.95 (0.7 - 2.1) µg/mL, growth hormone (GH) 0.2 (<0.42) ng/mL, prolactin (PRL) 6.2 (2.0 - 30) ng/mL, luteinizing hormone (LH) 2.6 (1.1 - 8.8) mIU/mL and follicle-stimulating hormone (FSH) 12.1 (1.8 - 3.6) mIU/mL. An ectopic pituitary adenoma and a tuberculum sellae meningioma were preoperatively suspected. The tumor was mainly localized in the chiasmatic cistern; thus, extended endoscopic endonasal surgery proceeded through the tuberculum sella. Tumor and suprasellar structures were recognized using a 5-mm, 0° - 30° 3D endoscope (Machida, Tokyo, Japan). The surgery proceeded in an operative MR suite (MRXO; the integration of MR, CT, X-ray and a high-end operating table) to evaluate the degree of tumor removal on the planum sphenoidale and around the right internal carotid artery. The endoscope was inserted into the right nostril and a pedicled septal mucosal flap was prepared. Anterior sphenoidectomy proceeded to allow a bilateral nostril approach and the posterior ethmoid sinus was partially opened. Thus, we exposed the tuberculum sellae, which is inferiorly encompassed by the sella turcica, superiorly by the planum sphenoidale and bilaterally by the optic canals. The tuberculum sellae and superior part of the sella turcica were drilled off and parallel transverse dural incisions were made above and below the anterior intercavernous sinus. The anterior intercavernous sinus was coagulated using a bipolar coagulator and sectioned. A soft tumor appeared after dural opening without attachment on the dura mater of the tuberculum sellae, and the pathological diagnosis was pituitary adenoma (Figure 2). The diaphragma sellae entirely separated the tumor from the normal pituitary gland. The tumor was debulked and then iMRI showed that the tumor extending on the planum sphenoidale was inferiorly mobilized and that a small amount of it wrapped around the right carotid artery (Figure 3A, B). The iMRI findings indicated that the tumor would be removable through the tuberculum sellae without opening the planum sphenoidale. The plane between the tumor and normal neurovascular structures

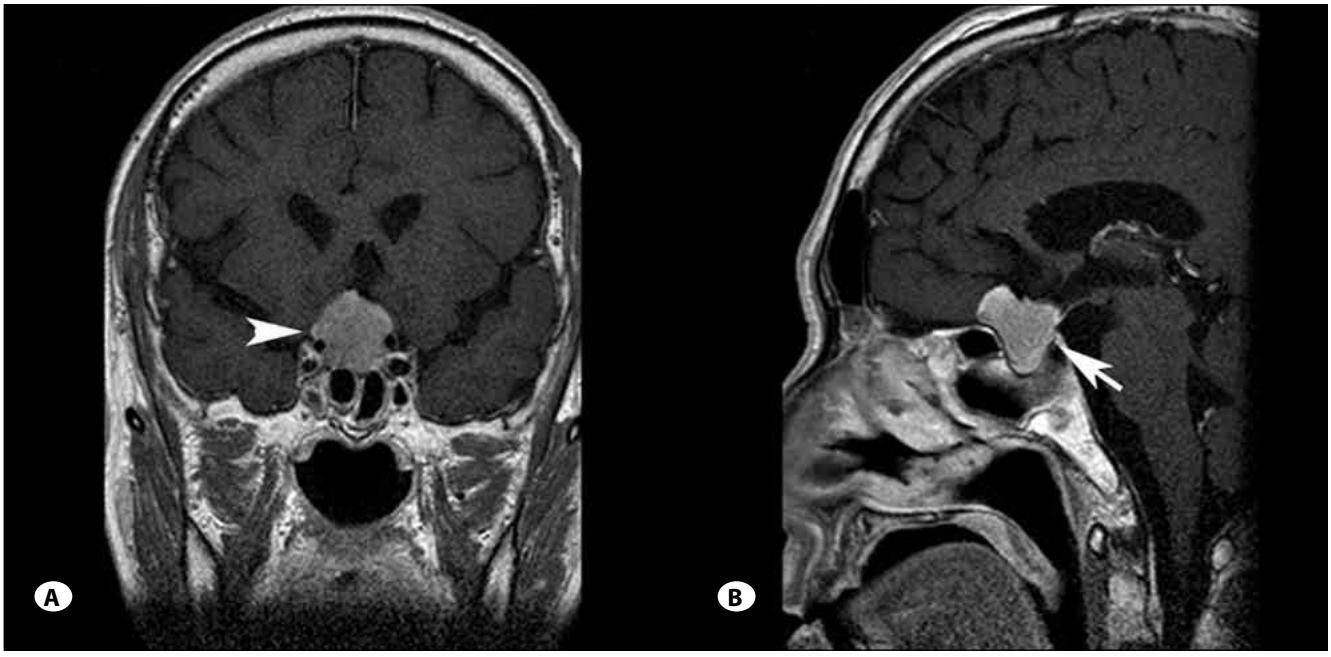

Figure 1: Preoperative MR images of suprasellar tumor compressing optic chiasma. **A)** Coronal and **B)** sagittal T_1-weighted gadolinium-enhanced images show that tumor extends to planum sphenoidale (b) and partially encases right internal carotid artery (arrow heads) (a). Pituitary gland is compressed inferiorly and pituitary stalk is located on posterior surface of tumor (arrow) (b).

was dissected in the subarachnoid space. The 3D endoscopic view facilitated steric visualization of the fine structures around the optic chiasma and pituitary stalk, and even behind corners (Figure 4A, B). Thus the tumor was removed while preserving the optic chiasma and pituitary stalk, and the optic chiasma was significantly decompressed (Figure 5A, B). The pseudo-capsule of the tumor around the right internal carotid artery was intentionally left behind to avoid damaging the perforators from the internal carotid artery. The skull base was reconstructed with the pedicled mucosal flap and fibrin glue, and then the pedicled flap was fixed with a sinus balloon. Spinal drainage was positioned for seven days. Cerebrospinal fluid did not leak and the postoperative course was uneventful. A full visual field was restored and postoperative MR imaging confirmed tumor removal and significant decompression of the optic chiasma.

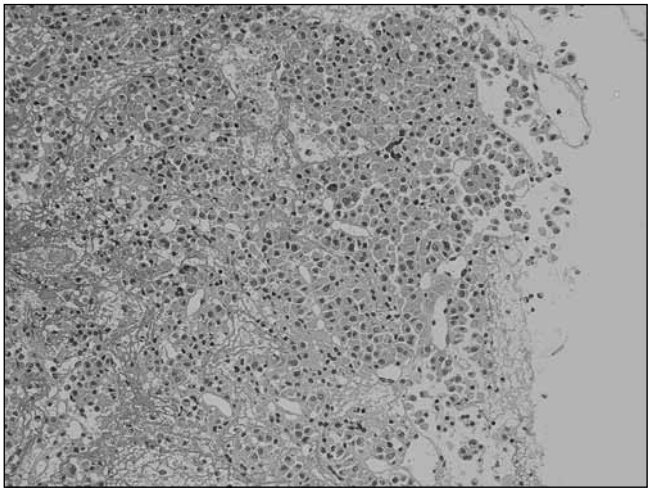

Figure 2: Tumor stained with hematoxylin and eosin. Pituitary adenoma has a sinusoidal pattern (original magnification ×100). Immunohistochemical staining is negative for anterior pituitary hormones.

DISCUSSION

Supra-diaphragmatic ectopic pituitary adenomas are thought to originate from the pars tuberalis or anterior pituitary cells in the leptomeninges of the peri-infundibular region (15). So far, 28 supra-diaphragmatic pituitary adenomas have been described in the literature, and transcranial or conventional trans-sphenoidal approaches have been taken (12). However, because of difficulties associated with reaching the supra-diaphragmatic area in the chiasmatic cistern to remove the tumors, secondary surgery has often been necessary (2, 5, 8). Kinoshita et al. reported the successful removal of a supra-diaphragmatic ectopic pituitary adenoma via the endonasal trans-tuberculum sellae approach with endoscopic assistance (12).

Recent advancements in endoscopic surgery have facilitated access to the midline skull base. Craniopharyngiomas and tuberculum sellae meningiomas arising in the chiasmatic cistern are considered ideal candidates for extended endoscopic endonasal surgery (3, 4, 13). Supra-diaphragmatic ectopic pituitary adenomas that arise from the same area, especially those localized in the pre-infundibular area without lateral extension beyond the internal carotid artery, would also be considered appropriate indications for extended endoscopic endonasal surgery.

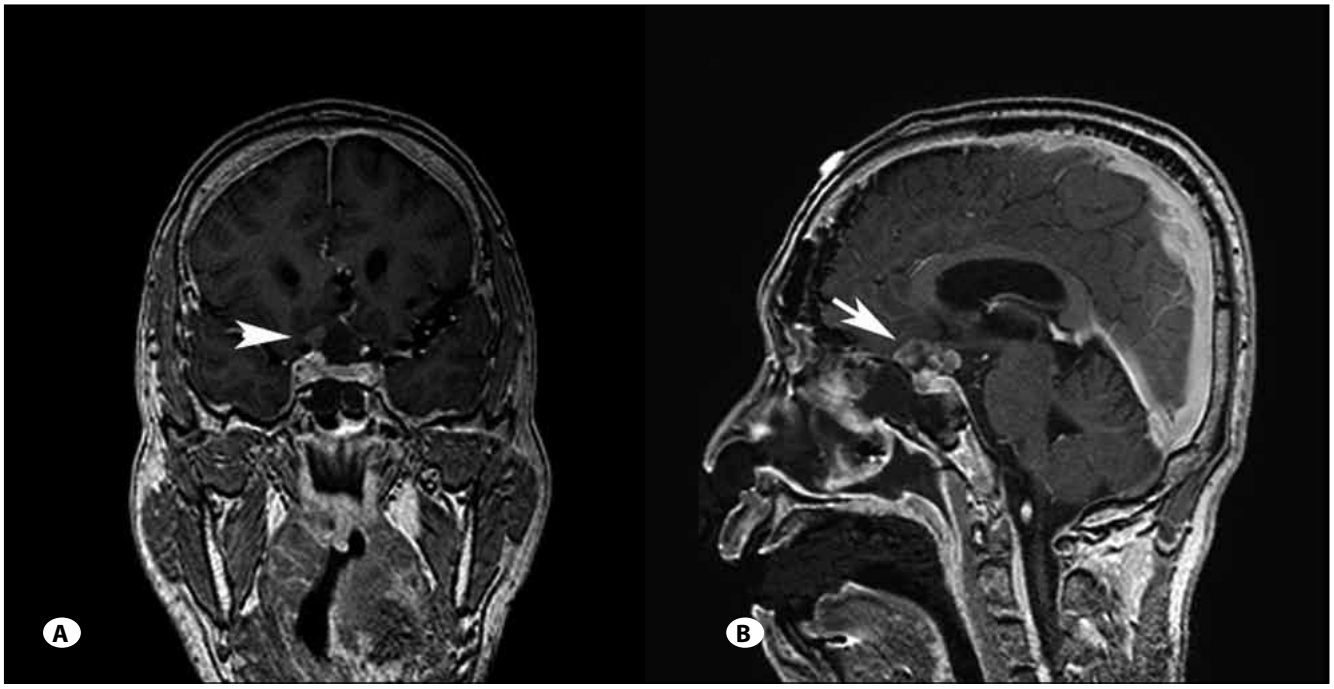

Figure 3: Coronal **(A)** and sagittal **(B)** T_1-weighted, gadolinium-enhanced intra-operative MRI images after tumor debulking. Tumor around right internal carotid artery remains (arrowhead) (a).Tumor extending to planum sphenoidale is mobilized (arrow) (b).

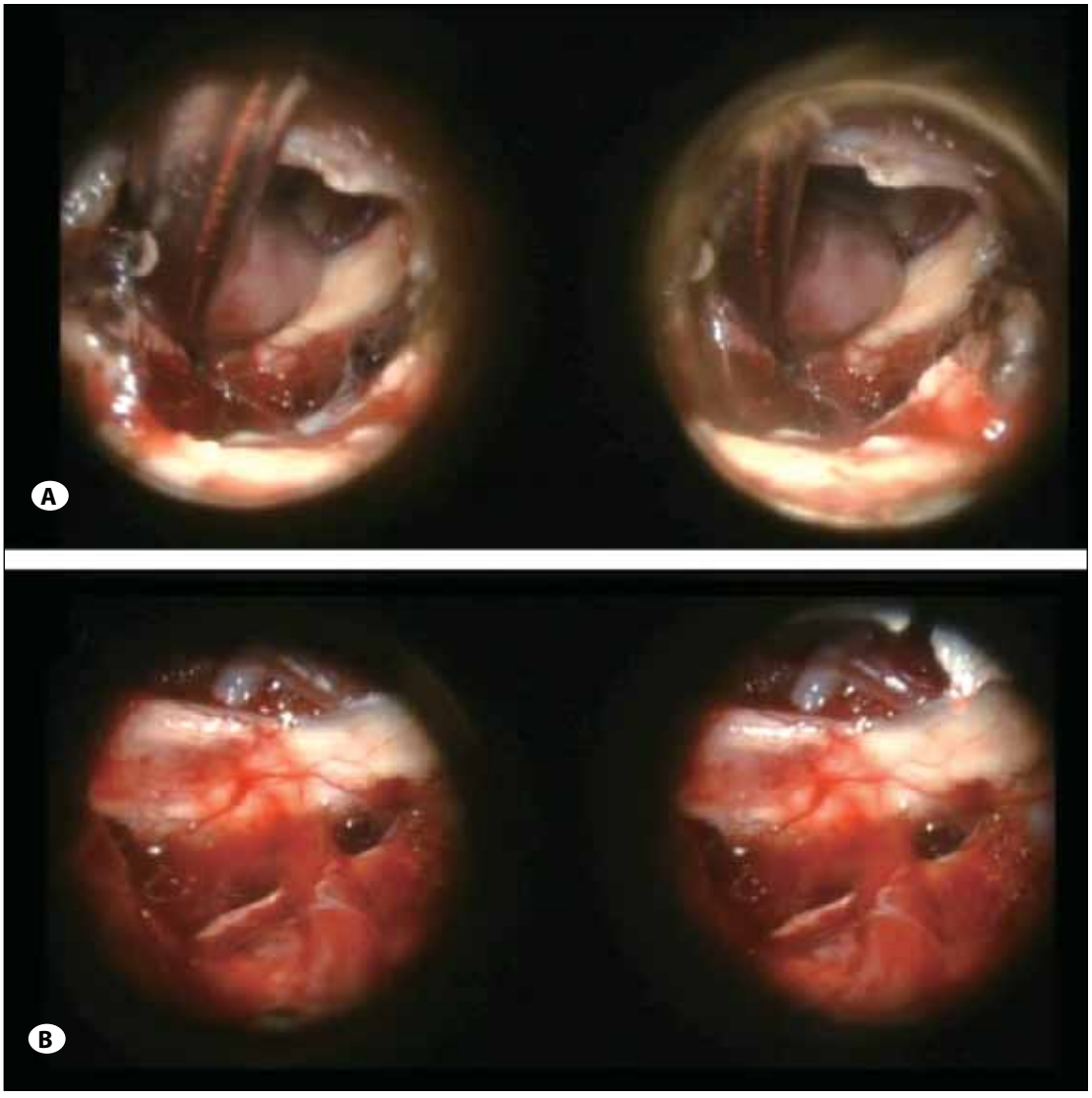

Figure 4: Three-dimensional endoscopic views during surgery **(A)** and after tumor removal **(B)**. Tumor, pituitary stalk and optic nerves are visualized with steric sense (a). Optic chiasm, pituitary stalk, and diaphragma sellae are recognizable (b).

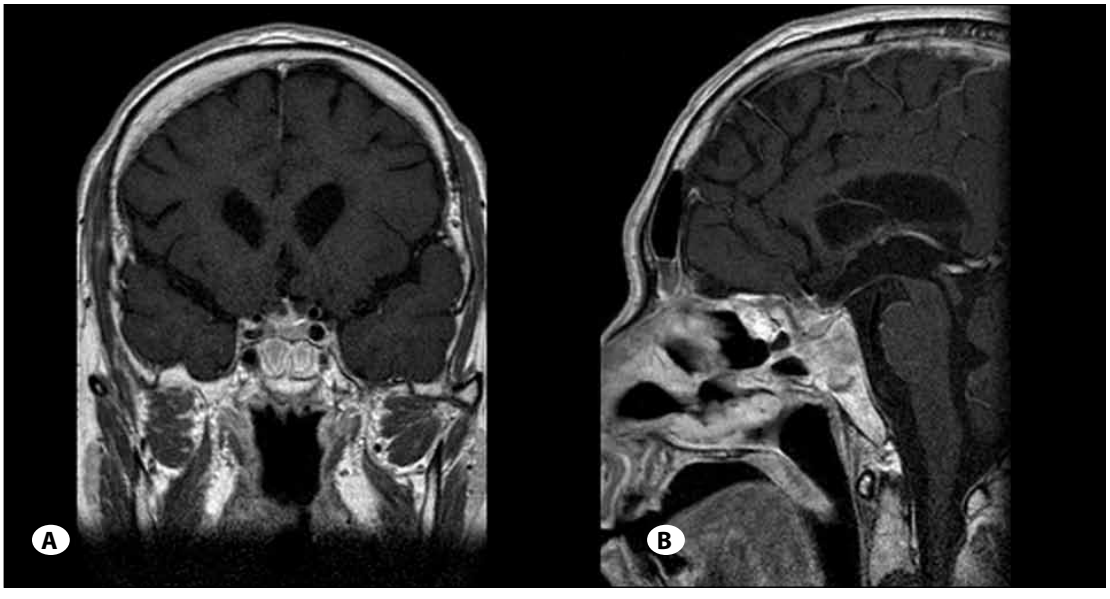

Figure 5: Postoperative coronal **(A)** and sagittal **(B)** T_1-weighted gadolinium-enhanced MR images. Tumor removal and significant optic chiasm decompression are confirmed.

Endoscopy is one modality through which to remove neoplasms with excellent visualization, as tumor borders and normal structures are clear and operators can see around corners even in deep and narrow corridors. However, the endoscopic view lacks steric sense, which a 3D endoscope can offer. Previous reports described the advantages of 3D endoscopic endonasal surgery (6, 16). Although complex structures such as the optic chiasm, pituitary stalk, internal carotid artery and perforators can be visualized in the suprasellar area via the trans-tuberculum sellar approach, applying 3D endoscopy to suprasellar surgery further facilitates understanding of the 3D forms of these structures. A reliable 3D view promoted safe manipulation for tumor removal.

We also use iMRI to enhance the safety and efficacy of endoscopic tumor removal. We debulked the tumor in this patient and then evaluated removal of the anterior tumor extension and the relationship between the internal carotid artery and the tumor during the surgery using iMRI. Had the tumor been a solid meningioma, additional bone removal and a dural incision of the planum sphenoidale would have been needed. A wider dural incision increases the risk of postoperative cerebrospinal fluid leakage. However, the tumor was a soft pituitary adenoma that extended to the anterior skull base and iMRI confirmed that it was posteriorly mobilized. Thus, the need for a dural incision and bone removal was minimized and the tumor was removed without opening the planum sphenoidale. Furthermore, the right internal carotid artery was partially encased by the tumor and prudent manipulation was required around the right carotid artery. However, iMRI accurately showed the location and relationship between the tumor and the internal carotid artery. Thus, the tumor around the internal carotid artery was safely removed without injuring vital structures. We believe that the iMRI evaluation contributed to the success of the surgical strategy and the excellent outcome.

In conclusion, safe and effective removal of a supra-diaphragmatic ectopic pituitary adenoma was accomplished via the extended endoscopic endonasal approach with visual information provided by 3D endoscopy and iMRI.

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