Endonasal endoscopic transsphenoidal chiasmectomy using a clival cranial base cranioplasty for visual loss from massive empty sella following macroprolactinoma treatment with bromocriptine: case report

G. Rene Alvarez Berastegui, MD,¹ Shaan M. Raza, MD,¹ Vijay K. Anand, MD,² and Theodore H. Schwartz, MD^{1,2,3}

Departments of ¹Neurosurgery, ²Otolaryngology, and ³Neuroscience, Weill Cornell Medical College, New York-Presbyterian Hospital, New York, New York

Visual deterioration after dopamine-agonist treatment of prolactinomas associated with empty sella syndrome and secondary optic apparatus traction is a rare event. Chiasmectomy has been described as a viable treatment option, although few cases exist in the literature. Here, a novel endonasal endoscopic approach to chiasmectomy is described and its efficacy is demonstrated in a case report.

A 55-year-old female patient with a history of a giant prolactinoma and 14 years of treatment using dopaminergic agonist therapy presented to our institution with a 1-month history of visual changes. Neuroophthalmological examination confirmed severe bitemporal field defects, and MRI revealed a large empty sella with downward optic chiasmal herniation. Endoscopic endonasal chiasmectomy was performed by elevating the chiasm with lumbar drainage and filling the clival and sellar defect with an extradural liquid (HydroSet; a cranioplasty bone cement), and a piece of AlloDerm was used to cover and cushion the chiasm. Postoperative imaging demonstrated successful anatomical elevation of the optic apparatus, and the patient showed functional improvement in the visual field at 3 months postoperatively.

Although rare, massive empty sellar and chiasmal descent from macroadenoma treatment can result in progressive visual loss. Here, a novel technique of endonasal endoscopic extradural cranioplasty aided by lumbar drainage is reported, which appears to be an effective technique for stabilizing and possibly reversing anatomical and visual deterioration.

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KEY WORDS bromocriptine; empty sella; endonasal; endoscopic; plasty; prolactinoma; transsphenoidal; chiasmectomy; pituitary surgery

THE term “empty sella turcica” was first coined by Busch in 1951² after examining 788 sellae of patients with no known pituitary disease. Colby and Kearns in 1962⁵ and then Lee and Adams in 1968¹⁶ described the term “empty sella syndrome” for patients with pituitary tumors who received treatment—either resection, radiation therapy, or both—and, at some time, subsequently presented with deterioration of their visual function that was suggestive of tumor recurrence, but no tumor was found when the sella was explored surgically. Currently, 2 types of empty sella syndrome are described in the literature: primary and secondary. The former was described

initially by Kaufman in 1968¹³ as a “distinct anatomical and radiographic entity” in patients with incompletely closed or wide-ring diaphragma sellae with the pituitary gland flattened to the bottom who presented with visual or endocrinological disturbances or spontaneous CSF rhinorrhea. Secondary empty sella syndrome refers to the same constellation of symptoms, but in patients who have been treated for sella turcica tumors. After the completion of medical, surgical, or radiation therapy, the imaging of this category of patients shows the descent of the optic nerves, chiasm, or even the posteromedial part of the frontal lobes into the tumor bed or “empty sella.”

ABBREVIATIONS ACoA = anterior communicating artery; CTA = CT angiography.

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The first reported case of visual decline while on dopamine-agonist therapy for a prolactinoma was a 35-year-old male patient whose medical therapy failed and was taken for transsphenoidal surgery that resulted in a dense postoperative bitemporal hemianopsia.¹⁸ Welch in 1971²⁵ first described the term “chiasmpexy” as a transcranial technique for untethering the optic nerve and anterior cerebral artery that were depressed into the sella by incising the diaphragma and inserting small pieces of silicone sponge beneath the optic nerve until it was restored to a more normal position. Seven months after the operation, preoperative visual loss was restored to normal.

There are only 3 reported cases of chiasmpexy for bromocriptine-treated macroprolactinoma, 2 of which were done through a craniotomy. The goals of chiasmpexy are either lysis of the adhesions between the optic chiasm and dura or elevation of the dura itself. The former requires a craniotomy, and the latter can be done through an extradural minimally invasive endonasal endoscopic approach. In this paper, we describe the latter technique, which utilizes a novel clival cranial base cranioplasty process, and discuss its advantages over previously reported techniques.

Case Report

History and Examination

A right-handed 55-year-old female patient with a history of a prolactinoma presented to our institution with a several-year history of visual deterioration, which had worsened over the past month and described as tunnel vision without issues of visual acuity or color perception. Her treatment history was notable for including the prior management of a giant macroprolactinoma diagnosed 14 years earlier that was treated with 5 mg of bromocriptine daily, resulting in massive shrinkage in the tumor. Her computerized visual fields showed a bitemporal hemianopsia (Fig. 1). Her preoperative prolactin levels were 10.2 ng/ml and had been stable for years and within the normal range. Her pretreatment MRI study was not available, but she was found to have a large empty sella with

downward herniation of the optic chiasm and the floor of the third ventricle (Fig. 2A–C). The distance between the vein of Galen-straight sinus confluence and the anterior communicating artery (ACoA) was 7.2 cm (Fig. 2C). Preoperative CT angiography (CTA) showed that the entire clivus had been eroded by the tumor, which was not gone, leaving minimal bone with which to buttress any sort of chiasmpexy graft (Fig. 2A).

Operative Plan

The decision was made to perform an extradural elevation of the chiasm through an endonasal endoscopic approach and to rebuild the clivus using HydroSet liquid bone cement cranioplasty to facilitate chiasmal elevation. To avoid pushing on the chiasm, the chiasm and dura would be elevated with intraoperative lumbar drainage of the CSF.

Operative Technique

After anesthesia induction, a lumbar drain was placed which softened the encephalocele and aided in its reduction. We administered 0.25 ml of 10% fluorescein (AK-Fluor, AKORN) with 10 ml of CSF via the lumbar drain to assist in the intraoperative identification of CSF leaks.^{20,23} Once in rigid head fixation, the patient was registered with frameless stereotactic equipment to preoperatively perform CTA with contrast. Under endoscopic visualization using a 0°, 18-cm-long, 4-mm-diameter rigid endoscope (Karl Storz), the middle and superior turbinates were gently lateralized to expose the natural ostium of the sphenoid sinus. A nasoseptal flap was harvested for skull base closure at the end of the procedure in case of CSF leakage. The sphenoid sinus and posterior ethmoid air cells were opened widely. Upon entry into the sphenoid, the encephalocele was readily visualized. Careful extradural dissection was performed to expose the entire encephalocele from the planum down to the floor of the clivus (Fig. 3A). The lumbar drain was opened, and 40 ml was removed with gentle pressure on the dura and meningocele using a cottonoid patty to elevate the chiasm. Once the encephalocele was adequately reduced, AlloDerm (LifeCell Corp.)

FIG. 1. A: Preoperative visual fields showing bitemporal hemianopsia. B: Postoperative visual fields showing improvement in the nasal and inferior temporal fields and stability in the superior temporal fields.

FIG. 2. A–C: Preoperative images. Sagittal CT angiogram (A), coronal T2-weighted MR image (B), and sagittal T1-weighted MR image with contrast (C) showing an arachnoid encephalocele occupying an enlarged empty sella with descent of the optic nerves and ACoA. D–F: Postoperative images. Sagittal CT angiogram (D) showing the skull base cranioplasty. Coronal T2-weighted MR image (E) and sagittal T1-weighted MR image with contrast (F) showing the corrected skull base defect and the return of the chiasm to a better position.

was placed in the epidural space to buttress the dural sac. This was then supported by a rigid construct consisting of the HydroSet injectable bone substitute (Stryker Leibinger GmbH & Co. KG) that was placed into the clival defect and sphenoid sinus (Fig. 3B and C). The plasty material hardened quickly and was immobile. This was covered with a vascularized nasoseptal flap followed by a final layer of DuraSeal (Covidien) to keep the flap in place (Fig. 3D). Floseal (Baxter) was then placed in the sphenoid and ethmoid sinuses for hemostasis, followed by Telfa nasal splints that were removed on postoperative Day 1, which served to decrease nasal discharge overnight. The lumbar

drain was left open for 24 hours at 5 ml/hour and then removed the night after surgery.

Visual and Radiological Outcomes

The patient had a good postoperative recovery and went home after 3 days. Eight months later at the evaluation at the clinic, she reported subjective improvement in her visual function. The computerized visual fields showed improvement of the nasal and inferior temporal fields and stability in the superior temporal fields (Fig. 1B). Her last brain MRI study revealed an adequate elevation of the sellar contents, including the optic nerves, and the ACoA to a normal position. The distance between the vein of Galen-straight sinus confluence and ACoA moved from 7.2 cm preoperatively to 5.6 cm postoperatively, showing a 1.6-cm elevation of the optic chiasm (Fig. 2C and F).

Discussion

Since Moster's¹⁸ first description in 1985 of delayed visual loss after dopamine agonist treatment for prolactinoma, 17 cases have been described (Table 1). Of these, only 3 were treated with surgical management. In the remaining patients, the dose of the dopamine agonist was either decreased or completely discontinued, resulting in variable improvement in vision in some patients and several instances of tumor regrowth.^{8,21} Four years after Moster's paper, Kaufman et al.¹⁴ specifically referred to chiasmepexy as a therapeutic option.

The etiology of delayed visual deterioration following bromocriptine therapy for empty sella syndrome has not been elucidated. Chiasmal herniation into a secondary empty sella in association with perineural scar tissue has been hypothesized to compromise chiasmal perfusion, but many reports show normal visual status in patients with intrasellar encephaloceles; therefore, no clear correlation

FIG. 3. Intraoperative findings. A: Exposition of sellar and clival arachnoid encephalocele. B: AlloDerm was placed over the optic chiasm. C: Sella packing with HydroSet (injectable bone substitute). D: Vascularized nasoseptal flap covering the corrected skull base defect, which is covering the HydroSet, with vascularized mucosa.

TABLE 1. Cases of delayed visual loss after dopamine-agonist treatment for prolactinoma

Authors & Year	No. of Cases	Age (yrs)/ Sex	Bromocriptine	Cabergoline	Pergolide	Time From Initiation of Therapy to Secondary Visual Loss		Treatment	Visual Outcome, Time to Final Result of Treatment
							Visual Loss		
Moster et al., 1985	1	35/M	Yes	No	No	11 mos	Transsphenoidal hypophysectomy	Worse, postop immediately	
Kaufman et al., 1989	1	56/M	Yes	No	No	NDR	NDR	NDR	
Taxel et al., 1996	1	64/F	Yes	No	No	8 mos	Decrease dose	Improved to normal, 4 mos	
Jones et al., 2000	7	48/M	Yes	No	No	12 mos	Decrease dose	Improved to normal, 2 wks	
		42/M	Yes	No	No	5 mos	Decrease dose	Improved to normal, NDR	
		35/M	Yes	No	No	4 mos	Decrease dose	NDR	
		63/M	Yes	No	No	6 mos	Decrease dose	NDR	
		21/F	Yes	No	No	10 yrs	Decrease dose	NDR	
		50/M	Yes	No	No	2 yrs	Decrease dose	NDR	
		49/M	No	Yes	No	10 mos	Decrease dose	NDR	
Chuman et al., 2002	1	64/F	No	No	Yes	7 mos	Decrease dose	Improved to normal, 12 mos	
Raverot et al., 2009	3	64/M	No	Yes	No	Immediate	Withdrawal, later replaced by bromocriptine	Improved to normal, 2 mos	
		30/M	No	Yes	No	4 yrs	Withdrawal 9 mos, then decrease dose	"Significant improvement," 1 yr	
		57/M	No	Yes	No	2.5 yrs	Withdrawal, then decrease dose	"Returned to a mild residual peripheral temporal defect," 4 mos	
Dhanwal & Sharma, 2011	1	36/M	No	Yes	No	6 mos	Decrease dose	"Marginal improvement," NDR	
Gkekak et al., 2013	1	NDR	NDR	NDR	NDR	3 yrs	Transglabellar resection of tumor & untethering of optic nerve & ACoA	"Left eye visual function substantially improved," NDR	
Present study, 2014	1	55/F	Yes	No	No	14 yrs	Endoscopic transsphenoidal chiasmectomy	Improvement of visual function	
Total to present	17								

NDR = no data recorded.

TABLE 2. Reported cases of chiasmepexy for secondary empty sella treatment

Authors & Year	No. of Cases	Age (yrs)/ Sex	Etiology of Empty Sella	Time From Initiation of Treatment to Secondary Visual Loss		Approach	Technique	Visual Outcome, Time to Final Result of Chiasmepexy
Welch & Stears, 1971	1	54/F	Transcranial pituitary adenoma resection & radiation	1 yr		Transcranial	Packing sella, silicone sponge	Improved to normal, 7 mos
Olson et al., 1972	2	44/M	Transsphenoidal pituitary adenoma resection	Immediate		Transcranial	Lysis of adhesions	Partially improved, NDR
		56/M	Radiation of pituitary adenoma	15 yrs		Transssphenoidal	Packing sella, fascia, muscle, bone plaques	Improved to normal, 6 wks
Decker & Carras, 1977	1	60/F	Transsphenoidal hypophysectomy for breast metastatic carcinoma	1 mo		Transssphenoidal	Lysis of adhesions, packing sella, fascia, bone strips	Partially improved, 1 mo
Scott et al., 1977	1	5/M	Optochiasmatic arachnoiditis, tuberculous meningitis	NDR		Transcranial	Lysis of adhesion	Partially improved, 1 mo
Fischer et al., 1994	1	22/M	Transsphenoidal Rathke's cleft cyst resection	1 mo & 20 days		Transcranial	Lysis of adhesion	Partially improved, 2 wks
Czech et al., 1999	3	24/M	Transcranial pituitary adenoma resection, octreotide	NDR		Transcranial	Lysis of adhesion	Improved to normal, NDR
		46/M	Transcranial pituitary adenoma resection, bromocriptine	NDR		Transcranial	Lysis of adhesion	Improved to normal, NDR
		31/F	Transcranial and transssphenoidal pituitary adenoma resection, bromocriptine, lisuride, quinagolide	NDR		Transcranial	Lysis of adhesion	Partially improved, NDR
Kubo et al., 2005	1	36/F	Postbromocriptine treatment of pituitary adenoma	2 yrs		Endoscopic trans-sphenoidal	Packing sella, silicone plate	Partially improved, 7 days
Gkekass et al., 2013	1	NDR	Postbromocriptine treatment of pituitary adenoma	3 yrs		Transcranial	Resection of tumor & untethering It optic nerve & ACoA	"Left eye visual function substantially improved," NDR
Present study, 2014	1	55/F	Postbromocriptine treatment of pituitary adenoma	14 yrs		Endoscopic trans-sphenoidal	Packing sella, AlloDerm & HydroSet	Improvement of visual function
Total to present	12							

has been identified between chiasmal intrasellar prolapse and visual impairment.^{1,21,24} Other proposed hypotheses include the possibility that the dopaminergic agonist causes direct toxicity, vasospasm-induced ischemia, or reversible perivascular fibrosis.^{4,12,21,24}

Until now there have been 11 cases of chiasmepexy for secondary empty sella reported in the literature and only 3 cases of postdopaminergic therapy for prolactinomas (Table 2). Of these, 2 cases had been treated transsphenoidally using a microscope and 1 with an endoscope (Table 2). The use of a cranioplasty material to reconstruct the clival defect has never been reported until this current case. In 1985, Moster reported a case of transsphenoidal hypophysectomy with poor postoperative visual outcome, which was possibly due to worsening empty sella and thus chiasm traction. Twenty years later, Kubo et al.¹⁵ described performing endoscopic transsphenoidal chiasmepexy in 2 patients, one with primary empty sella and the other with secondary empty sella caused by bromocriptine for the treatment of prolactinoma; visual function recovered in both patients. Finally, Gkekas et al.¹⁰ described a transglabellar approach in which “left eye visual function substantially improved.”

Chiasmepexy techniques are based on 2 principles: chiasm untethering⁹ and elevation of the sellar contents.^{11,19} The former, which requires lysis of the adhesions, requires a craniotomy and intradural exposure. The latter, on the other hand, can be done extradurally with sellar packing. The approach can be either transcranial or transsphenoidal, which must be decided based on the etiology of the chiasmal descent; however, the endonasal endoscopic approach offers many advantages, and the use of bone cement plasty is also theoretically advantageous.^{3,17} With regard to the need to lyse adhesions to elevate the chiasm, this can only really be done transcranially since the chiasm may adhere to the basal dura to which it is tethered. Rather than risk devascularizing the chiasm, it is more logical to elevate the dura along with the chiasm into a normal position in order to release the traction on the chiasm. This can be done through an extradural transsphenoidal approach, which reduces the risk of CSF leakage as well as the risk of ischemia to the chiasm.

With regard to the material used to elevate the chiasm, several options exist. The muscle and fascia are autologous, nonvascularized materials which can be reabsorbed, and thus the chiasm elevation would only be temporary. Moreover, in some cases, delayed necrosis and adhesion formation have been reported.⁷ Bone and cartilage are good choices because they are rigid and not as susceptible to reabsorption, but these are not always available and difficult to conform into exactly the correct size and shape. Since 1971, synthetic materials such as silicone sponge,²⁵ silicone plates,¹⁵ and silastic coils²⁶ have been described that are softer and more malleable. However, these materials require a buttress on which to rest, such as a residual clivus or other rigid component of the skull base. In our case, there was so much eroded bone that the clivus needed to be rebuilt, and we essentially tried to fill the clival defect with bone cement to make sure that it held up the encephalocele adequately and was in contact with the residual bone of the clivus. Depending on the amount

of erosion of the bone, the amount of cement will differ between patients. Finally, we placed a soft layer of AlloDerm between the chiasm and the plasty material to soften the pressure on the chiasm, buffer intracranial pulsations, and prevent any exothermic reaction of the plasty material from creating a thermal injury to the chiasm. The results speak for the efficacy of the technique.

Although rare, visual apparatus herniation into an empty sella can cause visual deterioration that is sometimes associated with the medical therapy for macroprolactinomas. Here, we have described a new extradural minimally invasive approach that uses endonasal endoscopic clival cranial base plasty, AlloDerm, and lumbar drainage.

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Author Contributions

Conception and design: all authors. Acquisition of data: all authors. Analysis and interpretation of data: all authors. Drafting the article: all authors. Approved the final version of the manuscript on behalf of all authors: Schwartz. Administrative/technical/material support: Schwartz. Study supervision: Anand.

Correspondence

Theodore H. Schwartz, Department of Neurological Surgery, NewYork-Presbyterian Hospital, Weill Medical College of Cornell University, 525 East 68th St., Box #99, New York, NY 10065. email: schwarh@med.cornell.edu.