Neurosurgical Forum
LETTERS TO THE EDITOR

Surgical strategy for craniopharyngiomas and the tumor-infundibulum relationship

TO THE EDITOR: The December 2016 edition of *Neurosurgical Focus* highlights the challenges in managing craniopharyngiomas and exemplifies the complexity and variability of the treatment strategies of these tumors based on the location, size, tumor consistency, and patient's symptoms. We read with interest the article by Morisako et al.² (Morisako H, Goto T, Goto H, et al: Aggressive surgery based on an anatomical subclassification of craniopharyngiomas. *Neurosurg Focus* 41[6]:E10, December 2016).

The resection of craniopharyngiomas has a high morbidity risk due to their relationship with the hypothalamus, pituitary gland/stalk, and surrounding neurovascular structures. Hence, selection of the surgical approach is controversial and most of the available literature in this subject is based on the surgeon's preference and experience rather than an unbiased choice based on anatomical relationships.

In the paper published by Morisako et al.,² the authors proposed a new subclassification of craniopharyngiomas that would guide the surgical approach selection. Their classification was based on the anatomical location, growth pattern, and origin of the tumor. The authors defined 4 groups: the intrasellar, prechiasmatic, retrochiasmatic, and intra-third ventricle. For the intrasellar type of craniopharyngioma, an endoscopic or microscopic transsphenoidal approach was applied. For the prechiasmatic type without lateral extension, the extended transsphenoidal approach was chosen, whereas the orbitozygomatic approach was used for the prechiasmatic type with lateral extension. For the small retrochiasmatic lesion type without extensive calcification, the orbitozygomatic approach was chosen, and the mini-transpetrosal approach was used for the retrochiasmatic type with extensive calcification or a large diameter (> 30 mm). For the intra-third ventricle type, the interhemispheric translamina terminalis approach was used as the surgical corridor. In support of their strategy, the authors showed their surgical results in a series of 72 patients.

The authors should be commended for their great results and illustrative article. In fact, we share similar thoughts and principles on the way in which craniopharyngiomas distort the normal anatomy. However, we believe that the

expanded endoscopic endonasal approach (EEA) has a bigger role than was stated in their article.

A similar classification discussing the approach selection based on the tumor relationship to the infundibulum was published in 2008.¹ Craniopharyngiomas were divided into 4 categories: preinfundibular (Type I), transinfundibular (Type II), retroinfundibular (Type III), and isolated third ventricular or optic recess tumors (Type IV). Type III was further subdivided into IIIa (extending into the third ventricle) and IIIb (extending into the interpeduncular cistern). Despite being cited thereafter by almost all articles discussing approaches for craniopharyngiomas, Kassam et al. was not cited in the recent work by Morisako et al.²

In 2008, the expanded EEA was emerging as a surgical alternative for the treatment of ventral skull base tumors, and it was not widely accepted. Over the past 9 years, the advantages of this approach were supported by surgical results data and the technique became standard for some types of craniopharyngiomas. As the EEA technique evolved, we also refined our surgical strategy to manage craniopharyngiomas.

First, our initial classification did not contemplate the intrasellar tumors that are thought to account for 7%–17% of all craniopharyngiomas.³ We have begun referring to the intrasellar craniopharyngiomas as Type 0 (unpublished data). These tumors with their origin at the sella may have different relationships to the diaphragma sellae. They can be contained within a competent diaphragm expanding the sella and suprasellar space, or they can grow beyond the aperture of the diaphragma sellae and create a “snowman” appearance similar to giant adenomas. Regardless of their relationship to the diaphragma sellae and the extent of intracranial tumor, we still refer to them as Type 0 because of their intrasellar component and origin. Type 0 tumors, therefore, by definition should not involve the subarachnoid space. In terms of surgical treatment, these tumors are approached like a pituitary adenoma, and often a complete resection may be achieved without a CSF leak (Fig. 1A and F).

Second, a more aggressive transplanum/transtuberculum EEA used to be performed in the past. The exposure for Type I (preinfundibular) tumors (Fig. 1B and G) included the superior intercavernous sinus (SIS), its junction with the dura mater over the sella and the dura of the planum sphenoidale, without opening the sella dura. The exposure for Type II (transinfundibular) tumors (Fig. 1C and H) would also have included drilling of the sellar bone

FIG. 1. Preoperative (panels A–E) and postoperative (panels F–J) sagittal T1-weighted MR images with gadolinium contrast. **A:** Type 0 craniopharyngioma resected through an EEA. **B:** Type I craniopharyngioma resected through an EEA. **C:** Type II craniopharyngioma resected through an EEA. **D:** Type III craniopharyngioma resected through an EEA with pituitary transposition. **E:** Type IV craniopharyngioma resected through an interhemispheric transcallosal transchoroidal approach followed by an EEA. **F:** Type 0, postoperative image. **G:** Type I, postoperative image. **H:** Type II, postoperative image. **I:** Type III, postoperative image. **J:** Type IV, postoperative image.

and division of the SIS in addition to the exposure done for Type I tumors.

Currently, we perform a standardized transplanum/transsphenoid EEA (with minor variants) for craniopharyngiomas Types I and II. The approach consists in a focused bone removal of the tuberculum sellae and only the posterior part of the planum sphenoidale. There is no need to extend the planum sphenoidale bone opening anteriorly because the surgical corridor used is below the optic chiasm and above the pituitary gland. Bone drilling and removal of the medial opticocarotid recess is performed in all cases to maximize latero-lateral exposure and to facilitate maneuverability of surgical instruments and microsurgical dissection. Likewise, the rostrum and floor of the sella are always removed, providing better maneuverability of surgical instruments and an upward angle of visualization. The dura is opened at the tuberculum sellae region and at the sella, the SIS is divided, and the diaphragma sellae is opened posteriorly in the direction of the pituitary stalk. This maneuver frees the pituitary stalk and enables better mobilization of the tumor, pituitary stalk, and gland in craniopharyngioma Types I and/or II. If the tumor has a mild lateral extension or significant lateral extension of cystic component, the EEA may be used as the sole approach. If the tumor has a significant lateral extension of a solid component or large vessel encasement, the EEA may be used as a first approach in a multistage setting.

Third, we used to advocate for a full pituitary transposition to reach the interpeduncular cistern and resect Type III craniopharyngiomas (Fig. 1D and I). Currently, we treat Type IIIa tumors with an approach similar to what is done for Type I and II tumors; we work around or through the pituitary stalk. Preoperative pituitary hormone status plays a major part in the aggressiveness and manipulation of the pituitary stalk. When the tumor extends dorsally to the dorsum sellae (Type IIb), we opt for a hemi- or unilateral transposition of the pituitary gland, in order to pre-

serve its function, and a posterior clinoidectomy to reach the most caudal aspect of the interpeduncular cistern.

The surgical approach for Type IV tumors has not changed. The expanded EEA is not favorable for most of the third ventricle craniopharyngiomas because the surgical corridor between the optic chiasm and pituitary gland is usually narrowed. Type IV craniopharyngiomas tend to push the optic apparatus and infundibulum anteriorly and downward. Access to the third ventricle is better achieved via a subfrontal/interhemispheric translamina terminalis approach, transcallosal transchoroidal approach, or transventricular transforaminal approach. The expanded EEA is reserved as an adjunct approach in a multistage setting, for eventual residual tumor located caudally that may not be reached through the transcranial approaches mentioned above.

Morisako et al.² recommended in their article that the EEA should be performed only for intrasellar and prechiasmatic (without lateral extension) craniopharyngiomas. These are equivalent, in our classification, to Types 0 and I tumors. We respectfully disagree and believe that the EEA should be the main approach, and not the exception, in the surgical management of most craniopharyngiomas (Types 0, I, II, and III).

In Illustrative Case 3, Morisako et al.² chose an orbitozygomatic approach to resect a Type I craniopharyngioma. Although we agree that extensive lateral tumor extensions are better resected via a transcranial or combined EEA/transcranial approach, the lateral extension of this particular case could most likely be addressed through an EEA.

Morisako et al. also recommended an orbitozygomatic or an anterior petrosal approach (when calcifications are present or tumor diameter is > 30 mm) for “retrochiasmatic” craniopharyngiomas.¹ They classified as retrochiasmatic what we believe to be the distinct Type II and III tumors.

Despite being resected via a similar approach (the

EEA), the intraoperative strategies we have for these tumors are quite different. For transinfundibular (Type II) craniopharyngiomas, the goal is to sharply divide the pituitary stalk longitudinally and dissect the plane between the tumor and neural tissue inside the pituitary stalk. Retroinfundibular (Type III) craniopharyngiomas involve a more challenging surgical resection that may require dissection around or through the stalk (Type IIIa) or hemitransposition of the pituitary gland with posterior clinoidectomy (Type IIIb).

Except for Type IV tumors (Fig. 1E and J), all other craniopharyngiomas are essentially located below/inferior to the optic nerves and chiasm. Anatomically, the surgical corridor provided by the EEA has an incomparable exposure and tumor visualization without any manipulation of the optic apparatus. Consequently, as long as the surgeon is careful to identify and preserve the superior hypophyseal arteries early in the EEA, the optic nerves and chiasm are at low risk for injury.

In conclusion, we believe that assessing craniopharyngiomas based on the relationship of the tumor and infundibulum¹ provides more details of and insights into the pathological anatomy (including the expected displacement of the optic apparatus), facilitating surgical approach selection. We also believe that the expanded EEA provides a unique surgical corridor and anatomical visualization that is perfectly suited for the majority of craniopharyngiomas.

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References

1. Kassam AB, Gardner PA, Snyderman CH, Carrau RL, Mintz AH, Prevedello DM: Expanded endonasal approach, a fully endoscopic transnasal approach for the resection of midline suprasellar craniopharyngiomas: a new classification based on the infundibulum. *J Neurosurg* **108**:715–728, 2008
2. Morisako H, Goto T, Goto H, Bohoun CA, Tamrakar S, Ohata K: Aggressive surgery based on an anatomical subclassification of craniopharyngiomas. *Neurosurg Focus* **41**(6):E10, 2016
3. Wang KC, Kim SK, Choe G, Chi JG, Cho BK: Growth patterns of craniopharyngioma in children: role of the diaphragm sellae and its surgical implication. *Surg Neurol* **57**:25–33, 2002

Disclosures

Dr. Carrau is a paid consultant for Medtronic. Dr. Prevedello is a paid consultant for Medtronic, Codman, and Leica Microsystems, and he has received an honorarium from Leica Microsystems. He has an ownership interest in Elum, Soliton, and Three Rivers, and he receives royalties from KLS Martin. He also receives clinical or research support (includes equipment or material) from Storz.

Response

We read with great interest the letter from Drs. Beer-

Furlan et al. They clearly have significant experience in dealing with craniopharyngiomas. Due to the anatomical location of these tumors and proximity to critical neurovascular structures, including the hypothalamus and ophthalmological systems, resections of craniopharyngiomas are associated with either higher rates of mortality and recurrence, or with lower rates of radical resection. Thus, the basic treatment policy for craniopharyngioma is aggressive resection performed using various surgical approaches while preserving function in the patient, and additional treatment with radiation is considered for small areas of residual tumor or recurrences.

Craniopharyngiomas are epithelial tumors that are presumed to arise from the remnants of Rathke's pouch. Because craniopharyngiomas can occur from any part of the primitive craniopharyngeal duct, the relationship of the tumor to surrounding structures such as the optic chiasm, hypothalamus, anterior communicating artery, and pituitary gland differs on a case-by-case basis. Therefore, rather than sticking to one surgical approach, the best way to determine the optimal surgical procedure would be to base the approach on the specific tumor origin. As a result, we have created an anatomical subclassification of craniopharyngiomas that specifically takes into consideration the best surgical approach, and have reported the utility of our management approach. Of course, approach selection remains controversial, and most of the available literature in this subject is based on surgeon preferences and experience, rather than unbiased choices based principally on anatomical relationships, as Beer-Furlan et al. mentioned.

Kassam et al. reported a similar classification in a 2008 discussion of approach selection based on the tumor's relationship to the infundibulum. The scheme proposed by Kassam et al., however, was designed specifically in relation to degree of surgical difficulty for the resection of the tumors via an endonasal approach. We recommend selecting an endonasal approach for intrasellar and prechiasmatic tumors without lateral extension (Type 0 according to Prevedello et al.'s classification and Type I according to Kassam et al.'s classification), because resection of these tumors is relatively easy and safe for any neurosurgeon. On the other hand, acquisition of technical expertise is indispensable for resecting retrochiasmatic tumors (Type III according to Kassam et al.'s classification), and only expert endoscopic neurosurgeons can remove such tumors radically without causing complications. Our criteria for the selection of surgical approaches based on anatomical subclassifications can be available in any skull base center to safely achieve radical resection, even if no expert endoscopic neurosurgeons are present in the institution. Our results demonstrated the benefits of treating craniopharyngiomas by aggressive tumor resection, with determination of the correct surgical approach essential for achieving successful outcomes.

Our study retrospectively reviewed 72 cases of craniopharyngioma treated between January 2000 and December 2014. In the initial to middle phase of the study, high-definition endoscopy was unavailable, and indications for resection of skull base tumors via an endoscopic approach have recently enlarged with advances in surgical equipment and techniques. We are now using an extended EEA as a first approach for huge craniopharyngiomas with a

FIG. 1. Preoperative axial (**A and B**), coronal (**C**), and sagittal (**D**) enhanced T1-weighted MR images. A huge craniopharyngioma was detected in a 40-year-old man suffering from cognitive dysfunction and severe visual acuity loss.

FIG. 2. Postoperative axial (**A and B**), coronal (**C**), and sagittal (**D**) enhanced T1-weighted MR images showing extent of surgery via an extended EEA. The central part of the tumor was removed as a first surgery.

FIG. 3. Postoperative axial (**A and B**), coronal (**C**), and sagittal (**D**) enhanced T1-weighted MR images showing extent of surgery via a transcranial approach. Residual tumor was resected radically without any complication, and the patient's Karnofsky Performance Scale score was ultimately improved.

solid component and large vessel encasement, followed by a transcranial approach in multistage surgery (Figs. 1–3). Our policy for treating craniopharyngiomas is aggressive tumor resection. Although we have resected tumors using surgical approaches based on our anatomical subclassification, other surgical procedures achieving the same radical resection, improvement of neurological functions, and long-term tumor control will result in similar or better outcomes, even in cases involving difficult and complicated conditions.

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