Craniopharyngiomas of the Third Ventricle: Trans-Lamina Terminalis Approach

Giulio Maira, M.D., Carmelo Anile, M.D.,
Cesare Colosimo, M.D., Daniel Cabezas, M.D.

Institute of Neurosurgery (GM, CA, DC), Università Cattolica, Rome, and
Institute of Radiology (CC), Università degli Studi di Chieti, Chieti, Italy

OBJECTIVE: Craniopharyngiomas usually grow on the cisternal surface of the hypothalamic region; these tumors can also grow from the infundibulum or tuber cinereum on the floor of the third ventricle, developing exclusively into the third ventricle. The aim of the present work was to establish the usefulness of the pterional trans-lamina terminalis approach for the removal of these tumors.

METHODS: Eight patients who were surgically treated for craniopharyngiomas located exclusively within the third ventricle were considered. The initial symptoms were acute hydrocephalus in two cases, psychological disturbances in two, amenorrhea in two, headaches in one, and hypopituitarism in one. The diagnoses were established, in all cases except one, with magnetic resonance imaging. In all cases, the tumor completely filled the third ventricle.

RESULTS: Total removal of the lesion was achieved in seven cases. One patient underwent partial removal. In the immediate postoperative period, no major complications were observed. Five patients required replacement hormonal therapy. All patients returned to a normal life. Many months after surgery, two patients exhibited psychological disturbances and died, the first because of voluntary withdrawal of replacement therapy (12 mo after surgery) and the second because of a severe imbalance in body fluids and electrolytes, with a subsequent hyperosmolar coma (27 mo after surgery). Only one patient who underwent initial total removal experienced a small recurrence of the lesion (30 mo after surgery); after 3 years, the lesion exhibited unchanged size.

CONCLUSION: In our experience, the trans-lamina terminalis approach is a valid choice for the removal of purely intraventricular craniopharyngiomas. These tumors can be removed without significant sequelae related to the surgical approach. The proximity to the hypothalamus requires accurate neuroendocrine and electrolyte control in the postoperative period, in some cases even years after surgery. (Neurosurgery 47:857–865, 2000)

Key words: Craniopharyngiomas, Lamina terminalis, Pterional approach, Third ventricle

Suprasellar craniopharyngiomas (CRFs) frequently grow from remnants of Rathke's pouch, located on the cisternal surface of the hypothalamic region. They can secondarily involve the anterior third ventricle, with displacement or distraction of the floor (20, 35). However, these tumors can also grow from the infundibulum or tuber cinereum in the floor of the third ventricle, exclusively developing into the third ventricle (2, 16, 34, 40). Purely intraventricular CRFs are rare. To our knowledge, only 45 cases among adults and 27 cases among children have been reported (*Tables 1* and *2*). Tumors with "mainly intraventricular extension" (20) or "extending into the third ventricle" (8) were excluded from this analysis.

Purely intraventricular CRFs represented 11% of all CRFs in a personal series (27), Sipos and Vajda (36) observed an incidence of 0.7%, and Villani et al. (43) described CRFs as 5.9% of all intraventricular tumors. These tumors present peculiar surgical and clinical problems because of their deep localization and their relationship with hypothalamic structures. Many surgical approaches have been used for the removal of these tumors (*Table 3*).

Since 1978, we have operated on purely intraventricular CRFs via a pterional approach with opening of the lamina terminalis (LT), planning for radical surgical removal whenever possible. We report on our series of eight purely intraventricular CRFs that were surgically treated via this approach.

PATIENTS AND METHODS

Patients

Eight patients who were surgically treated for CRFs located exclusively within the third ventricle were considered (*Table 4*).

TABLE 1. Review of the Literature on Craniopharyngiomas of the Third Ventricle in Adults

Series (Ref. No.)	No. of Cases
Dobos et al., 1953 (11)	1
Cashion and Young, 1962 (5)	1
Cashion and Young, 1971 (6)	2
Long and Chou, 1973 (26)	4
Rush et al., 1975 (34)	1
Nanba and Tsuboi, 1977 (30)	1
Fitz et al., 1978 (12)	1
King, 1979 (17)	3
Asari et al., 1980 (2)	1
Kubota et al., 1980 (21)	1
Goldstein et al., 1983 (15)	1
Matthews, 1983 (28)	1
Bose et al., 1985 (3)	2
Carmel, 1985 (4)	2
Lanzieri et al., 1985 (24)	4
Kunishio et al., 1986 (22)	1
Kunishio et al., 1987 (23)	1
Urasaki et al., 1988 (40)	1
Linden et al., 1989 (25)	1
Fukushima et al., 1990 (14)	1
Iwasaki et al., 1992 (16)	2
Fujitsu et al., 1994 (13)	2
Maira et al., 1995 (27)	6
Sipos and Vajda, 1997 (36)	1
Villani et al., 1997 (43)	2
Urbach et al., 1998 (41)	1

TABLE 2. Review of the Literature on Craniopharyngiomas of the Third Ventricle in Infants

Series (Ref. No.)	No. of Cases
Van Den Bergh and Brucher, 1970 (42)	2
Long and Chou, 1973 (26)	2
King, 1979 (17)	1
Ravindram et al., 1980 (32)	1
Mori et al., 1980 (29)	4
Takahashi et al., 1985 (39)	3
Klein and Rath, 1989 (18)	3
Choux et al., 1991 (7)	11

They represent 11% of a surgical series of 72 CRFs that were primarily surgically treated by us between 1976 and 1997. Female patients were predominant (62.5%), and patient ages ranged from 17 to 51 years (mean, 34.5 yr). Follow-up periods varied from 4 to 21 years (mean, 12 yr). The initial symptoms were acute hydrocephalus in two cases, psychological disturbances in two cases, amenorrhea in two cases, headaches in one case, and hypopituitarism in one case.

Hormonal and imaging evaluations

Complete preoperative hormonal evaluations were performed for all patients. Four patients (50%) exhibited panhypopituitarism, two (25%) exhibited hyperprolactinemia, one (12.5%) exhibited an isolated impairment of gonadotropic functions, and one exhibited no hormonal deficits (12.5%).

The tumor diagnoses were established, in all cases except Case 1, by using magnetic resonance imaging. Magnetic resonance imaging indicated mass lesions that were entirely confined to the third ventricle and were homogeneously enhancing after gadolinium diethylenetriamine penta-acetic acid injection, without evidence of calcifications or cystic regions (*Figs. 1–4*). Magnetic resonance imaging was repeated each year during the follow-up period.

Surgical approach

In all cases, we used the pterional approach, which allows access to virtually all parts of the anterior cisterns. After careful inspection of the supra- and parasellar cisterns, removal of the tumor was performed by opening the LT between the optic tracts and behind the chiasm.

Clinical outcomes

The surgical outcome was considered to be good if the patient (even if requiring hormonal replacement therapy) resumed a normal life, being able to work or attend school without mnemonic, psychological, or hypothalamic disorders. The outcome was considered to be fair if the patient exhibited mild neurological or psychological problems after resuming a normal life. It was considered to be poor if the patient experienced severe neurological problems or compromised consciousness. Immediate postoperative and long-term hormonal evaluations were performed.

External radiotherapy

No patient received adjunctive external radiotherapy.

RESULTS

Surgical observations and results

For all patients, after opening of the LT, we observed a solid, compact, noncalcified mass, without oily or necrotic cysts. The tumor was attached to the anterior infundibular part of the wall of the third ventricle, whereas a clear dissection plane was present between the tumor and the posterior part of the ventricular wall. Total removal of the tumor was possible for seven patients (*Table 5*; *Figs. 1–4*). In one case, part of the tumor, extending toward the interpeduncular cistern, was left in place. In six patients (Patients 1, 3, 4, 5, 6, and 7) (*Tables 4* and *5*), the anterior floor of the ventricle was intact after removal of the tumor. In one patient who underwent total removal (Patient 8) (*Fig. 4*) and in the patient who underwent partial removal (Patient 2), the anterior ventricular floor was opened by the tumoral mass protruding into the interpeduncular cistern. In these patients, the interpeduncular cistern and the upper part of the basilar artery could be observed through the hole in the floor of the ventricle, corresponding to the tuber cinereum, after tumor removal.

TABLE 3. Surgical Approaches Used for the Removal of Purely Intraventricular Craniopharyngiomas[a]

Series (Ref. No.)	No. of Cases	Total Removal	Outcome
Transventricular approach			
Dobos et al., 1953 (11)	1	No	Died 15 d later
Rush et al., 1975 (34)	1	No	NR
Nanba and Tsuboi, 1977 (30)	1	No	Died 2 mo later
Kubota et al., 1980 (21)	1	No	Died after reoperation
Matthews, 1983 (28)	1	Yes	Good
Lanzieri et al., 1985 (24)	2	No	NR
Iwasaki et al., 1992 (16)	2	Yes	Good
Transcallosal approach			
Long and Chou, 1973 (26)	4	Yes	Good for 1
Asari et al., 1980 (2)	1	No	Died 4 mo later
Lanzieri et al., 1985 (24)	3	Yes for 2	NR
Kunishio et al., 1987 (23)	1	No	Died 5 mo later
Sipos and Vajda, 1997 (36)	1	Yes	Good
Villani et al., 1997 (43)	2	Yes	Good
Trans-lamina terminalis approach			
King, 1979 (17)	2	No	Good for 1
Goldstein et al., 1983 (15)	1	No	Good
Carmel, 1985 (4)	2	NR	NR
Urasaki et al., 1988 (40)	1	Yes	NR
Fukushima et al., 1990 (14)	1	Yes	Good
Fujitsu et al., 1994 (13)	2	Yes	Good
Maira et al., 1995 (27)	6	Yes for 5	Good for 5

[a] **NR, not reported.**

TABLE 4. Preoperative Data

Patient No.	Sex/Age (yr)	Initial Symptoms	Hormonal Findings	Year of Surgery
1	F/33	Amenorrhea	Increased prolactinemia	1978
2	F/45	Psychological disturbances	Panhypopituitarism	1981
3	F/17	Amenorrhea	Increased prolactinemia	1984
4	M/45	Headaches	No deficits	1984
5	F/25	Hypopituitarism	Panhypopituitarism	1989
6	M/28	Hydrocephalus	Panhypopituitarism	1990
7	F/51	Hydrocephalus	Gonadotropin dysfunction	1995
8	M/25	Psychological disturbances	Panhypopituitarism	1996

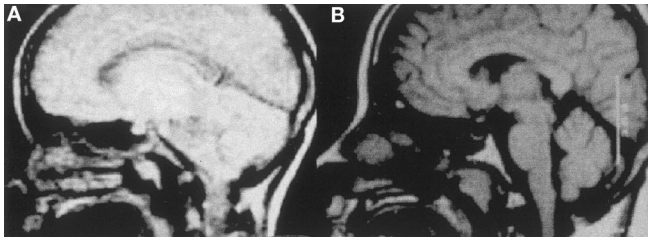

FIGURE 1. Patient 3, preoperative (*A*) and postoperative (*B*) magnetic resonance imaging scans. The preoperative sagittal magnetic resonance imaging scan demonstrated a mass lesion located exclusively within the third ventricle (*A*). Total removal of the lesion was observed (*B*).

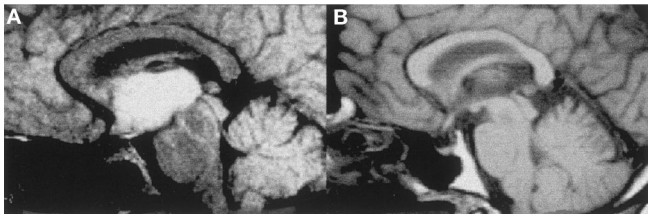

FIGURE 2. Patient 5, preoperative (*A*) and postoperative (*B*) sagittal magnetic resonance imaging scans. Total removal of the lesion was observed (*B*). The mass was almost homogeneously enhanced with gadolinium, and there was no evidence of calcification or cystic regions.

Clinical results

The postoperative period was uneventful and the clinical results were considered to be good for six of seven patients who underwent total removal. All of those patients returned to normal lives, with no mnemonic, psychological, or hypothalamic deficits. Patient 8 remained confused for 40 days after surgery. A severe imbalance of body fluids and electro-

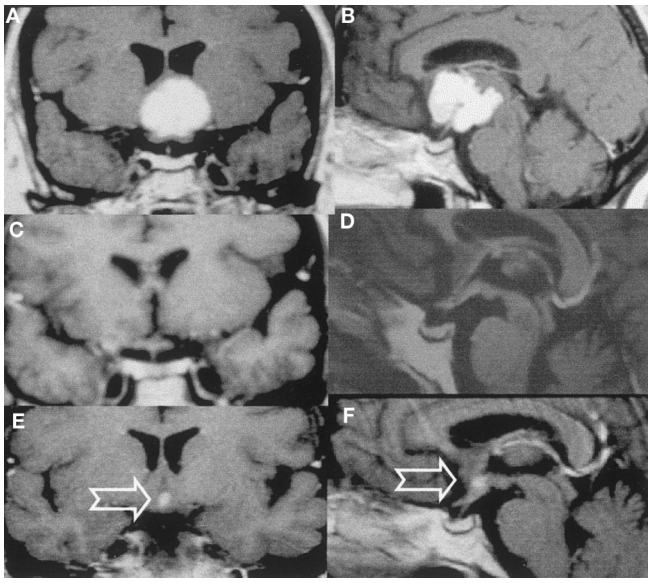

FIGURE 3. Patient 7, coronal and sagittal preoperative (*A* and *B*) and postoperative (*C–F*) magnetic resonance imaging scans. Total removal of the mass was achieved (*C* and *D*). Recurrence after 30 months of follow-up monitoring was observed (*E* and *F*, *arrows*). Hydrocephalus (resulting from occlusion of the foramen of Monro) present in the preoperative period improved after surgery.

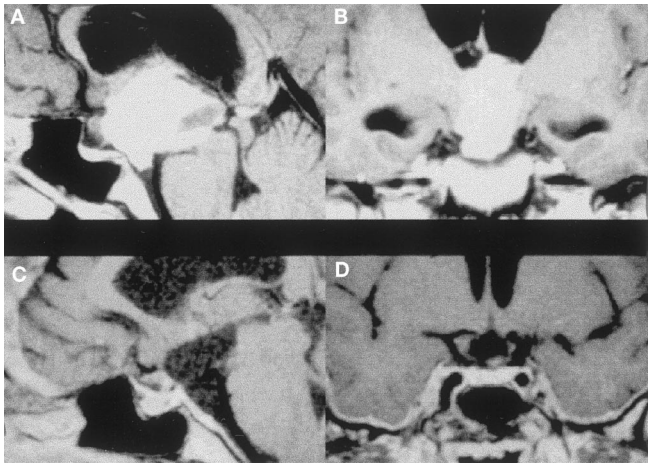

FIGURE 4. Patient 8, sagittal and coronal preoperative (*A* and *B*) and postoperative (*C* and *D*) magnetic resonance imaging scans. Total removal of the lesion can be observed. The third ventricle is almost virtual and is completely opened in the interpeduncular cistern.

lytes was present and required a long stay in the intensive care unit. The patient slowly improved until a normal life was resumed, but he required complete hormonal replacement therapy. Panhypopituitarism, coupled with diabetes insipidus and a defective thirst mechanism, resulted in periodic hypernatremia and serum hyperosmolarity. Preexisting mild psychological disturbances remained in the postoperative period, and the immediate surgical result was classified as fair. Twenty-seven months after surgery, the patient was hospitalized in another institution because of the appearance of severe hyperthermia and water overload, with an electrolyte imbalance, and then died, probably as a result of inappropriate treatment of hyperosmolarity.

The patient who underwent partial removal returned to a normal life, with persistence of the psychological disturbances and hypopituitarism that were present before surgery. Twelve months later, the patient died as a result of voluntary withdrawal from the replacement therapy. Visual functions were preserved for all patients.

Hormonal findings

The postoperative hormonal findings are reported in *Table 5*. Five patients required replacement hormonal therapy. Normal pituitary functions were restored for one patient (Patient 6). One patient (Patient 7) with a preoperative gonadotropic deficit resumed normal menses.

Recurrences

For one of the six surviving patients for whom total removal was achieved, we observed, 30 months after surgery, the appearance of localized hypothalamic enhancement, strongly indicating a small recurrence, which has not yet been surgically treated and which exhibits the same lesion size after 3 years of follow-up monitoring (*Fig. 3*).

Histopathological findings

Histopathological findings indicated a prevalence of the adamantinomatous type of CRFs (75%), compared with the papillary type (25%).

DISCUSSION

Purely intraventricular CRFs differ from the more common suprasellar infundibular CRFs with respect to clinical features, neuroradiological findings, and surgical approaches. These patients may exhibit signs of increased intracranial pressure, secondary to obstructive hydrocephalus, or evidence of hypothalamic or pituitary dysfunction. Visual field defects are rare (15) and were absent in our series. Magnetic resonance imaging demonstrated homogeneous masses that were entirely confined to the third ventricle and homogeneously enhanced with contrast material, without evidence of calcification or cystic lesions (*Figs. 1–4*).

CRFs of the third ventricle present a particular problem because of the difficulty of reaching them and the risk of producing damage to the optic pathways and the hypothalamus, which constitute the walls of the ventricular cavity. Various surgical approaches have been used for their removal (*Table 3*).

Searching for an approach that permitted us to reach the hypothalamus from a short distance and to remove the tumor with reduced risks of neurological damage, since 1978 we have chosen the pterional approach, with opening of the LT, for exposure of the tumor. The LT offers easy access to the inferior part of the third ventricle where the tumor is attached,

TABLE 5. Postoperative Data

Patient No.	Removal	Immediate Results	Hormonal Findings	Follow-up Period (mo)	Late Results	Recurrence
1	Total	Good	Panhypopituitarism	252	Good	No
2	Partial	Fair	Panhypopituitarism	12	Death	No
3	Total	Good	Panhypopituitarism	180	Good	No
4	Total	Good	Normal	180	Good	No
5	Total	Good	Panhypopituitarism	120	Good	No
6	Total	Good	Normal	108	Good	No
7	Total	Good	Normal	55	Good	Yes[a]
8	Total	Fair	Panhypopituitarism	27	Death	No

[a] **Thirty months after surgery, localized hypothalamic enhancement was observed; the lesion has not yet been surgically treated and is unchanged after 3 years of follow-up, monitoring.**

at the side of the tuber cinereum, and it is readily exposed by standard subfrontal or pterional approaches (13, 19, 33).

The LT is a soft, thin, white-matter structure located in the inferior part (two-thirds) of the anterior ventricular wall, between the optic tracts, proceeding from the anterior commissure to the posterior limit of the chiasm (*Fig. 5*). It is crossed by the anterior cerebral arteries and by the anterior communicating artery. The LT, which is often distended by the mass, must be incised anterior to the anterior communicating artery, to permit observation of the tumor and access to the third ventricle. It is important to distinguish the LT from the thinned-out medial border of the optic tract and from the posterior limit of the chiasm. The supraoptic nuclei and the columns of the fornix lie in the anterior wall of the hypothalamus just dorsal to the optic chiasm and just lateral to the LT. The organum vasculosum of the LT, which is implicated in body fluid homeostasis and reproduction, lies beneath the anterior commissure in the midline of the LT. The floor of the third ventricle is formed by the tuber cinereum. Damage to this region can result from excessive retraction or damage to perforating vessels originating from the anterior cerebral artery (31).

Both the pterional-transsylvian and subfrontal approaches provide exposure of the LT, through which the anteroinferior portion of the third ventricle can be accessed (19, 20, 31, 33). The trans-LT approach was first described by Stookey and Scarff (37) in 1936. They used this approach for the treatment of tumor-related hydrocephalus. Dandy (10) had earlier described an approach to the third ventricle in which the chiasm was divided. That approach was used by Cushing (9) in one case for evacuation of the contents of a pituitary adenoma, and Svien (38) mentioned its use for limited procedures, such as cyst drainage.

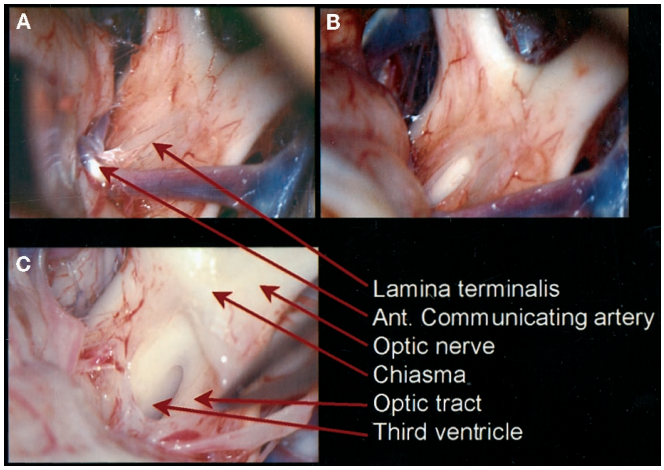

FIGURE 5. Anatomic features of structures surrounding the LT and a view into the third ventricle after its opening.

The use of the trans-LT approach was advocated for the removal of an intraventricular CRF by King (17) in 1979. Excluding our previously reported cases, nine patients who were surgically treated using this approach have been reported in the literature to date (*Table 3*).

In the literature, total removal of purely intraventricular CRFs was reported in 21 of 45 cases (46%) described. In only nine of these cases was a trans-LT approach used. The results of surgery were good in 77% of the cases (*Table 3*).

In our series, we always used a pterional approach with opening of the LT, aiming at total removal of the tumor because of an absence of adhesions to the ventricular walls. During surgery, the chiasm was usually observed to be forced toward the tuberculum sellae by the tumor, making it, in effect, prefixed. The incision of the LT was in the most anterior part of the ventricle, immediately posterior to the chiasm, and extended from one optic tract to the other (*Fig. 5*). After opening of the LT, the tumor was identified and dissected by the anterolateral neural structures, with care being taken to preserve the visual pathways and the hypothalamic structures. Distinguishing between tumor and normal tissue was not always easy but was facilitated by the differences in color (more white-yellow for the optic pathways and hypothalamus and more gray for the tumor) and by the fact that the tumors were not infiltrative. Internal decompression was afforded by smooth dissection, traction, and piecemeal removal. An ultrasonic aspirator could be successfully used. Accurate skillful use of angled pituitary curettes was important to remove the more posteriorly located tumor. Endoscopy could be very useful for observation of this part of the tumor. The tumoral mass was progressively reduced until it could be pulled through the small hole corresponding to the opening of the LT. Anatomic maintenance of the ventricular floor and walls and of the infundibulum was a major objective. The area of

attachment to the floor of the ventricle was recognized as a firm peduncle connected at a point just behind the chiasm. CRFs can sometimes open the posteroinferior part of the third ventricle, between the infundibulum and the mamillary bodies (the so-called tuber cinereum), and protrude into the retrochiasmatic cisterns. CRF removal is followed by direct observation of the basilar artery (*Fig. 6*). It is important to note that, among the patients in our series, the two patients who experienced the most severe postoperative symptoms and late death were those in whom the ventricular floor was completely opened by the tumor, which protruded in the interpeduncular cisterns. This anatomic condition probably indicates more severe hypothalamic damage by the tumor.

In our series, complete removal was achieved for seven patients (87.5% of cases). For one patient, part of the tumor, extending toward the interpeduncular cistern, was left in place. Good surgical outcomes were obtained for six patients, all of whom underwent total removal. The seventh patient who underwent total removal and the patient who underwent partial removal achieved surgical outcomes considered as fair.

In the postoperative period, particular care must be paid to the fluid balance charts and to the body temperature, the regulation of which may be disturbed by hypothalamic damage. Accurate and repeated evaluation of hormone and electrolyte levels is essential in the follow-up period, particularly for patients who exhibited severe hypothalamic imbalances after surgery. Diencephalic insufficiency, related to disruption of the hypothalamic nucleus, can appear months or even years after surgery if replacement therapy is not well established or if it is interrupted. Two of our patients died as a result of this late diencephalic insufficiency.

With the approach through the LT, a substantial risk to the optic nerves, optic chiasm, and optic tracts exists when removal of a large tumor is performed. All movements with surgical instruments and the surgical maneuvers of dissection must be performed with great care with respect to the optic structures. None of our patients exhibited visual problems after surgery.

Interestingly, like the previously described purely intraventricular CRFs (15, 27), all of our cases were solid tumors without calcifications, necrotic material, or oily cysts. The latter anatomic features, in contrast, were predominant in the intrasellar and infundibular varieties of CRFs (27).

In our series, we observed a high incidence of adamantinomatous CRFs (75%), in contrast to previous literature reports (1, 8). Adamantinomatous CRFs exhibit a recurrence rate of 13% in adults, are associated with a lower incidence of visual deficits, compared with the papillary type, and cause a high incidence of endocrine abnormalities. Adamantinomatous CRFs, as described by Adamson et al. (1), are less frequently associated with calcifications (which can be observed, however, in cases of recurrence). Similar findings have been reported (8) for the papillary type (no calcifications in computed tomographic scans and predilection for the third ventricle).

Our patients did not receive postoperative radiotherapy. We observed, 30 months after primary radical excision, a case of recurrence, which has not yet been subjected to a second operation. The lesion remains the same size after 3 years of follow-up monitoring.

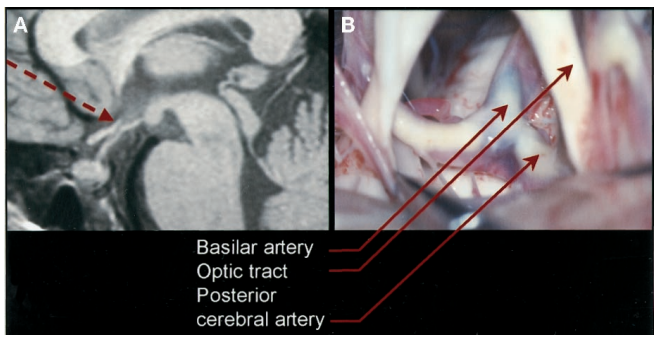

FIGURE 6. Surgical route to the third ventricle through the LT and view of the basilar artery when the ventricular floor is completely opened in the interpeduncular cistern.

CONCLUSIONS

The trans-LT approach seems to be a safe useful approach for achieving total removal of purely intraventricular CRFs. Anatomic preservation of the visual pathways, the pituitary stalk, and the anterior cerebral arteries is possible with this approach. The walls of the third ventricle may be safety dissected by the tumor, with easy control of the point of attachment to the hypothalamus. Severe disruption of the diencephalic nuclei caused by the tumor, as indicated by psychological disturbances and severe hypopituitarism, together with intraoperative observation of anatomic interruption of the floor of the ventricle, are important findings that increase the possibilities of postoperative signs of hypothalamic dysfunction. Accurate neuroendocrine and electrolyte control is critical even months or years after surgery.

Received, April 11, 2000.
Accepted, June 7, 2000.
Reprint requests: Giulio Maira, M.D., Institute of Neurosurgery, Catholic University, L. go A. Gemelli, 8, 00168 Rome, Italy. Email: iclnc@rm.unicatt.it

REFERENCES

1. Adamson TE, Wiestler OD, Kleihues P, Yasargil MG: Correlation of clinical and pathological features in surgically treated craniopharyngiomas. **J Neurosurg** 73:12–17, 1990.
2. Asari S, Sakurai M, Suzuki K, Hamasaki M, Sadamoto K: CRF in the third ventricle. **Neurol Med Chir (Tokyo)** 20:1039–1047, 1980.
3. Bose B, Huang P, Myers D, Osterholm J: Intrinsic ventricular craniopharyngioma: Two case reports with review of the literature. **Del Med J** 57:389–394, 1985.
4. Carmel PW: Tumours of the third ventricle. **Acta Neurochir (Wien)** 75:136–146, 1985.
5. Cashion EL, Young JM: Craniopharyngioma in the third ventricle. **J Tenn Med Assoc** 55:156–160, 1962.
6. Cashion EL, Young JM: Intraventricular craniopharyngioma: Report of two cases. **J Neurosurg** 34:84–87, 1971.
7. Choux M, Lena G, Genitori L: Craniopharyngioma in children [in French]. **Neurochirurgie** 37:59–64, 1991.

8. Crotty TB, Scheithauer BW, Young WF, Davis DH, Shaw EG, Miller GM, Burger PC: Papillary craniopharyngioma: A clinicopathological study of 48 cases. **J Neurosurg** 83:206–214, 1995.
9. Cushing HW: The craniopharyngiomas, in Bailey P (ed): *Intracranial Tumors*. Springfield, Charles C Thomas, 1933, pp 93–98.
10. Dandy WE: Diagnosis, localization and removal of tumors of the third ventricle. **Bull Johns Hopkins Hosp** 33:188–194, 1922.
11. Dobos EI, Freed CG, Ashe SMP: An intrinsic tumor of the third ventricle. **J Neuropathol Exp Neurol** 12:232–243, 1953.
12. Fitz CR, Wortzman G, Harwood-Nash DC, Holgare RC, Barry JF, Boldt DW: Computed tomography in craniopharyngiomas. **Radiology** 127:687–691, 1978.
13. Fujitsu K, Sekino T, Sakata K, Kawasaki T: Basal interfalcine approach through a frontal sinusotomy with vein and nerve preservation: Technical note. **J Neurosurg** 80:575–579, 1994.
14. Fukushima T, Hirakawa K, Kimura M, Tomonaga M: Intraventricular craniopharyngioma: Its characteristics in magnetic resonance imaging and successful total removal. **Surg Neurol** 33:22–27, 1990.
15. Goldstein SJ, Wilson D, Young B, Guidry G: Craniopharyngioma intrinsic to the third ventricle. **Surg Neurol** 20:249–253, 1983.
16. Iwasaki K, Kondo A, Takahashi JB, Yamanobe K: Intraventricular craniopharyngioma: Report of two cases and review of the literature. **Surg Neurol** 38:294–301, 1992.
17. King TT: Removal of intraventricular craniopharyngiomas through the lamina terminalis. **Acta Neurochir (Wien)** 45:277–286, 1979.
18. Klein HG, Rath SA: Removal of tumors in the third ventricle using the lamina terminalis approach: Three cases of isolated growth of craniopharyngiomas in the third ventricle. **Childs Nerv Syst** 5:144–147, 1989.
19. Konovalov AN: Technique and strategies of direct surgical management of craniopharyngiomas, in Apuzzo MLJ (ed): *Surgery of the Third Ventricle*. Baltimore, Williams & Wilkins, 1987, pp 542–553.
20. Konovalov AN, Gorelyshev SK: Surgical treatment of anterior third ventricle tumors. **Acta Neurochir (Wien)** 118:33–39, 1992.
21. Kubota T, Fujii H, Ikeda K, Ito H, Yamamoto S, Nakanishi I: A case of intraventricular craniopharyngioma with subarachnoid hemorrhage [in Japanese]. **No Shinkei Geka** 8:495–501, 1980.
22. Kunishio K, Sunami M, Yamamoto Y, Asari S, Akagi T, Ohtsuki Y: An autopsy study on the origin of craniopharyngioma confined to the third ventricle: Case report. **Neurol Med Chir (Tokyo)** 26: 712–717, 1986.
23. Kunishio K, Yamamoto Y, Sunami M, Asari S, Akagi T, Ohtsuki Y: Craniopharyngioma in the third ventricle: Necropsy findings and histogenesis. **J Neurol Neurosurg Psychiatry** 50:1053–1056, 1987.
24. Lanzieri CF, Sacher M, Som PM: CT changes in the septum pellucidum associated with intraventricular craniopharyngiomas. **J Comput Assist Tomogr** 9:507–510, 1985.
25. Linden CN, Martinez CR, Gonzalvo AA, Cahill DW: Intrinsic third ventricle craniopharyngioma: CT and MR findings. **J Comput Assist Tomogr** 13:362–368, 1989.
26. Long DM, Chou SN: Transcallosal removal of craniopharyngiomas within the third ventricle. **J Neurosurg** 39:563–567, 1973.
27. Maira G, Anile C, Rossi GF, Colosimo C: Surgical treatment of craniopharyngiomas: An evaluation of the transsphenoidal and pterional approaches. **Neurosurgery** 36:715–724, 1995.
28. Matthews FD: Intraventricular craniopharyngioma. **AJNR Am J Neuroradiol** 4:984–985, 1983.
29. Mori K, Handa H, Murata T, Takeuchi J, Miwa S, Osaka K: Results of treatment for craniopharyngiomas. **Childs Brain** 6:306–312, 1980.
30. Nanba S, Tsuboi M: Craniopharyngioma in the third ventricle [in Japanese]. **No To Shinkei** 29:45–49, 1977.
31. Page RB: Diencephalic structures at risk in third ventricular surgery, in Apuzzo MLJ (ed): *Surgery of the Third Ventricle*. Baltimore, Williams & Wilkins, 1987, pp 553–556.
32. Ravindram M, Radhakrishnan VV, Rao VR: Communicating cystic craniopharyngioma. **Surg Neurol** 14:230–232, 1980.
33. Rhoton AL Jr, Yamamoto I: Operative approaches to the third ventricle, in Wilkins RH, Rengachary SS (eds): *Neurosurgery*. New York, McGraw-Hill, 1996, ed 2, vol 1, pp 1435–1449.
34. Rush JL, Kusske JA, De Feo DR, Pribram HW: Intraventricular craniopharyngioma. **Neurology** 25:1094–1096, 1975.
35. Samii M: Technical aspects of excision of giant basal tumors with third ventricular involvement, in Apuzzo MLJ (ed): *Surgery of the Third Ventricle*. Baltimore, Williams & Wilkins, 1987, pp 684–697.
36. Sipos L, Vajda J: Craniopharyngioma of the third ventricle. **Acta Neurochir (Wien)** 139:92–93, 1997.
37. Stookey B, Scarff J: Occlusion of the aqueduct of Sylvius by neoplastic and non-neoplastic processes, with a rational surgical treatment for the relief of the resultant obstructive hydrocephalus. **Bull Neurol Inst N Y** 5:348–377, 1936.
38. Svien JH: Surgical experiences with craniopharyngiomas. **J Neurosurg** 23:148–155, 1965.
39. Takahashi H, Nakazawa S, Shimura T: Evaluation of postoperative intratumoral injection of bleomycin for craniopharyngioma in children. **J Neurosurg** 62:120–127, 1985.
40. Urasaki E, Fukumura A, Ito Y, Itoyama Y, Yamada M, Ushio Y, Yokota A, Wada S: Craniopharyngioma in the third ventricle [in Japanese]. **No To Shinkei** 16:1399–1404, 1988.
41. Urbach H, Behrens E, Von Deimling A, Reul J: Solid craniopharyngioma in the 3rd ventricle: Differential diagnostic aspects [in German]. **Aktuelle Radiol** 8:95–97, 1998.
42. Van Den Bergh R, Brucher JM: The transventricular approach in cranio-pharyngioma of the 3rd ventricle: Neurosurgical and neuropathologic aspects [in French]. **Neurochirurgie** 16:51–65, 1970.
43. Villani R, Papagno C, Tomei D, Grimoldi N, Spagnoli D, Bello B: Transcallosal approach to tumors of the third ventricle: Surgical results and neuropsychological evaluation. **J Neurosurg Sci** 41: 41–50, 1997.

COMMENTS

The majority of extra-axial cranial base tumors, including acoustic neuromas, meningiomas, and pituitary adenomas, are extra-arachnoid lesions, in that they are covered by a layer of arachnoid membrane that separates them from the underlying subarachnoid space and the important neurovascular structures contained within it. Therefore, the separation of these tumors from the surrounding neurovascular structures should proceed along the tumor-arachnoid membrane interface and not between the arachnoid membrane and the neurovascular structures. Craniopharyngiomas (CRFs) differ in this regard, in that they can be completely extra-arachnoid (as, for example, when they are completely intrasellar), they can be partially extra-arachnoid and partially intra-arachnoid, or they can be completely intra-arachnoid, and in fact partially intrapial, interdigitating with the neuropil of the hypothalamic floor. Finally, they can also be completely intraventricular. The explanation for such varied anatomic relationships between CRFs and the surrounding pia/arachnoid membranes and the ependyma of the third ventricle can be found in the anatomic development of these tumors. Two important

embryological events play a role in this respect. First, as the anterior pituitary gland develops from the ventral portion of Rathke's sac, it begins to rotate, with its inferior part turning counterclockwise toward the hypothalamic floor (1). In the process, remnants of the columnar epithelial cells from Rathke's duct that may have remained attached to Rathke's sac are brought into contact with the neuroectodermal layer of the ventral aspect of the cerebral vesicle, the precursor of the infundibulum and of the third ventricle floor. The second important event is the development of the pia/arachnoid membranes from the mesoderm intervening between the stomodeum and the cerebral vesicle. Depending on the sequence of these two events, CRFs can arise either extrapially, extra-arachnoidally, intrapially, or in fact intraventricularly. The former scenario occurs when the pial membrane develops in approximately the fifth week of gestation, before the anterior pituitary gland rotates, in which case columnar epithelial cells that may have remained attached to the anterior pituitary gland are excluded from the subpial space by the already formed pia membrane. Depending on the degree of rotation of the anterior pituitary gland, these residual columnar epithelial cells may be brought into contact with the pia membrane high along the hypothalamic floor, low along the stalk, or even lower along the simultaneously developing posterior lobe. Consequently, if a CRF arises from these cell remnants, it develops either intra- arachnoidally (but extrapially), partially intra-arachnoidally and partially extra-arachnoidally, or completely extra-arachnoidally. In contrast, when the development of the pia membrane lags in time, the rotation of the anterior pituitary gland can bring the residual columnar epithelial cells directly into contact with the neuroectoderm of the developing cerebral vesicle, where they can remain implanted. If these cells then undergo squamous metaplasia and develop into a CRF, such a tumor remains intimately adherent to and interdigitated with the neuropil of the hypothalamic floor. It is not difficult to imagine that the columnar epithelial cells can easily migrate through the signal neuroectodermal layer of the early cerebral vesicle and develop into an intraventricular CRF (2).

Clearly, the surgical approach for third-ventricle CRFs should be chosen with consideration of the embryological and surgical anatomic features of these tumors. An important distinction should be made between purely intraventricular CRFs and those that are retrochiasmatic and insinuate themselves into the floor of the third ventricle, simulating an intraventricular presence. My own preference has always been to approach purely intraventricular CRFs using the transfrontal/transcallosal/transforaminal route and to approach retrochiasmatic CRFs via a subfrontal approach in conjunction with a pterional (but with good access to the midline) craniotomy that includes an orbito-zygomatic-clinoidal cranial base dissection. I have rarely found it necessary to open the lamina terminalis (LT) to reach such retrochiasmatic tumors, because it has always been possible to find an avenue between the ipsilateral optic nerve and track on one side and the carotid artery on the other, working underneath the optic nerves and chiasm. I have occasionally resorted to removal of the tuberculum sellae to gain better access to the retrochiasmatic space, especially in patients with a prefixed chiasm. Opening the LT as a means of reaching into the retrochiasmatic space, which anatomically requires opening of the floor of the third ventricle as well, has always made me uncomfortable. Finally, to the best of my recollection, the LT in our patients was usually crowded by the anterior cerebral arteries, the anterior communicating artery, and the perforators emanating from these vessels. The contributions of the authors should certainly be considered by neurosurgeons endeavoring to remove CRFs in this region. However, I think that this method should not be the principle approach for the removal of CRFs, because it may be associated with considerable risks, but should be considered an ancillary route to be used when all other extra-axial approaches have proven inadequate.

Ivan S. Ciric
Evanston, Illinois

The trans-LT approach is useful in the surgical treatment of CRFs, as the results presented in this article testify. It can be used for tumors that are located largely in the third ventricle, as in this report, and it is also useful for CRFs when the optic nerves are short. In the case of short optic nerves, if the tuberculum sellae is removed and the LT is opened, then the tumor can be pushed from behind, via the third ventricle, under the chiasm and out between the optic nerves.

Another surgical option for CRFs located largely in the third ventricle is to remove them from above, via an interforniceal approach. In this approach, a craniotomy is performed along the sagittal sinus, the corpus callosum is divided, and the septum pellucidum is followed to the interforniceal fissure. The fornices are separated, which provides a clear view of the third ventricle. The tumor is removed piecemeal; at the end, the floor of the third ventricle is usually wide open and the basilar bifurcation is in sight. Although this approach initially seems to involve a greater distance, it is surprisingly easy to perform and is very well tolerated by patients, perhaps better than the trans-LT approach. The details of this approach have been published (1).

Russel H. Patterson, Jr.
New York, New York

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1. Apuzzo MLJ (ed): *Surgery of the Third Ventricle*. Baltimore, Williams & Wilkins, 1998, ed 2.

The authors have documented the usefulness of the trans-LT approach, and they point out that the approach can be used with either a subfrontal or pterional craniotomy. It is usually possible to predict the tumors for which a trans-LT approach will be helpful, on the basis of preoperative magnetic resonance imaging scans showing the chiasm pushed forward and the tumor located within the third ventricle. I prefer to approach the LT along the inferior surface of the frontal lobe, either via the medial part of a pterional approach or, more frequently, via a small frontal craniotomy above the

supraorbital rim. The LT can be exposed by working along the sylvian fissure in the middle portion of the pterional approach. However, the oblique angle at which the LT is viewed through the pterional approach makes it difficult to see posteriorly into the third ventricle, whereas the more medial subfrontal route provides observation of the third ventricle behind the LT even posterior to the aqueduct or to the basilar apex if the floor has been penetrated by the tumor. Care is required to preserve the perforating arteries, which arise from the anterior communicating artery and ascend on the LT, because these supply the columns of the fornix and damage may result in memory deficits. The LT is usually observed below the anterior communicating artery. All of the tumors within the third ventricle in this series were solid. We have observed several cystic CRFs within the third ventricle, which were removed via the trans-LT approach. The authors have achieved admirable results with this difficult group of tumors.

Albert L. Rhoton, Jr.
Gainesville, Florida

Reinventing Neurosurgery

Michael L.J. Apuzzo
Honored Guest

51st Annual Meeting of the
Congress of Neurological Surgeons
San Diego, California

The Congress of Neurological Surgeons is very pleased to announce that Michael L.J. Apuzzo will be the Honored Guest at the 2001 Annual Meeting in San Diego, California from September 29 to October 4.

Michael L.J. Apuzzo is the Edwin M. Todd/Trent H. Wells, Jr. Professor of Neurological Surgery, Radiation Oncology, Biology and Physics at the Keck School of Medicine at the University of Southern California in Los Angeles.

One of the world's best known and respected surgeons, researchers and academicians, he is considered a principal visionary in the field, being referred to as "a primary intellectual catalyst in neurosurgery." His work and contributions cover an unusually broad and diverse range of neurosurgical activities. Their scope and importance has had significant influence in shaping clinical practice and the state of modernity in the field.

Following surgical and neurosurgical training at McGill University's Royal Victoria Hospital and the Yale School of Medicine, he gained additional influential experience in the United States Navy Nuclear Powered Submarine Service and went on to devote career focus to refinement of concepts of cerebral surgery, advanced neuro-oncology, and the development with transfer of complex technology initiated within the aerospace and defense industries to the operating room and other areas of patient care. He has pioneered, introduced, and championed important clinical areas of deep cerebral microsurgery, neuroendoscopy, imaging directed stereotaxy, radiosurgery, minimally invasive techniques and the emerging field of cellular and molecular neurosurgery with neurorestoration while publishing more than 450 contributions to the scientific literature including 32 published volumes.

During his career he has been an ardent advocate for internationalism, education, and facilitated global communication in neurosurgery. He has presented more than 50 keynote, named, or commemorative lectures and 130 invited professorships worldwide while holding principal leadership and innovative roles in program and educational committees of all major national and international organizations.

He has served on more than 25 editorial review boards. As Editor of *Neurosurgery*, he has instituted and fostered innovations in scientific publishing, internet activities and the scope of organized neurosurgery in global unification and education.

His professional activities have been influenced by and continue to reflect his avid personal interests in architecture, fine painting, classical musicology, history, mythology, athletics and historical elements of American cinema and cinematography.

In concert with his career course, experience and objectives, Dr. Apuzzo will address the following subjects during the meeting program:

- **Surgery of the Human Cerebrum: A Collective Modernity**
- ***Quid Novi?* In the Realm of Ideas: The Neurosurgical Dialectic**
- **A Vision of the Neurosurgical Operating Room for the 21st Century**
- **Brave New World: The Dawn of Neurorestoration and The Emergence of Molecular and Cellular Neurosurgery**
- **Reinventing Neurosurgery**
- **The Neurosurgeon in the Arena of Sport**