Childs Nerv Syst (2017) 33:357–362
DOI 10.1007/s00381-016-3249-1

CASE REPORT

Congenital craniopharyngioma treated by radical surgery: case report and review of the literature

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Received: 28 October 2015 / Accepted: 6 September 2016 / Published online: 26 September 2016

Abstract
Purpose Craniopharyngiomas are 5–10 % of all pediatric tumors, but are seldomly encountered in the perinatal period. Only seven instances of a truly antenatal diagnosis of a congenital craniopharyngioma that subsequently underwent radical surgery have been reported. We present the case of a patient who received the diagnosis of a suprasellar tumor during the prenatal period and received radical surgery.
Methods We report a case of a neonatal craniopharyngioma treated surgically.
Results The pregnancy progressed uneventfully until a routine ultrasound at 37 weeks of gestation showed a 15 × 15 mm high echoic mass in the center of the fetal head. Neonatal Gd-enhanced T1-weighted MRI at 5 days of life showed a homogenously enhanced mass (16×22×15 mm) in the sellar and suprasellar lesion. As the tumor showed rapid growth at the 3rd month of life, the patient underwent a surgical treatment and the mass was totally removed. Three years later, the physical and mental development of the patient was normal, and Gd-MRI studies showed no tumor recurrence.
Conclusion The present case is the eighth case of a truly antenatal diagnosis of a craniopharyngioma that underwent successful radical surgery. Craniopharyngioma is a benign tumor and thought to be a slow growing tumor in childhood. The results of radical surgery were very poor, and the mortality and morbidity rates were high in the previous reports due to the huge size of tumor at operation. The present case demonstrated the rapid growth in short interval of Gd-MRI. This is the first report of tumor kinetics of congenital craniopharyngioma with previous reports. The calculated tumor doubling time in our case was 37 days.

Keywords Congenital brain tumor · Craniopharyngioma · Tumor doubling time

Introduction

The reported incidence of all congenital tumors ranges from 1.7 to 13.5 per 100.000 live births [1]. Intracranial teratoma, a relatively uncommon central nervous system (CNS) tumor in older children, is the most common congenital brain tumor. It accounts for approximately half of all reported cases. Other relatively common tumors are astrocytomas, choroid plexus papillomas, craniopharyngiomas, and primitive neuroectodermal and atypical teratoid/rhabdoid tumors [1–3].

Craniopharyngiomas are the most common brain tumors seen in children in the parasellar region. They are 5–10 % of all pediatric tumors, but they are seldomly encountered in the perinatal period. Overall, craniopharyngiomas account for 5.6 % of all fetal and neonatal tumors [2, 3]. They are benign and their first-line treatment is surgical resection. However,

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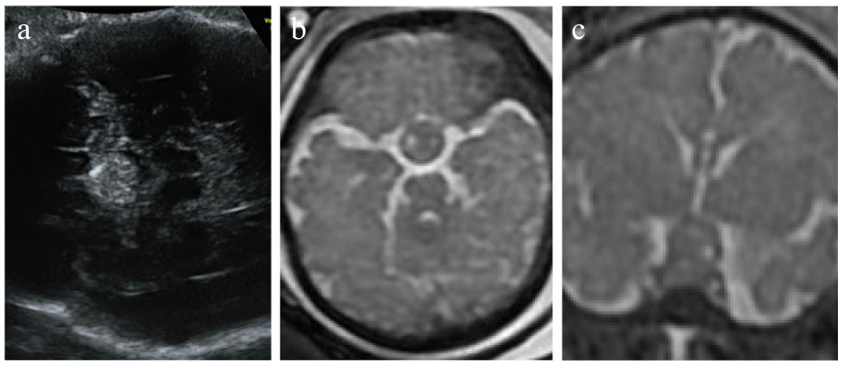

Fig. 1 Ultrasonography at 37 weeks of gestation (**a**) and T2-weighted MRI at 38 weeks (**b**, **c**) showing a 15 × 15 mm suprasellar mass containing solid and microcyst components

the management of this tumor in neonates remains controversial.

We report the prenatal diagnostic findings, postnatal evaluation, and successful radical surgical removal of a congenital craniopharyngioma and our kinetic study of this tumor.

Case report

The pregnancy progressed uneventfully until a routine ultrasound at 37 weeks of gestation showed a 15 × 15 mm hyperechoic mass in the center of the fetal head. Prenatal magnetic resonance imaging (MRI) performed at 38 weeks confirmed a suprasellar lesion containing a solid and microcyst component; there was no hydrocephalus (Fig. 1). The prenatal course remained uncomplicated and the infant was delivered at 40 weeks of gestation via uneventful Cesarean section. The body weight was 3142 g, the Apgar score was 8 in the first minute and 9 after 5 min. The neonate manifested normal reactivity; the fontanel was flat and soft and the head circumference was 33.4 cm. The pupils were isocoric and photoreactive. Endocrinologic evaluation returned normal findings. A head CT and MRI performed on the 5th day of life showed a calcified mass in the sellar and suprasellar region with an isointense signal on T1- and a hypointense signal on T2-weighted images. Contrast enhancement was rather homogeneous; the enhanced area measured 15.8 × 21.9 × 15.2 mm (Fig. 2). Follow-up MRI studies were performed once a month for the next months. Although the head circumference was within the normal range and the fontanel was flat and soft, gadolinium (Gd)-enhanced T1-weighted MRI showed growth of the mass and the presence of a new cystic component in the tumor. The mass measured 20.1 × 26.6 × 19.8 mm in the 1st and 25.9 × 30.3 × 23.0 mm in the 2nd month of life (Fig. 2). At the 3rd month of life, we planned the radical surgery under the preoperative diagnosis of germ cell tumor, especially teratoma, because of the rapid growth of tumor.

At the time of admission to our hospital, the tumor was 31.8 × 35.2 × 26.4 mm in diameter (Fig. 2). In the 3rd month

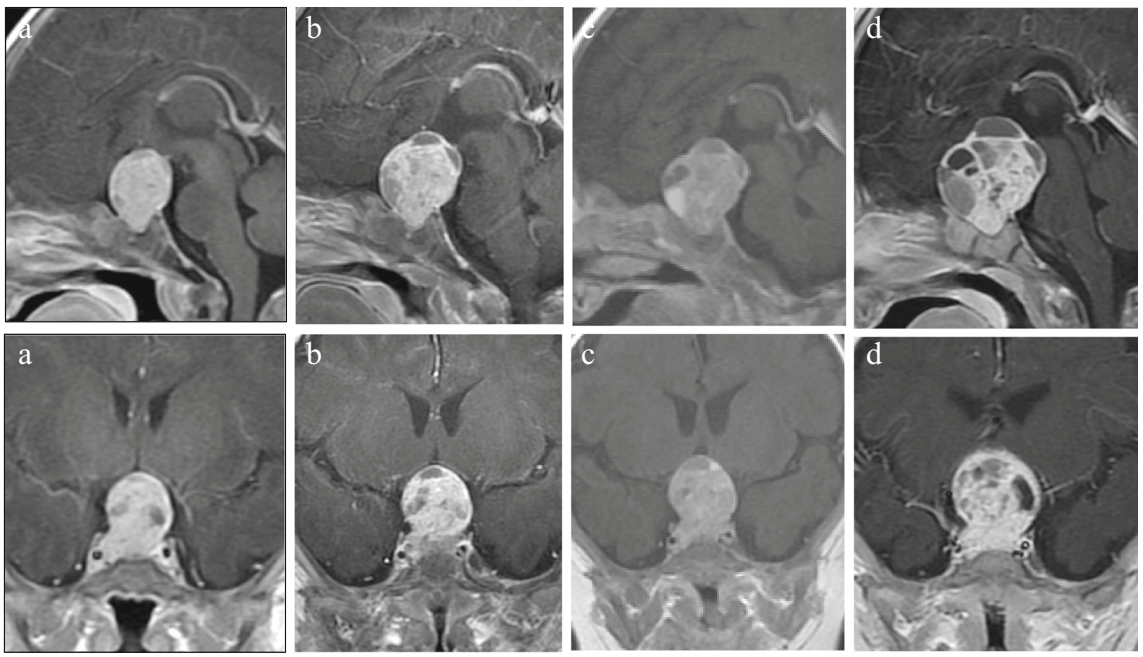

Fig. 2 Gd-enhanced T1-weighted MRI obtained on the 5 days (**a**), 1st (**b**), 2nd (**c**), and 3rd (**d**) month of life showing rapid tumor growth

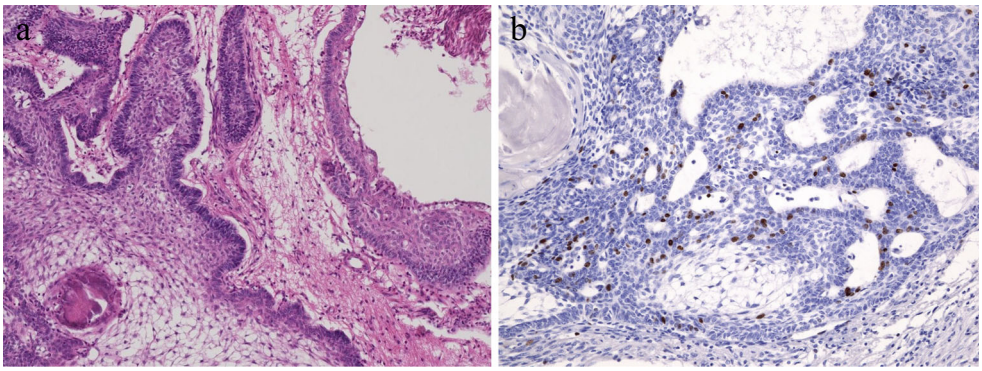

Fig. 3 Hematoxylin-eosin-stained section showing the epithelial structure. Palisaded cells alternate with cystic areas. There is evidence of focal keratinization and calcification (**a**). The MIB-1 LI as a proliferative activity is counted as 12.7 % (**b**)

of life, we performed gross total resection of the tumor via the anterior interhemispheric approach because the tumor was located in the midline portion. As pituitary stalk could not recognize during operation, we presumed that the tumor was completely removed without preservation of the pituitary stalk. A tumor specimen proved it to be an adamantinomatous craniopharyngioma (Fig. 3a). The MIB-1 labeling index (LI), a marker of cell proliferation, was counted as 12.7 % (Fig. 3b). The postoperative course was uneventful. Polyuria was controlled by the administration of a vasopression analogue, and hormonal deficits were corrected by hormone replacement therapy because hormone secretion load test revealed no response. There appeared to be no visual disturbance. Postoperative MRI confirmed the total removal of the tumor. The neonate was discharged 1 month after surgery; hydrocortisone (10 mg/day), L-thyroxin (30 μg/day), and desmopressin were prescribed. Growth hormone replacement therapy has been introduced at the age of 10 months. Four years later, the physical and mental development of the patient was normal, substitution treatment was continued, and Gd-MRI studies showed no tumor recurrence (Fig. 4). At 4 years and 2 months after birth, the body height and weight were 103.0 cm and 17.98 kg, respectively. The body mass index (BMI) was calculated as 16.95, which was a normal range as a Japanese child.

Discussion

Neonatal tumors are rare; they represent 0.5–1.9 % of all intracranial tumors in children [3, 4]. The most common prenatally diagnosed tumor of the CNS is teratoma. Craniopharyngiomas are the most common parasellar tumors seen in children and adults; however, they are rarely encountered in the perinatal period [1–3]. They are thought to arise from embryonic squamous cell remains of an incompletely evolved ectodermic hypophyseal pharyngeal duct or Rathke's pouch. This structure, which extends from the sella to the pharynx, is found at the origin of the adenohypophysis [5]. The first neonatal diagnosis of a craniopharyngioma was reported by Iyer in 1952 [4]. Only seven neonates with an antenatal diagnosis of congenital craniopharyngioma reportedly underwent radical surgery [6–12] (Table 1).

The antenatally diagnosed tumor reported here grew rapidly after birth; the tumor diameter was 15 mm at 37 weeks of gestation. Gd-MRI studies performed 5 days and 1, 2, and 3 months after birth showed that the average tumor diameter was 17.6, 22.2, 26.4, and 31.1 mm and the estimated tumor volume was 2.86, 5.73, 9.63, and 15.75 cm^3, respectively. The tumor volume in the 3rd month of life was 5.5 times that recorded 5 days after birth. We calculated the rate of tumor growth by using its maximum diameter on monthly Gd-MRI scans. The daily tumor growth rate was 3.4 % from birth to the

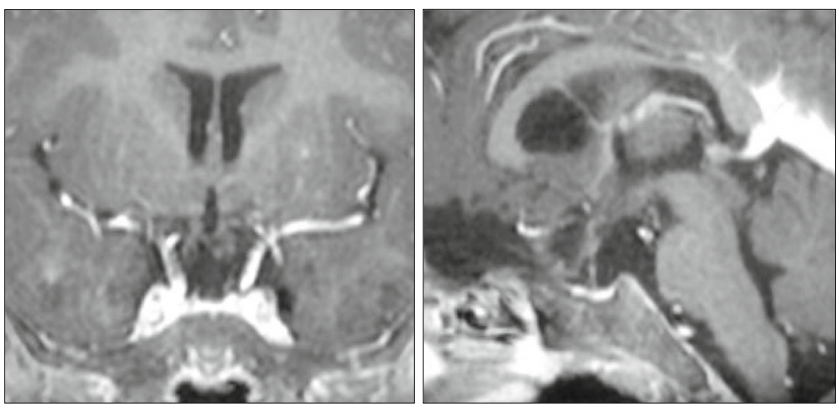

Fig. 4 Gd-enhanced T1-weighted MRI performed 3 years after the operation. There is no tumor recurrence

Table 1 Reviews of reported antenatal diagnoses of congenital craniopharyngiomas and their radical surgery

Reference	Time of diag.	Time of surgery	Tumor size			Surgical outcome	Survival	Visual symptoms and/or delayed psychomotor development	Calculated TDT (days)[a]	
			At diag.	At birth	At surgery				Antenatal period	Neonatal period
Kültürsay et al. [9]	29 weeks	4 weeks	25 mm	39 mm	NA	Died during surgery	Died during surgery	NA	59	NA
Müller et al. [11]	28 weeks	17 days	40 mm	50 mm	NA	Staged surgery	8 years	yes	72	NA
Arai et al. [6]	33 weeks	9 months	32 × 23 mm	32 × 28 × 30 mm	45 × 40 × 40 mm	GTR	6 years	no	164	152
Lonjon et al. [10]	29 weeks	40 days	32 × 23 × 22 mm	NA	NA	GTR	1 year	no	NA	NA
Wallons [12]	40 weeks	8 days, 15 days	80 × 60 × 70 mm	NA	NA	Staged surgery GTR	1 year	yes	NA	NA
Jurkiewicz et al. [8]	28 weeks	4 weeks	40 × 35 × 34 mm	49 × 40 × 58 mm	55 × 45 × 63 mm	GTR	3.5 months	yes	42	67
do Prado Aguiar et al. [7]	29 weeks	14 days, 32 days	44 mm	68 × 66 × 62 mm	NA	Staged surgery PR	Died 8 months after op	NA	37	NA
Present case	37 weeks	3 months	15 mm	16 × 22 × 15 mm	32 × 35 × 26 mm	GTR	4 years	no	30	37

NA not available, *PR* partial resection, *GTR* gross total resection

[a] In the earlier reports, the tumor doubling time (TDT) was calculated as the change in tumor enhancement volumes with the formula: $TDT = t \times (\ln 2) / \ln (V/V_0)$, where t is the interval in days, and V_0 and V are the volumes at the start and the end of the interval period

1st month of life, 2.4 % from the 1st to the 2nd month, and 1.9 % from the 2nd to the 3rd month.

The tumor doubling time (TDT) was calculated as the change in the tumor enhancement volume using the formula

$$TDT = t \times (\ln 2)/\ln(V/V_0),$$

where t is the interval in days, and V_0 and V are the volumes at the start and the end of the interval period, respectively [13]. In our case, the antenatal and neonatal observation period using MRI were 21 and 90 days, respectively. Therefore, the calculated TDT and growth rate in the antenatal period were 30 days and 2.9 % per day, respectively. These in the neonatal period were 37 days and 5.0 % per day, respectively.

Calculation of the average TDT in the earlier reports showed that it was 75 days (range 37–164 days) for the antenatal and 110 days (range 67–152 days) for the neonatal period (Table 1). We found only two earlier reports that documented the TDT and growth rate in neonates harboring a craniopharyngioma. According to Arai et al. [6], the tumor size was 30 mm at birth and 42 mm at 8 months of life; the calculated TDT was 152 days. Jurkiewicz et al. [8] reported the tumor size as 49 mm at birth and as 54 mm at 4 weeks of life; the calculated TDT was 67 days. Therefore, the TDT was markedly faster in our than the earlier reported patients.

There have been no previous reports which analyzed the correlation between TDT and proliferative activity in patients with congenital craniopharyngioma. The proliferative index of present case demonstrated high MIB-1 LI at 12.7 %. The present case demonstrated the correlation between TDL on MRI and proliferative index on immunohistochemistry. The wide range of MIB-1 LI observed among pediatric craniopharyngioma, from 0.75 to 21 %, has contributed to the lack of correlation between a high proliferative index and tumor recurrence in most study [14–18]. The particularly rapid progression in pediatric craniopharyngioma as our case observed in the reported by Anegawa et al. [14] supports the potential influence of a high proliferative index on rapid craniopharyngioma regrowth.

Although craniopharyngiomas are considered as benign tumors with >90 % 10-year survival rates in older children and adults [19], congenital craniopharyngiomas carry a worse prognosis. Among 17 cases reviewed by Isaacs [2, 3], only 4 patients (23 %) survived, and there were 3 stillborn. Only 4 congenital craniopharyngiomas that could be totally excised have been reported in the literature. The results of radical surgery in the neonatal period were extremely poor and the mortality rate, even during surgery, was very high. These poor clinical results are attributable to the large size of the tumor at the time of diagnosis. The average tumor diameter in the 7 earlier cases was 55 mm at surgery, and in 3 (43 %), it exceeded 60 mm [6–12] (Table 1). As we found evidence for the rapid growth of congenital craniopharyngiomas in the neonatal period, we recommend radical surgery be performed as soon as possible although the rate of postoperative morbidity is high and panhypopituitarism, visual disturbance, and psychological disorders have been reported. Puget et al. reported that hypothalamic involvement of tumor on the preoperative MRI significantly predicted poor outcome [20]. This further support the decision to perform radical surgery before hypothalamic involvement takes place. If radical surgery cannot be safely achieved in the neonatal period, we recommend staged surgery to prevent surgical morbidity. Three reported patients underwent staged surgery due to the huge size of tumor at diagnosis [3, 4. 20]. We performed a radical surgery and removed the tumor totally at the 3rd month of life without preservation of pituitary stalk due to the huge size of tumor, and the patient has no tumor recurrence 4 years after surgery. Surgery remains the treatment of choice to prevent tumor recurrence, especially in children in whom radiation therapy is extremely deleterious. Only 3 patients, including ours, manifested no postoperative visual symptoms or delayed psychomotor development [6, 10] (Table 1).

The prognosis for children diagnosed with a congenital brain tumor tends to be unfavorable. While craniopharyngiomas remain a challenge for surgeons irrespective of the patient age, limitations imposed by the physiology of the newborn and the potentially large tumor size render the treatment of neonatal craniopharyngiomas a particularly difficult neurosurgical challenge.

Conclusion

The neonatal diagnosis of craniopharyngioma is rare. The clinical results of radical surgery of reported congenital craniopgaryngioma were very poor due to the huge size of tumor at operation. We performed successful radical surgery without critical damage of hypothalamus at the 3rd month of life. The present case demonstrated the rapid growth in the both antenatal and neonatal period.

Compliance with ethical standards

Conflict of interest The authors have no personal financial or institutional interest in any of the drugs, materials, or devices cited in this article.

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