Neonatal intracranial teratoma

Case report

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The authors report the successful total excision of an intracranial teratoma in a neonate. The pathology of this rare tumor and its prognosis in relation to the maturity of individual cell lines is discussed. A review of the previous operation experience in the neonatal age group shows that radical surgical excision of the tumor has seldom been attempted. There are no reported survivors with normal neurological development. The clinical presentation, preoperative evaluation, and operative management are discussed. Emphasis is laid on intensive supportive care in the perioperative period. The difficulty in predicting a benign or malignant course in these tumors justifies extreme caution in making a prognosis and demands careful follow-up supervision. Reoperation is indicated for recurrent benign tumors; malignant germ-cell tumors may respond to combined irradiation and chemotherapy.

KEY WORDS □9 brain tumor □9 hydrocephalus □9 neonate □9 intracranial teratoma

Intracranial teratoma is rarely encountered. Because of the embryonic origin of this tumor the diagnosis is often made only after delivery of a stillborn or moribund infant. The poor clinical condition of children with this condition has rarely permitted direct surgical attack; biopsy and shunt procedures allow transient improvement and only short-term survival. We believe that recent advances in neuroradiographic techniques and surgical management permit earlier diagnosis and successful treatment of these patients.

Case Report

This 6-day-old baby boy was admitted to the Children's Hospital of Eastern Ontario in November, 1982, with a history of progressive macrocephaly since birth. The infant was the product of a full-term first pregnancy without complications in a 28-year-old woman. The child was born via a forceps-assisted vaginal delivery. The Apgar score at birth was 10, and there were no neonatal problems apart from mild jaundice which did not require treatment. The occipitofrontal head circumference was 37.5 cm at birth and increased rapidly, prompting neurosurgical consultation.

Examination. On admission the patient's occipitofrontal head circumference was 38.5 cm, greater than the 98% percentile. Length and weight were at the 25th percentile for his age. The head was large and the anterior fontanel bulging. All cranial sutures were split and the scalp veins prominent. There were small bilateral cephalhematomas, more marked on the right. Auscultation of the skull failed to reveal any intracranial bruits. The baby was alert and responded appropriately to painful stimulus. There was normal tone and movement in all extremities, and he exhibited a good suck and normal cry. The tonic neck and Moro reflexes were present, equal, and symmetrical. The cranial nerves were normal. The “sun setting” sign was present. Deep-tendon reflexes were slightly increased in the upper limbs and the plantar responses were extensor bilaterally.

Plain skull x-ray films only showed signs of raised intracranial pressure, but computerized tomography (CT) revealed a large intracranial mass filling most of the anterior horn of the right lateral and third ventricles (Fig. 1). The lobulated mass was speckled with calcifications and measured about 5 cm in diameter. The tumor density increased considerably after the intravenous administration of 12 ml of 50% Hypaque (diatrizoate meglumine). The lateral ventricles and third ventricle were dilated, but the fourth ventricle was small.

The patient was started on a course of Dilantin (phenytoin) in preparation for surgery. On the 5th
hospital day, selective right carotid angiography was performed from the femoral approach. Serpiginous vessels arising from the right posterior cerebral artery supplied the tumor, but no prominent vascular blush was seen (Fig. 2).

Operation. A right frontoparietal craniotomy was performed the next day (when the patient was aged 12 days), and the tumor was approached through the dilated lateral ventricle. A huge multilobulated cystic mass presented immediately under the ependyma, filling the anterior horn as far as the atrium, and blocking the foramen of Monro. The tumor was completely excised, with a total blood loss and replacement of 125 cc.

An epidural sensor was placed to monitor intracranial pressure postoperatively. The baby awoke and cried vigorously following the 6-hour procedure.

Pathological Examination. The tumor specimen was highly cellular, showing tissue elements derived from all three germ layers in various stages of development (Fig. 3). It consisted mainly of immature neuroectodermal tissue with foci of immature cartilage, pigmented neuroepithelium, mature cartilage and bone, squamous epithelium, mucus-secreting glands, mature smooth and striate muscle cells, and blood vessels. The histopathological diagnosis was immature teratoma.

Postoperative Course. The postoperative course was complicated by the inappropriate secretion of antidiuretic hormone syndrome. Despite fluid restriction, generalized focal seizures began when the serum sodium reached 122 mEq/liter, and phenobarbital was added to the regimen. Both problems were rapidly controlled and the intracranial pressure was never elevated. Abdominal distention with vomiting occurred on the 5th day, secondary to small-bowel obstruction; this responded to manual reduction of a left inguinal hernia. Hypertension developed the same day, with systolic blood pressures of 150 to 200 mm Hg. The possibility of renal abnormalities associated with the congenital teratoma was ruled out by a normal renal nuclear scan. The blood pressure fell dramatically following cessation of dexamethasone therapy. A follow-up CT scan on the 12th postoperative day showed residual hydrocephalus; ventricular cerebrospinal fluid (CSF) was in continuity with the subarachnoid space through the corticectomy. Daily ventricular taps were performed until the CSF
Neonatal intracranial teratoma protein level fell to 120 mg/dl, and then a left ventricularperitoneal shunt was inserted, followed by bilateral inguinal herniorrhaphies. The baby was well when he was discharged on the 22nd day after surgery. Twelve days following discharge he was readmitted because of increasing head size. Injection of radioactive isotope (technetium-99m pertechnetate) into the ventricular reservoir of the shunt suggested a distal block. At shunt revision, cellular debris was found blocking the peritoneal catheter; CSF taken from the ventricles at surgery showed abundant histiocytes and giant cells, with occasional immature squamous cells. The protein level was 80 mg/dl and glucose concentration was 19 mg/dl. On repeat clinical examination, at age 4 months, the baby was normal and the shunt was functioning well. Head circumference was 41 cm, in the 50th percentile for his age. The follow-up CT scan showed no residual tumor (Fig. 4).

Discussion Teratomas are rare neoplasms, constituting 0.5% to 1.2% of all intracranial tumors; nevertheless, they account for 2% to 4% of intracranial tumors in children. According to Willis, a teratoma is a true tumor or neoplasm composed of multiple tissues foreign to the part in which it arises. The characteristic of progressive uncoordinated growth qualifies this lesion as a true tumor and not merely a quiescent malformation. Teratomas should be distinguished from incomplete forms of twinning (acardiac monsters, parasitic twins, fetus-in-fetu, and the like) which lack neoplastic attributes. Teratomas are distinguishable from such incomplete forms of twinning by their lack of a vertebral column or other somatic distribution of parts. In teratomas, tissues and organoid structures differentiate with extreme haphazardness: there is nervous tissue but no brain, for example.

Teratomas as a whole constitute a single class; subclassifications on the basis of structural or behavioral characteristics were arbitrary. The tumor may be termed “solid” or “cystic,” yet each contains portions of the other. Similarly, although tissues from one germ layer may predominate, all true teratomas are tridermal if closely examined. Tumors wholly composed of mature tissues are usually benign, whereas those composed of embryonic or immature tissues are malignant. However, admixtures of mature and immature tissues occur in varying proportions, and degrees of immaturity are encountered, so that a continuum of maturity and benignity exists. The natural history of each tumor is therefore highly unpredictable.

The histogenesis of these tumors has been debated in the past. Askanazy was the first to conclude that teratomas must arise from abnormal tissue primordia in early embryonic life. Their preferential location in median or paramedian sites led Budde to conclude that anomalies of the primitive streak and its derivatives were implicated. But axiation and orderly somatic development — which determine that a mass of living tissue will become a vertebrate organism — are completely lacking in the teratoma, indicating its early escape from the influence of the primary organizer. Organoid structures are seen, and imply the interplay of neighboring tissues on one another during their differentiation, but this is evidence of second-grade and third-grade organizers. For reasons yet unknown, these tumors must arise from tissue foci which in early embryonic life become separated from the primary organizer and undergo differentiation along divergent lines determined by purely local factors.

In 1960, Greenhouse and Neuburger reviewed all neonatal teratomas to that date. They concluded that

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**FIG. 3.** Operative specimen measuring approximately 5 x 7 cm in diameter. This tumor was highly cellular, showing tissue elements derived from all three germ layers in various stages of development.

**FIG. 4.** Follow-up computerized tomography scan with contrast enhancement, 4 months after surgical intervention, showing no evidence of residual or recurrent tumor.
the patients fell into three groups: 1) Children who were normal at birth but abruptly developed cranial enlargement days to weeks later. Relatively small tumors blocking CSF pathways were involved. 2) Stillborn infants with massive heads caused by a tumor that virtually replaced normal brain substance. 3) Infants born alive but with enlarged heads harboring intermediate-sized tumors. These authors suggested that Group 1 patients were amenable to surgical treatment for hydrocephalus with good early results, but that surgical attack directed at the tumor was hazardous and seldom allowed prolonged survival. Good results have been obtained in neonates presenting with craniopharyngeal tumors (usually epignathics). These tumors are extrapial but intracranial, and will not be discussed here. 9

Takaku, et al., 11 reviewed brain tumors in the newborn and found only 103 cases in children aged 2 months or younger; over 50% of these were teratomas. The majority of neonatal tumors were supratentorial, in contrast to the usual infratentorial site in older children. Before the advent of CT scanning, diagnosis was difficult prior to autopsy; surgery was seldom attempted. Sudden neurological deterioration from internal hydrocephalus occurred in four of Takaku's five case presentations, and Hirsh, et al., 7 reported that a diagnosis of congenital brain tumor should be considered whenever recurrent shunt malfunction occurs in the hydrocephalic neonate.

The clinical presentation of intracranial teratomas in infants is quite stereotyped. Depending on the tumor's size and proximity to CSF pathways, hydrocephalus is apparent at birth or shortly thereafter. The baby is commonly born by Cesarean section for cephalopelvic disproportion. 15 The obstetric literature has emphasized the importance of prenatal diagnosis by ultrasound 5, 10 in order to reduce maternal morbidity. The general and neurological examinations are often normal, 12, 16 apart from evidence of raised intracranial pressure. Plain skull films commonly show pathological calcifications, and CT scanning delineates such details as the site and size of the lesion, ventricular size, and midline shift. Echoencephalography, pneumoencephalography, and positive-contrast ventriculography have been superseded by this investigation, but cerebral angiography remains valuable to show tumor vascularity and the displacement of normal vessels.

Various treatment modalities have been used, aimed at CSF diversion plus surgical biopsy or subtotal or complete removal. The total number of patients subjected to surgery in the neonatal period is small and the outcome poor (Table 1). However, the noninvasive character of CT scanning plus current neuroanesthetic and pediatric neurosurgical methods should allow more frequent diagnosis and successful treatment of this tumor. Such cases demand thorough preoperative evaluation; in our patient, the preoperative angiogram influenced our decision to approach the tumor through the dilated lateral ventricle. The vascular pedicle was then secured prior to actual tumor removal. Close cooperation with the neuroanesthetist and postoperative monitoring in an intensive care unit are mandatory if the complex pulmonary, metabolic, and neurological problems of these small patients are to be managed successfully.

If possible, complete excision should be attempted because of the teratoma's inherent tendency to grow. Mature teratomas may recur and still behave in a benign fashion, and hence reoperation is indicated. In general, calcification within the tumor implies benignity. 4, 14 The use of postoperative irradiation is questionable, but probably contraindicated in the neonate. Since these germ-cell tumors run such an unpredictable course, lengthy follow-up monitoring is needed. Some authors 1 have found that specific germ-cell tumors manufacture markers such as alpha-fetoprotein (AFP) and human chorionic gonadotropin (HCG). Markers found in serum and CSF correlate well with tumor activity, marker levels consistently fall when chemotherapy is given and rise with tumor recurrence. 14 Takeuchi, et al., 13 reported that serum AFP is a valuable marker for malignant intracranial teratomas such as embryonal cell carcinoma, but unfortunately the benign teratomas do not elaborate this marker.

The prognosis for all forms of teratoma must remain

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TABLE 1

Operative experience and outcome of neonates with intracranial teratomas*

<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>Sex, Age</th>
<th>Operation(s)</th>
<th>Site of Tumor</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingraham &amp; Bailey, 1977</td>
<td>M, 8 days</td>
<td>resection of cysts</td>
<td>frontal</td>
<td>alive 18 mos postop</td>
</tr>
<tr>
<td>Hirsh, et al., 1977</td>
<td>F, 4 days</td>
<td>VP</td>
<td>pineal</td>
<td>died aged 8½ wks</td>
</tr>
<tr>
<td>Takaku, et al., 1978</td>
<td>M, 3½ wks</td>
<td>VP</td>
<td>pineal</td>
<td>died aged 7½ wks</td>
</tr>
<tr>
<td>Sañó, 1979</td>
<td>½, 2 mos</td>
<td>subtotal excision</td>
<td>pineal</td>
<td>died 15 mos postop</td>
</tr>
<tr>
<td>Takaku, et al., 1983</td>
<td>M, 15 days</td>
<td>complete excision &amp; VP</td>
<td>frontal &amp; VP</td>
<td>died 10 days postop</td>
</tr>
<tr>
<td>Villarejo, et al., 1980</td>
<td>?, 1 day</td>
<td>subtotal excision</td>
<td>VP</td>
<td>died of malignant recurrence</td>
</tr>
<tr>
<td>Whittle &amp; Simpson, 1981</td>
<td>F, 3 days</td>
<td>subtotal excision</td>
<td>lateral ventricle</td>
<td></td>
</tr>
<tr>
<td>Venturaeyra &amp; Herder, 1983</td>
<td>M, 6 days</td>
<td>complete excision &amp; VP</td>
<td>lateral ventricle</td>
<td></td>
</tr>
</tbody>
</table>

* These patients ranged in age from birth to 60 days. VP = ventriculo-peritoneal shunt.
† Cases reviewed by Whittle and Simpson. 14
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guarded. Careful histological examination of the entire specimen is needed to search for malignant areas. Whittle and Simpson\textsuperscript{16} reported a case in which an initially complete tumor removal was accomplished in an 8-week-old boy, who died 11 months later from massive recurrence of embryonal-cell carcinoma. Despite this gloomy picture, other authors\textsuperscript{8} have reported considerable success with chemotherapy for malignant intracranial germ-cell tumors. On the other hand, even mature and benign teratomas cannot always be cured by complete excision. Aoyama, \textit{et al.},\textsuperscript{2} reported a rare case of double teratomas in the pineal region and fourth ventricle.

\textbf{Conclusions}

Although teratomas are rare, they constitute the majority of intracranial tumors in the neonate. Growth during intrauterine life may result in a massive tumor replacing brain, but infants commonly present with signs of raised ICP which is refractory to CSF diversionary procedures. The present widespread use of CT scanning and improved pediatric anesthetic and neurosurgical care should allow a longer survival period in this particular age group. Recurrent non-malignant tumors should be dealt with aggressively, and some success is now being obtained with combination chemotherapy in malignant germ-cell tumors.

\textbf{References}


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