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Case Reports & Case Series

Subdural hydroma; A postoperative complication of desmoplastic infantile ganglioglioma and astrocytoma: A report of two cases and literature review

Fu Wei[a], Seidu A. Richard[a,b], Zhigang Lan[a], Yan Ju[a,*]

[a] Department of Neurosurgery, West China Hospital, Sichuan University, 37 Guo Xue Xiang Street, Chengdu, 610041, PR China
[b] Department of Surgery, Volta Regional Hospital, P.O. Box MA-374, Ho, Ghana

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ABSTRACT

Introduction: Desmoplastic infantile ganglioglioma (DIG) and desmoplastic infantile astrocytoma (DIA) are rare benign childhood intracranial tumors that are classified under neural and mixed glioneuronal tumors. Although many authors have written on surgical treatment of these disease conditions and indicated satisfactory outcomes, no author have written on the postoperative formation of a subdural hydroma after surgery.

Case presentation: We present two cases of DIG and DIA infants in whom we achieved total or subtotal tumor resection and observed postoperative hydroma as complications. Their main symptoms were vomiting, seizures and head enlargement. In both cases magnetic resonance imaging (MRI) revealed huge solid-cystic mass located in left frontal, temporal and parietal lobes. Histopathological staining confirmed the diagnosis of DIG and DIA in both cases. A second surgery may be required in patients with this kind of postoperative complication if clinical and radiological imaging evaluation reveal deteriorating of the patient's condition otherwise conservative treatment usually gives a total resolution of this complication.

Conclusion: The pathophysiology of this occurrence after surgery is as the result of a potential space created after excision of tumor and subsequent influx of CSF into the potential space between the subdural.

1. Introduction

Desmoplastic infantile ganglioglioma (DIG) and desmoplastic infantile astrocytoma (DIA) are rare benign supratentorial tumors that are classified under neural and mixed glioneuronal tumors [10,13,20,35]. They are usually referred to as World Health Organization (WHO) grade I [10,12,13,20,26]. Cases of occipital lobe, brain stem, thalamus and suprasellar region involvement has also been seen [5,22,28]. Although most of them are seen in infants less than 2-years-old, about 23% are seen in children older than 2 years and sometimes in adults [10,12,26,28,39].

The adult types are much more rarer and often referred to as non-infantile variant (DNIG or DNIA) and so far, only about 16 cases have been reported in literature [24,26]. The age range of DNIG or DNIA varies from 5 to 25 years [24,26]. The male to female ratio is 1.7:1 which means that these lesions are often seen in male children [28]. Clinically macrocephaly is seen is about 40% case. This is usually as a result of hydrocephalus. Seizures have also been reported in about 20% cases. Other common presentations are bulging fontanelles, bony bossing, visual disturbance, and paresis [5,11,12,28,36].

DIG or DIA characteristically manifests as large, solitary, solid-cystic, supratentorial tumors, situated at the cortical surface and usual have a dural attachment. Also, aggressive variants with multifocal localizations or leptomeningeal spread have been seen, though these are exceptionally very rare [12,20,25]. Multilobar occurrence has also been reported in about 60% of cases [22,28]. The lesions often appear with enhancing solid segments and nonenhancing cystic segments on imaging studies. Therefore, in addition to clinical evaluation, imaging gives the final and reliable diagnosis although histopathological studies confirm the diagnosis [13,19,28,39].

Gross absolute resection of solitary DIG or DIA typically has a good prognosis, but treatment outcomes of multifocal DIG or DIAs still problematic due to nonexistence of literature on the appropriate management option [1,20,25,28,35,36]. To the best of our knowledge, no author has reported a case or cases series on postoperative subdural hydroma of DIG and DIA. We therefore present two case and literature review.

* Corresponding author at: Department of Neurosurgery, Postgraduate Training Centre, West China Hospital, Sichuan University, 37 Guo Xue Xiang Street, Chengdu, Sichuan, 610041, PR China.
E-mail address: wmdsfq@qq.com (Y. Ju).

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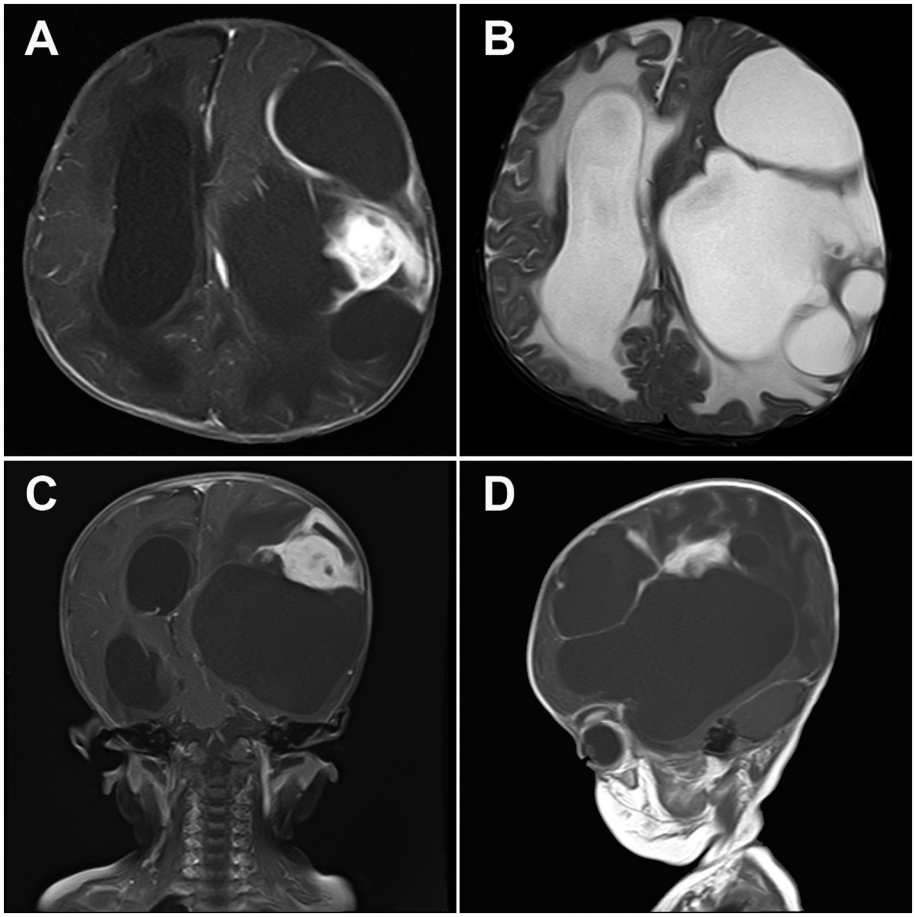

Fig. 1. A–D are pre-operative MRIs showing solid-cystic masses located in left frontal, temporal and parietal lobe.

2. Case presentation

2.1. Case 1

The patient was a five-month-old boy with one-month history of aberrant enlargement of the head. He was born full term via spontaneous vaginal delivery with no obvious motor deficits. No family history of such disease. Neonatal neurological examination was unremarkable except the increased head circumference with bulging anterior and posterior fontanelles. Routine laboratory and ancillary investigations were all normal. Magnetic resonance imaging (MRI) revealed a huge solid-cystic mass located in left frontal, temporal and parietal lobe measuring about 12 × 10 × 8 cm in diameter with a solid component. On T1-weighted imaging, the lesions appear hypointense at the cystic components and heterogeneous enhancement at the solid parts. On T2-weighted, the cystic components were hyperintense and solid parts vary from iso to hyperintense. The solid part was enhanced significantly after contrast enhancement. The left ventricle was compressed and the right ventricle significantly enlarged with cerebrospinal fluid leakage. Midline structure were remarkably pushed to the right with left tentorium incisura herniation (Fig. 1, A–D).

Surgical resection of the lesion was achieved via the frontotemporal approach. We lied adequate tack-up and tent up sutures. Intraoperatively we noticed that the skull bone was very thin and the dura tightly adhered to it. After cutting the dura a large quantity of transparent liquid was suction out. The solid part of tumor was located at the left frontal lobe and slightly adhered to dura. It looked grayish with indistinct margins compare to the normal cerebral parenchymal. Although we saw the feeding arteries, they were only two and very small in size. We resected the solid part after evacuating the fluid component. The dura was closed water-tight. Histopathological examination confirmed the DIA diagnosis (Fig. 6A). Immunohistochemistry revealed GFAP (+), Oligo2 (+), IDH1 (R132H) (−), EMA (−), MGMT (+, 20%), P53 (+), CD56 (+), NeuN (+), Syn (+), NF (+); INI1 (+), CD99 (−), S-100 (+/−), Calretinin (−), CD34 (−) and reticulocyte staining showed tumor rich reticular fibers with Ki- 67 (MIB-1) positive rate of about 5%, with no definite variation of IDH1/2. This support the diagnosis of DIA consistent with WHO grade I. Patient was discharged home ten days after operation.

The baby recovered very well after operation and was discharged home. One the first outpatient scheduled visit three months after the initial operation, the patient presented swelling at the surgical site. On examination, we noticed a scalp mass at incisional scar. MRI revealed subdural hydroma and focal infarction of frontal lobe at the ipsilateral hemisphere. The lesion was hypointense on T1 weighted image and hyperintense on T2-weight image. The left lateral ventricle was compressed and midline structure shifted to the right. The lesions demonstrate significantly enhancement and expansion of the supratentorial ventricular system (Fig. 2, A–D). Another operation was carried out via the old incisional scar. Intraoperatively we notice adhesion of the dura to the bone flap. We suctioned out yellowish fluid after opening the dura. The residual mass was reddish and slightly adhered to surrounding brain parenchymal which we total resected. This signified recurrence of the tumor with hydroma. Patient was discharge home ten days later and one-year outpatient scheduled visit revealed no recurrence.

2.2. Case 2

The patient was a six-month-old girl with a ten days' history of

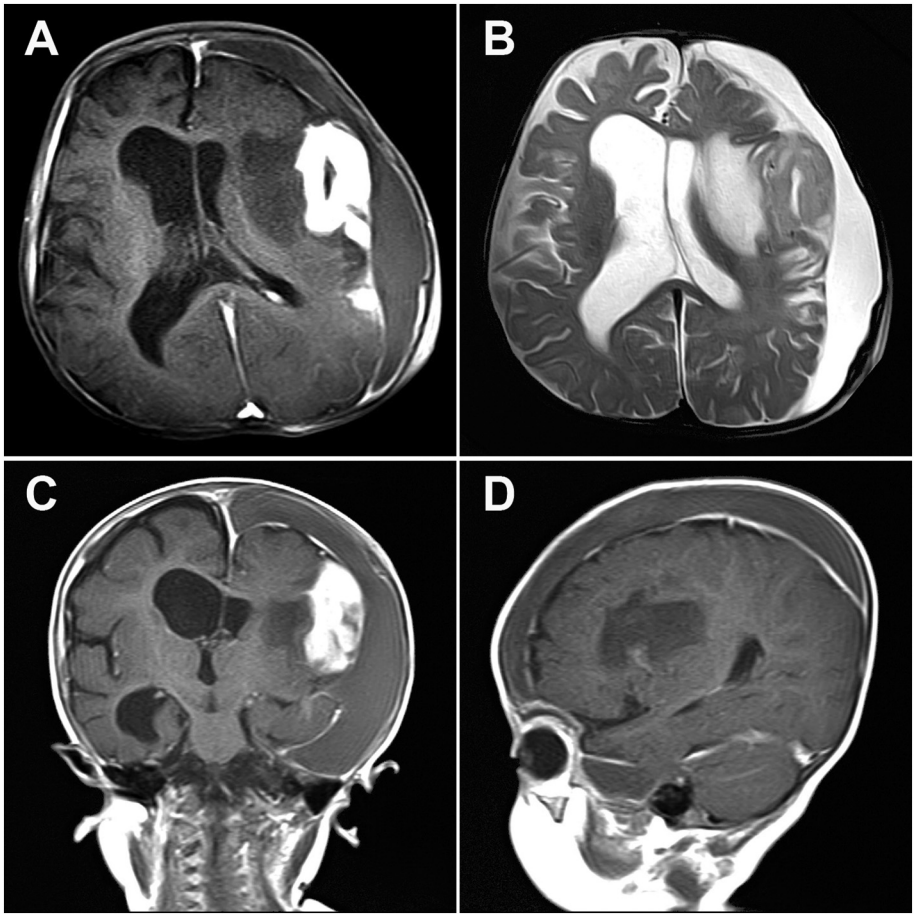

Fig. 2. A–D are post-operative MRIs showing subdural hydroma and focal infarction of frontal lobe occurred in ipsilateral hemisphere three months after initial operation.

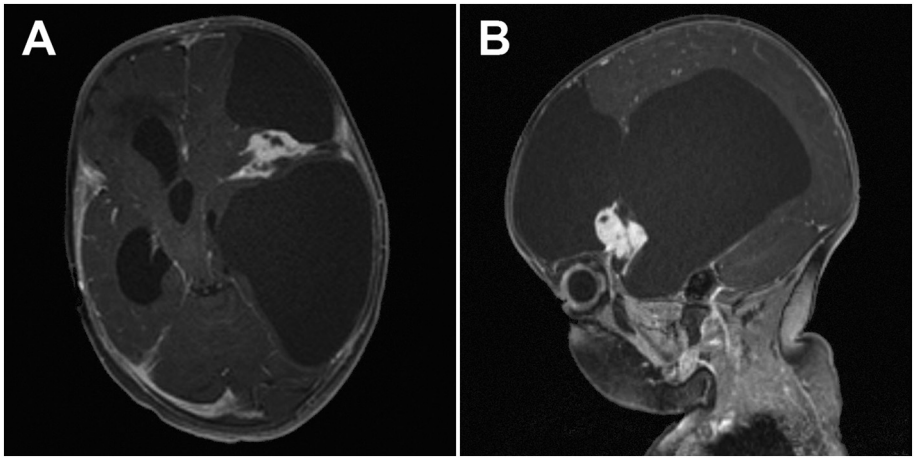

Fig. 3. A & B are pre-operative MRIs solid-cystic masses located in left frontal, temporal and parietal lobes. Left ventricle was compressed and middle structure shifted to right side.

repetitive vomiting and seizures. She was born full term via spontaneous vaginal delivery without motor deficits. At presentation, she had an increased head circumference with bulging anterior and posterior fontanelles. No family history of such disease. Neonatal neurological examination, routine laboratory and ancillary investigations were all normal. MRI revealed a huge solid-cystic mass located in left frontal, temporal and parietal lobe measuring about 15 × 12 × 10 cm in diameter with a solid component. The solid part was significantly enhanced after injected the contrast agent. The left ventricle was compressed and middle structure shifted to right side with enlargement of supratentorial ventricular system (Fig. 3, A & B).

Surgical resection of the lesion was achieved via the frontotemporal approach. We lied adequate tack-up and tent up sutures. Intraoperatively we noticed that the skull bone was very thin and the dura tightly adhered to it. We notice yellowish viscous fluid when we opened the dura. Solid tumor component was located at the left frontal lobe extending deep into the lateral ventricle. Tumor was grayish white and firm in consistence and had very rich blood supply and tightly

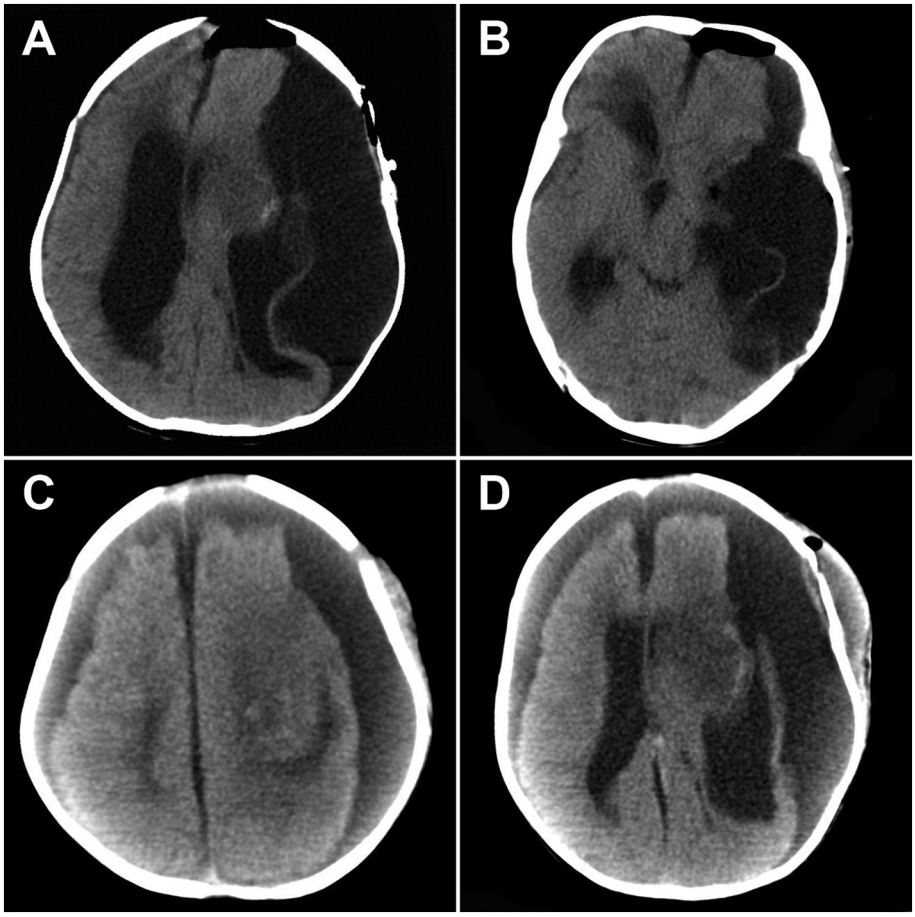

Fig. 4. A–D are post-operative CT scans showing accumulation of fluid at the left frontal and temporal regions with compression on left parenchymal hemisphere.

adhered to the pericallosal artery and middle cerebral artery adhesion. After resecting the solid part of the tumor, the dura was closed watertight. Histopathological staining confirmed the DIG diagnosis (Fig. 6B). Immunohistochemical staining revealed GFAP (+), S-100 (+), Oligo2 (+), ATRX (+), P53 (+, minority), EMA (−), PR (−), STAT6 (−), CD34 (−), CD99 (−), Syn (−), IDH1 (−) LIN28a (−), Desmin (−) and reticulocyte staining showed tumor rich reticular fibers with Ki- 67 (MIB-1) positive rate of about 5%, which is consistent with the diagnosis of an infant desmoplastic astrocytoma WHO grade 1.

Five days after operation, CT scan revealed accumulation of CSF-like fluid at the left frontal and temporal regions with compression on left parenchymal hemisphere. The left lateral ventricle and the third ventricle were also compressed and markedly enlarged signifying hydrocephalus (Fig. 4A & B). A repeated CT scan seven days later revealed no obvious charge in the size of subdural hydroma at surgical region and new onset accumulation of the CSF-like fluid at the right frontal and temporal lobe. The lateral ventricles were significantly smaller (Fig. 4C & D). His condition was stable so we managed her conservatively. Two weeks later the patient was discharged home with monthly scheduled visits. On the third follow-up, three months after the operation we notice a marked improvement on the infant's condition with no clinically visible neurological deficits. MRI showed increased in volume of hydroma at left frontal and temporal regions and formation of subdural hematoma at right frontal lobe which appear hyperintense on T1-weighted image and hypo to hyperintense on T2-weighted image (Fig. 5, A–F). We managed this occurrence conservatively with series of clinical and MRI evaluations.

3. Discussion

DIGs are rare benign supratentorial tumors that were first described by VandenBurg et al. in 1987 as a unique clinicopathologic permanence [9,13,18,28,41]. They reported only 11 cases. On the other hand, Taratuto et al. in 1984 described DIA [13,37]. These two pathological entities have meticulous association [13,37]. In 2007, WHO categorized these lesions as grade I tumors under neuronal and mixed neuronal-glial tumors [3,13]. The main distinctive features between DIG and DIA are the presence of a neuronal component in DIG while DIA has no neuronal component [3,13,21].

Although most of them are seen in infants less than 2-years-old, about 23% are seen in children older than 2 years and sometimes adults [10,12,26,28,39]. The adult types are much more rarer and often referred to as non-infantile variant (DNIG or DNIA) and so far, only about 16 cases have been reported in literature [24,26]. The age range of DNIG or DNIA varies from 5 to 25 years [24,26]. To the best of our knowledge, no author has reported a case or cases series on post-operative subdural hydroma of DIG and DIA.

DIG or DIA have unique macroscopic qualities such as large size, with uni or multiloculated cysts filled with clear or xanthochromic fluid, usually located at the temporal, frontal and parietal lobes, without hemispheric preference. Furthermore, cases of occipital lobe, brain stem, thalamus and suprasellar region involvement has also been seen [5,22,26,28]. Multilobar presentation is often in detected in about 60% of cases [22,28]. The solid portions are characteristically superficially situated and usually with a focal attachment to the superimposing dura, connecting the cerebral cortex and leptomeninges [15,20,37,41]. The loculated cystic portion seems to be situated deep than the solid portion [20,27,40].

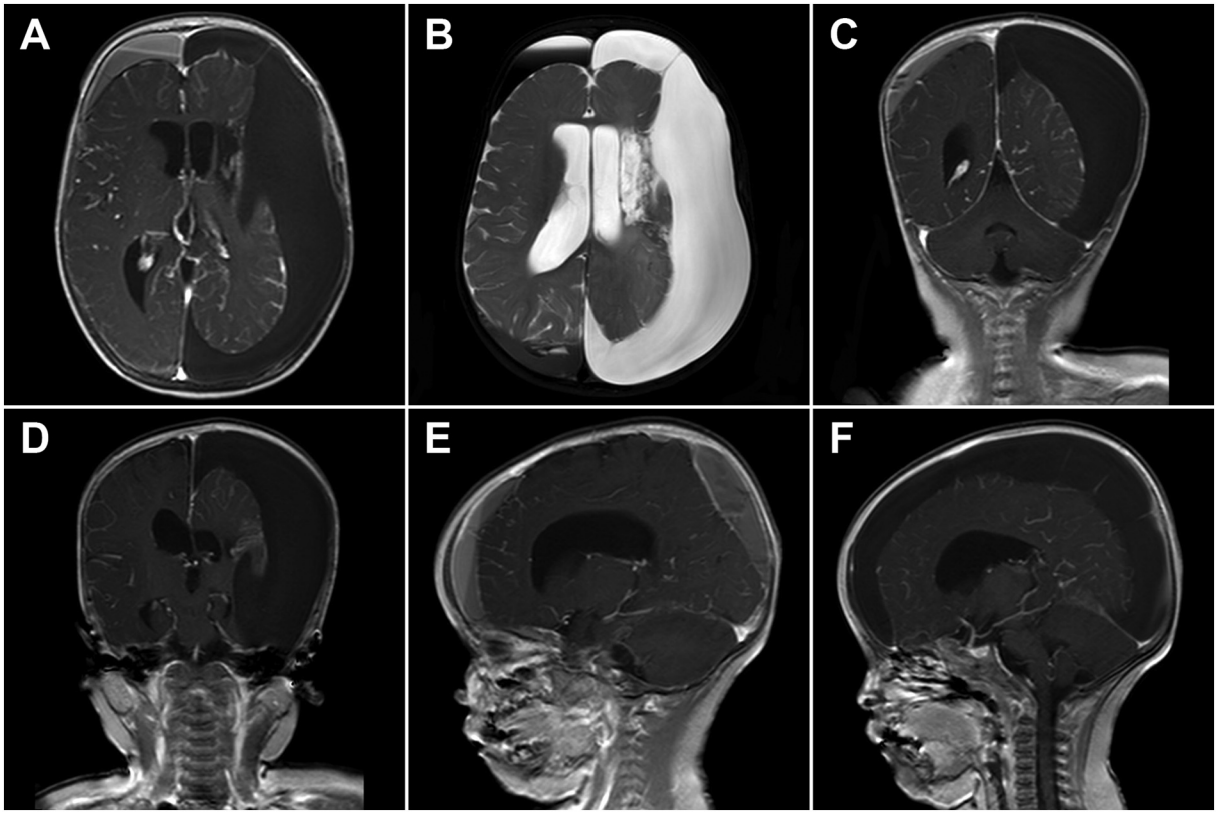

Fig. 5. A–F are Post-operative MRI showing increased in volume of hydroma at left frontal and temporal regions and formation of subdural hematoma at right frontal lobe three months after operation.

The most common clinical presentation is macrocephaly which usually occurs due to hydrocephalus in about 40% of cases. Seizures also occur in about 20% of cases. Other obvious signs and symptoms include bulging fontanelles, bony bossing, visual disturbance, and paresis [5,11,12,28,36]. Most of the patients have an ephemeral clinical history with a median duration of symptoms of 3–6 months [9,18,30,35]. Also, intracranial hemorrhage has been observed in a nine-day-old neonate [28,38]. On CT scan, DIG and DIA manifests as a large, hypodense or slightly hyperdense superficial component that lengthening's into the superimposing meninges and demonstrates intensely contrast enhancement [11].

A sizable portion of the lesion usually comprises of a large cyst, with insignificant adjacent vasogenic edema as well as a solid component [13,16]. The cystic part is typically situated deep, while the solid part is peripheral [11,23,39]. MRI is the supreme diagnostic modality for DIG and DIA. MRI is able to distinguish the presence of (1) a large supratentorial tumor involving more than one lobe, (2) a lesion consisting of a large cystic part seen on T1 as hypointense and no T2 as hyperintense as well as smaller solid part which appear on T1 and T2 as isointense with cortical component that enhances intensely, and (3) apposition of the superficial solid component to a meningeal surface, with enhancement along the dura [11,22,23,31]. MRI is also able to differential

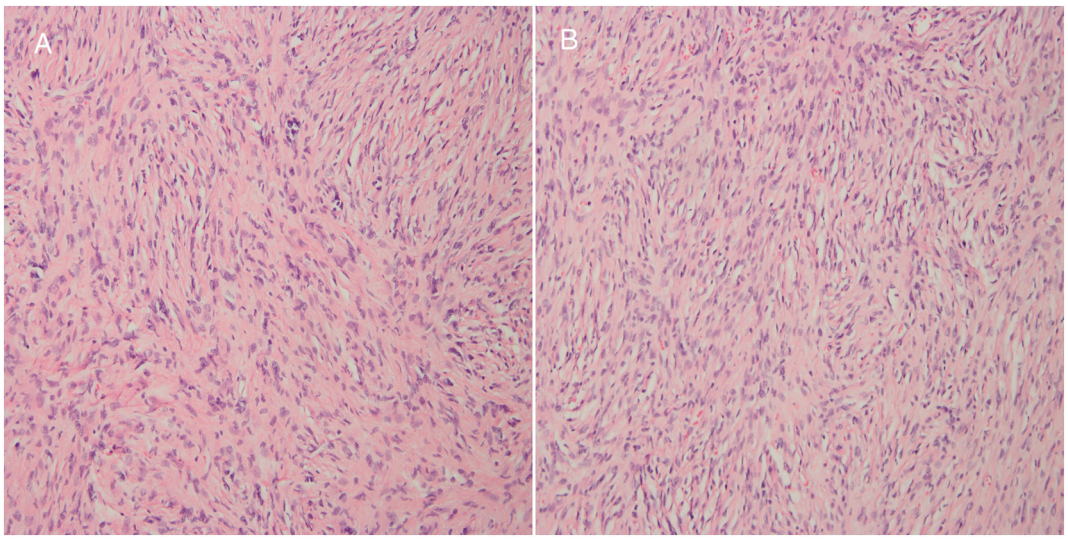

Fig. 6. Histopathological images. A is a histopathological image of DIA while B is a histopathological image of DIG.

pleomorphic xanthoastrocytoma which also has leptomeningeal involvement, ganglioglioma, and primitive neuroectodermal tumor from DIG and DIA [11,22].

MR spectroscopy offers the inimitable possibility of monitoring the metabolic changes in neoplasms of the brain non-invasively [4]. Some authors have evaluated the possibilities of MR spectroscopy in monitoring pediatric brain tumors most specifically DIGs and DIAs and found it to very beneficial [4,23,33,42]. Changes in tumor metabolism are firmed by evaluating the integral peak intensities conforming to choline (3.22 ppm), myoinositol (3.55 ppm), *N*-acetyl L-aspartate (2.01 ppm), and creatine (3.02 ppm). Furthermore, short TE pulse sequences were used to achieve better signal to noise ratios in all MR spectroscopic evaluations and high signal in J coupling resonance of mI [4,14,29].

Gross total resection is the preferred treatment option. Although surgical resection is achievable in 70% of DIG and DIA cases [28], only 56% of patients have access to complete resection [11] Intraoperatively, the solid superficial extracerebral component of the lesion is firm or rubbery in consistency, gray or white in color, and classically with dural attachment. Complete resection offers better prognosis than partial resection [3]. If partial resection is combined with adjuvant therapy, the disease-free periods are between 8.3 and 20 years [11,28,36].

Some authors propose that no complementary treatment is desirable in cases in which complete resection lesion is achievable [11,32,35]. When partial resection is attained, cautious follow-up is required to monitor possible tumor recurrence; however, similar to other forms of low-grade tumors, long relapse-free intervals have been described even after partial resections, signifying the possibility of tumor residual stabilization after a partial tumor removal [8,11,17,18]. Sporadically, spontaneous regression has been seen in some cases [28,34]. The main hindrance to total resection is the deep locations of the tumor or bilateral extension. The tumor location and the presence of multiple large cysts surrounding the tumor also determine the prognosis of patients after surgery [11].

Blood loss is a main intraoperative delinquent as indicated by Tamburrini et al. [11,35] The sheer size and diffuse vascularization of DIGs and DIA particularly contribute to amplified hemodynamic risk [11]. The degree of intraoperative hitches and blood loss should not be undervalued in patients with DIG and DIA. Preoperatively, it is fundamental to understand the association between the tumor, the sinuses and deeper vascular structures, and if this cannot be adequately seen on MRI it would be advisable to perform preoperative angiography [6]. The most common postoperative complication we have observed in these kinds of patients after surgery is the formation of a hydroma which is usually due to a potential space created after excision of tumor and subsequent influx of CSF into the potential space between the dura. The time interval between the operation and the formation of the hydroma in our cases ranged from one week to three months. We propose further observational studies in patients with DIG and DIA after surgery.

Chemotherapy is an optional treatment modality for infants with advancing disease after surgery when no further surgical resection is possible [8,9,11,17,21,35,37]. Another treatment modality is radiation therapy. It is advisable to deliver cranial radiation in doses of 3500–5000 cGy [11,37]. The prognosis is mostly virtuous in cases of complete resection, and recurrence-free intervals range from 6 months to 19 years in spite of the high cellularity and mitotic activity that has been seen in some areas of the tumoral mass [9,11,35]. In cases of recurrence, perhaps, a second surgical intervention is suggested.

Histopathologically, DIG and DIA are usually depicted with desmoplastic stroma in which neuroepithelial elements are found in capricious quantities with fibroblastic differentiation [28]. The neuronal elements can be perceived in different stages of maturation, revealing small and medium size ganglion cells exhibited in a diffuse form or in groups within the desmoplastic stroma, which may contain eosinophilic granular bodies and perivascular lymphocytic infiltrate [22,28]. The presence of gemistocytic bodies has also been observed in many instances. Furthermore, these lesions can possess undifferentiated cells with mitotic and necrotic figures, which can be anaplastic areas. The occurrence of this rare meticulous feature, as well as necrosis and endothelial proliferation, may signify an unfavorable prognosis [2,28].

The immunohistochemical profile of DIG often reveal a desmoplastic leptomeningeal component and fibroblast-like cells which express vimentin, GFAP, synaptophysin and NeuN. Furthermore, PGP9.5, neurofilament, and specific neuronal enolase are also seen with the stroma showing positive prominent reticulin rete as well as Masson trichrome [11,22,28]. The proliferation index of Ki67 is usually low with a composition of about 0.5–15% and normally interrelated with some low-grade qualities seen on radiologic images [11,28,39]. Currently h-CaD expression is very beneficial in differentiating smooth muscle cells/lesions, epithelioid mesothelioma, gastrointestinal stromal tumor, glomus tumor, myopericytoma and perivascular epithelioid cell tumors [7,28].

4. Conclusions

To the best of our knowledge, no author has reported a case or cases series on postoperative subdural hydroma of DIA and DIG. We believe the pathophysiology of this occurrence after surgery is as the result of a potential space created after excision of tumor and subsequent influx of CSF into the potential space between the subdural. The time interval between the operation and the formation of the hydroma in our cases ranged from one week to three months. A second surgery may be required in patients with this kind of postoperative complication if clinical and radiological imaging evaluation reveal deteriorating of the patient's condition otherwise conservative treatment usually gives a total resolution of this complication.

Abbreviations

DIG	Desmoplastic infantile ganglioglioma
DIA	Desmoplastic infantile astrocytoma
WHO	World Health Organization
DNIG or DNIA	non-infantile variant
MRI	Magnetic resonance imaging

Ethics approval and consent to participate

The ethical committee of the West China Hospital full approved our case series. Their parents were informed about our intension to involve them in a case series and they agreed to partake in the study. They signed the concern form before the operation was carried out according to all surgical protocols.

Consent for publication

Their parents were dually informed about our intention to publish their cases and they fully concerted to the use of their documents. The hospital also concerted to the use of their information for publication.

Availability of data and material

The datasets generated and/or analyzed during the current study are not publicly available due (confidentiality of the patients) but are available from the corresponding author on reasonable request.

Competing interests

All the authors have no competing interest to disclose.

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Authors' contributions

S.A.R. and F.W. conceived the project and S.A.R designed the study. S.A.R. and F.W. collected patient's data. Z.L and Y.J provided technical assistance in the study. S.A.R analyzed the data, F·W prepared the illustrations and S.A.R wrote the paper. All authors approved the paper for the submission.

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