

# Brain herniation in a neonate

Wong C Y, Azizi A B, Shareena I, Rohana J, Boo N Y, Isa M R

## ABSTRACT

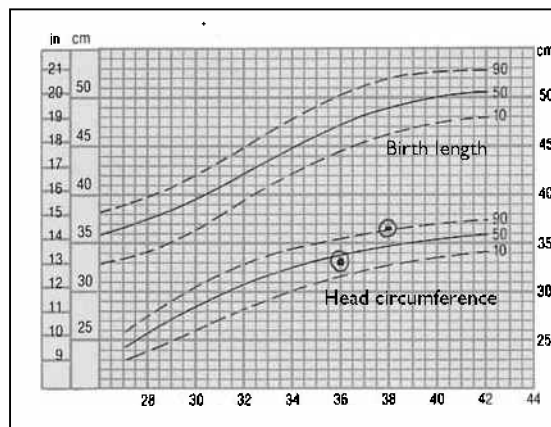
Brain herniation is generally thought to be unlikely to occur in newborns due to the presence of the patent fontanelles and cranial sutures. A review of the literature published from 1993 to 2008 via MEDLINE search revealed no reports on neonatal brain herniation from intracranial tumour. We report a preterm Malay male infant born via elective Caesarean section for antenatally diagnosed intracerebral tumour, which subsequently developed herniation. Cerebral magnetic resonance imaging showed features that were compatible with a large complex intracranial tumour causing mass effect and gross hydrocephalus. Tumour excision was scheduled when the infant was two weeks old. Unfortunately, on the morning of the surgery, he developed signs of brain herniation and had profuse tumour haemorrhage during the attempted excision. Histopathological examination revealed an embryonal tumour, possibly an atypical rhabdoid/teratoid tumour. This case illustrates that intracranial tumours in newborns can herniate and should therefore be closely monitored.

**Keywords:** brain herniation, intracranial brain tumours, neonate

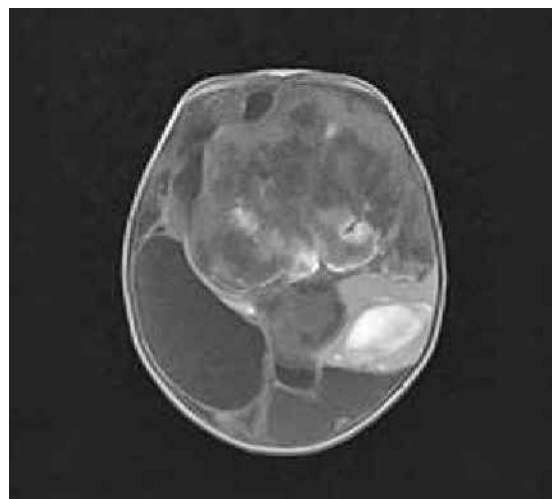
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## INTRODUCTION

Neonatal brain tumours are rare. It is generally thought that these tumours are unlikely to cause cerebral herniation due to the presence of the patent fontanelles and cranial sutures in newborns. In 1988, Radkowski et al reported a series of 12 infants who presented with brain tumours within 60 days of birth, but none of them developed signs of herniation.<sup>(1)</sup> A MEDLINE search of works published in 1993–2008 (using the terms ‘cerebral herniation’, ‘neonate’ and ‘brain herniation’) revealed that no cases or studies on herniation due to neonatal intracranial tumours have been reported. The present report describes a case of an atypical teratoid/rhabdoid tumour (AT/RT) in a newborn that developed evidence of brain herniation.



**Fig 1.** Graph shows a rapid increase in the patient's serial head circumference measurements within a period of two weeks. (Data source: Kitchen WH. Revised intrauterine growth curves for an Australian hospital population. *Aust Paediatr J* 1983; 19:157-61).



**Fig 2** Axial T1-W unenhanced MR image of the brain shows the tumour epicentre within the left frontal lobe.

## CASE REPORT

A Malay infant was born to a 34-year-old woman (para 4 + 2) who had an uneventful pregnancy until 35 weeks of gestation. Routine antenatal ultrasonography had revealed the presence of Type III placenta praevia and a mass in the foetal brain at the region of the Circle of Willis, measuring 3 cm × 3.6 cm with midline shift. The baby was subsequently delivered via elective Caesarean section at 36 weeks due to the above findings. At delivery, the infant weighed 2,400 g and his Apgar score was 9 at one and five minutes of life. No abnormalities were detected on physical examination, and no focal neurological signs were observed. The infant's anterior fontanelle was not

Department of  
Paediatrics,  
Universiti Kebangsaan  
Malaysia Medical  
Centre,  
Jalan Yaacob Latif,  
Kuala Lumpur 56000,  
Malaysia

Wong CY, MBBS,  
MMed  
Lecturer

Shareena I, MBBS,  
MMed  
Lecturer

Rohana J, MD, MMed  
Associate Professor

Boo NY, MRCP,  
FRCPE, FRCPG  
Professor

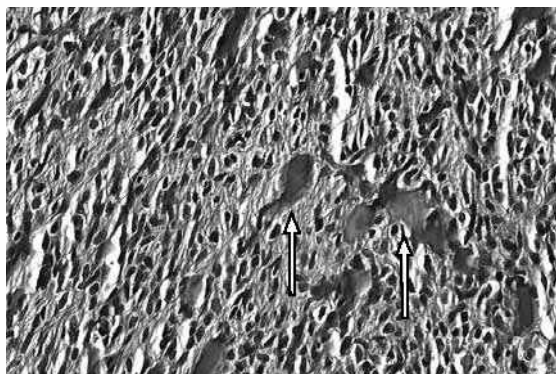
Department of Surgery

Azizi AB, MBBS, MS  
Lecturer

Department of  
Pathology

Isa MR, MBBS, DCP  
Associate Professor

**Correspondence to:**  
Dr Chee-Yeng Wong  
Tel: (603) 9132 2022  
ext 8811  
Fax: (603) 9139 2129  
Email: cheeyeng@  
gmail.com



**Fig. 3** Photomicrograph of the tumour tissue shows the presence of rhabdoid cells (arrows) (Haematoxylin & eosin,  $\times 200$ ).

bulging and the cranial sutures were not widely separated. An ultrasonography of the brain conducted on the first day of the infant's life showed a heterogeneous echoic lesion measuring 4.8 cm  $\times$  6.6 cm  $\times$  4.7 cm in the right parietal region extending to the midline with significant midline shift. There was gross right ventriculomegaly with a right periventricular cystic lesion.

Serial measurement of the infant's head circumference showed progressive rapid increment (Fig. 1). By the tenth day of life, the infant's cranial sutures were noted to be separated and his anterior fontanelle was bulging but soft. At two weeks of age, magnetic resonance imaging of the brain was carried out, which revealed a tumour with features that were suggestive of an aggressive, congenital, large complex intracranial tumour causing mass effect and gross hydrocephalus (Fig. 2). Excision of the tumour was scheduled on the following day. However, on the morning of the surgery, the infant developed signs of brain herniation with Cushing's reflex (heart rate 60 beats/minute, blood pressure 92/53 mmHg) and desaturation. After intubation and resuscitation, he was brought to the operating theatre and tumour excision was attempted. Unfortunately, the infant developed profuse uncontrollable haemorrhage from the tumour and died.

Histopathological examination of the tumour tissue revealed fragments of cellular tumour tissue admixed with cerebellar tissue and blood clot. The tumour was composed of sheets of malignant cells with areas of geographical necrosis and palisading of tumour cells around the necrosis. Associated small capillary proliferation was observed. The malignant cells had mild to moderate nuclear pleomorphism with hyperchromatic nuclei and abundant eosinophilic cytoplasm. In other areas, the tumour cells had eccentrically placed nuclei with vacuolated cytoplasm. Immunohistochemically, the malignant cells were positive for glial fibrillary acidic protein, vimentin and neuron-specific enolase, but negative for cluster differentiation (CD99), leucocyte common antigen, synaptophysin,

neurofilament protein and cytokeratin (Fig. 3). The final diagnosis was intracranial embryonal tumour, unclassified (World Health Organization [WHO] Grade IV), with the possibilities of AT/RT.

## DISCUSSION

Traditionally, medical students and doctors have been taught that cerebral herniation in a neonate due to intracranial tumours is unlikely to occur due to the presence of the patent fontanelles and sutures in newborns. These fontanelles and sutures enable the neonatal skull to expand as these tumours grow and keep the intracranial pressure down to a minimum. However, as this case illustrates, some malignant tumours can grow so fast that they can overwhelm the skull's capability to expand, thus causing raised intracranial pressure. This subsequently results in Cushing's reflex and coning.

The fourth edition of the WHO Classification of Tumours of the Central Nervous System classifies AT/RTs under Grade IV tumours.<sup>(2)</sup> A Grade IV classification is assigned to cytologically malignant, mitotically active and necrosis-prone neoplasms that are typically associated with rapid pre- and postoperative disease evolution and a fatal outcome. The clinical course of our patient and the immunohistochemical features of his tumour fit these descriptions.

AT/RTs of the central nervous system (CNS) are extremely rare and aggressive tumours of childhood. In 2004, a registry was established in North America to create an outcome database to facilitate biology studies for these tumours.<sup>(3)</sup> The database to date reveals that the age at diagnosis for these tumours ranged from 1.5 to 118 months (median 24 months), with a male to female ratio of 2:1. The incidence of AT/RTs was estimated to be 2%–3% of the primary CNS tumours that can occur in children aged 18 years or below.<sup>(4)</sup> Bhattacharjee et al noted that most of these tumours were located in the cerebellum (65%), as was found in our patient, but they might arise from any site.<sup>(5)</sup>

AT/RTs have a dismal prognosis. Studies<sup>(5-7)</sup> have reported a mean postoperative survival of only 11 months in the late 1990s and early 2000s. However, the chance of survival based on the North American registry was slightly better, with the reported median overall survival being 16.75 (range 2.5–96) months and the median event-free survival (EFS) at ten (range 1–96) months. This registry also reported that the overall survival and EFS were much lower in children below three years of age.<sup>(3)</sup>

The early literature on AT/RT has reported poor outcomes with conventional therapy. Survival has improved with the use of aggressive and intrathecal chemotherapy. Some centres have reported the use of high-dose chemotherapy in combination with stem-cell rescue for high-risk brain tumours. This registry also evaluated the role of surgery in the treatment of AT/RT. The EFS for patients who had gross total resection was 14 (range 1.5–72) months, while that for patients with partial resection was 9.25 (range 1–96) months.<sup>(3)</sup>

Cytogenetic abnormalities have been detected in patients with AT/RT.<sup>(3,4,6)</sup> Deletion at the 22q11 region was found in nearly 50% (11 of 23) of patients in the North American registry, while integrase interactor 1 (INI-1) mutation was found in 14 patients. A previous report has also implicated mutations/deletions in the INI-1 gene as being responsible for AT/RTs.<sup>(4)</sup> It also reported that the immunohistochemical reagent for INI-1 failed to stain the nuclei of tumour cells with INI-1 mutations, but did stain the cells of normal or reactive tissue. Molecular genetic analysis of the INI-1 gene may be useful in confirming the diagnosis of AT/RT in our patient. Unfortunately, at present, our hospital does not have the capability to perform a molecular genetic analysis of the INI-1 gene.

Neonatal brain tumours, although rare, should not be ignored. Cerebral herniation or coning due to the tumour

can occur rapidly in a neonate. Thus, close monitoring and early intervention are important in infants with a brain tumour.

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