CASE REPORT

Delayed extradural haemorrhage: a case for intracranial pressure monitoring in sedated children with traumatic brain injury within tertiary centres

Anna Hughes,¹ Conrad Lee,² Fenella Kirkham,³ Andrew J Durnford⁴

¹University of Southampton, Southampton, UK

²BSMS Teaching Building, University of Sussex, Brighton, UK

³Department of Pediatric Neurology, University Hospital Southampton, Southampton, UK

⁴Wessex Neuroscience Centre, University Hospital Southampton, Southampton, UK

Correspondence to
Anna Hughes,
aj8g08@soton.ac.uk

SUMMARY

A 15-year-old girl sustained a mild isolated traumatic brain injury following a pedestrian road traffic accident. She was ventilated for head computed tomography (CT) scan which revealed no intracranial abnormalities. Ventilation was not withdrawn until 15 h later when poor neurological recovery prompted urgent repeat CT, which demonstrated a delayed extradural haemorrhage (EDH). She underwent surgical evacuation, and intracranial pressure (ICP) monitoring was initiated postoperatively. She developed persistently raised ICP resistant to medical therapy, prompting further CT. This showed a recurrence of the delayed EDH requiring further surgical drainage. She made a good neurological recovery. There should be a low threshold for repeat CT to exclude delayed EDH when neurological status is poor despite normal CT soon after initial primary injury. ICP monitoring should be undertaken in children and adolescents who have normal initial CT, but in whom serial neurological assessment is not possible owing to sedation.

BACKGROUND

In adults extradural haemorrhage (EDH) occur in 1–2% of all head injury admissions; however, since skull fractures are less common in children because of the immature calvaria, the paediatric incidence may be less,¹ although rates of 3% in small paediatric series have been reported.² Delayed EDH is relatively uncommon and there are only limited reports in the literature describing delayed EDH in the paediatric population. In adults, the reported incidence is between 9 and 10%,³ with some series reporting rates as high as 30%.⁴ It is however, an important condition to consider in children with traumatic brain injury (TBI) with a deteriorating or poor neurological status, despite a normal initial CT head scan performed soon after initial primary injury.

This case highlights the use of intracranial pressure (ICP) monitoring to aid management in tertiary centres. In mild-to-moderate TBI, when serial neurological assessment is not possible owing to anaesthesia or sedation, ICP monitoring is advocated in tertiary centres. In this case, ICP measurement was a valuable monitoring tool for detection of recurrent EDH.

CASE PRESENTATION

A 15-year-old girl was hit by a car as she stepped out from behind a bus. She had a short loss of consciousness at the scene and was taken by ambulance to a local accident and emergency department.

Upon arrival at 18:00 h, she was agitated and confused, with a Glasgow Coma Score (GCS) of 13/15. Examination revealed a right scalp laceration in the parietal region measuring 7 cm, but no other visible injuries. She was haemodynamically stable (BP 159/74 mm Hg). She was intubated and ventilated for CT head and neck imaging.

INVESTIGATIONS

CT head and neck imaging showed no abnormalities except for possible traumatic subarachnoid haemorrhage. The patient was ventilated overnight on an adult intensive therapy unit with a plan to extubate her in the morning. The sedation was stopped at 16:00 h but the patient failed to recover consciousness by 20:00 h. A repeat CT head (figure 1) showed a right-sided extradural haemorrhage of 2 cm with 3 mm of midline shift. The patient was transferred from her local hospital to a tertiary neurosurgical unit for surgery.

DIFFERENTIAL DIAGNOSIS

- ▶ TBI
- ▶ Cerebral mass lesions—extradural or subdural haematoma

Figure 1 CT scan showing right-sided extradural haemorrhage with mass effect and associated soft tissue swelling.

To cite: Hughes A, Lee C, Kirkham F, et al. *BMJ Case Rep* Published online: [please include Day Month Year] doi:10.1136/bcr-2012-007543

TREATMENT

She underwent a right temporal mini-craniotomy and evacuation of extradural haemorrhage on arrival at 01:15 h. The bone flap was noted to be tight on replacement. A drain was left in situ and a right frontal ICP monitoring bolt inserted. ICP measured 25 mm Hg at closure. She was transferred postoperatively to the paediatric ICU and managed according to standard head injury protocols. Upon arrival her ICP measured 27 mm Hg. She was sedated with morphine and midazolam (100+100 mcg/1 g/h) with boluses of propofol and fentanyl as per head injury management protocols. She received norepinephrine inotropic support to maintain cerebral perfusion pressure (CPP) via a femoral central line. Her head was elevated and the patient was normothermic and normocapnic. Sodium was 142 mEq/l.

Despite neuromuscular blockade ICP remained elevated, therefore thiopentone therapy was started (7 mg/1 g/h) and titrated to a maximum dose. However, the ICP remained 25–30 mm Hg with spikes over 30 mm Hg although CPP was 60 mm Hg. A repeat CT head was undertaken which showed a recurrent right-sided extradural haemorrhage 16 mm deep with a dome mass effect and small haemorrhagic contusions on the surface of the left frontal and temporal lobes. The drain looked extracranial. She therefore returned to theatre for a reopening of her previous right craniotomy. As per standard head injury protocols, postoperative targets were ICP <25 mm Hg, CPP >60 mmHg, PaCO₂ 4–4.5 kPa and pO₂ >10 kPa. Good decompression was achieved and a wound drain inserted which was removed the following day.

The patient remained on the paediatric intensive care unit (PICU) postsurgery and her ICP remained below 25 with thiopentone, while an adequate CPP was maintained with norepinephrine. Thiopentone was stopped after a further 3 days following her second operation. A further 3 days later the ICP bolt was removed and the patient was moving all four limbs, opening eyes spontaneously and responding to commands with mouth movements but inappropriate speech. A repeat CT showed a resolving contusion in the left frontal and temporal lobes, no significant extradural reaccumulation, small ventricles, patent basal cisterns but a tight brain overall.

Pupils remained equal and reactive throughout her admission. She was discharged from PICU to the neurosurgery ward 11 days after her accident and was discharged to rehabilitation 12 days later.

OUTCOME AND FOLLOW-UP

The patient developed a nosocomial chest infection which responded to a 5-day course of cefotaxime. She also had ileus which was managed with total parenteral nutrition and a course of erythromycin.

Although the patient showed no clinical long-term neurological deficit, school reports from her teachers suggest that her academic performance and behaviour did not return to the level documented before the accident.

DISCUSSION

Paediatric guidelines for ICP monitoring were published in 2012 by Kochanek.⁵ These reported an association between intracranial hypertension and/or systemic hypotension and poor outcomes after severe TBI. Clinical factors indicating a higher incidence of intracranial hypertension include:

- ▶ Children with diffuse cerebral swelling on CT (75% specific)⁶;
- ▶ Children without spontaneous motor function (80% have ICP>20 mm Hg).⁷

Kochanek suggests that ICP monitoring is useful because of the association between intracranial hypertension (defined as >20 mm Hg) and poor neurological outcome or death. This indicates that ICP is an important prognostic variable in patients that should be measured. Kochanek also reports that successful ICP monitor-based management of intracranial hypertension is associated with improved survival and neurological outcome.

ICP monitoring following head injury can be routinely undertaken in an operating theatre or at the bedside in intensive care. Monitors are usually placed in the right-frontal region, under local anaesthesia, through a small burr hole made with a handheld twist drill. Various types of ICP monitors exist including intraventricular catheters, subdural and parenchymal, which are the most frequently used in head injury.⁸ It is a safe procedure and overall incidence of infection is 1.4% and, although intracranial haemorrhage rates in the paediatric population have been reported as 10%, all were graded as clinically silent and required no neurosurgical intervention.⁸

In anaesthetised or sedated children with severe TBI there is no clinical method of serial, reliable assessment of intracranial pressure without using invasive ICP monitoring. Despite this, only 59% of children presenting with severe TBI have ICP monitoring and only half of clinical units caring for these children use monitoring technology.⁹ The local hospital where this patient was treated initially in an adult intensive care unit (ICU) did not have facilities for ICP monitoring.

Guidelines for the management of adults with severe TBI published in 2007 recommend that ICP monitoring is started in¹⁰:

- ▶ Salvageable patients with severe TBI (GCS<8 after resuscitation) and an abnormal CT scan.
- ▶ Patients with severe traumatic brain injury with a normal scan and two of the following features: age >40 years, unilateral or bilateral motor posturing or systolic blood pressure <90 mm Hg.

Kochanek states that children with severe TBI (GCS<8) combined with an abnormal CT head scan suggests a high likelihood (53–63%) of raised ICP. However, those with a normal CT scan may also have intracranial hypertension. Therefore, detecting and managing raised ICP in all these patients is important.

Kochanek suggests that clinicians *could consider* invasive ICP monitoring in:

- ▶ Conscious children with abnormal CT head scans;
- ▶ Children with mild-to-moderate TBI in whom serial neurological examinations cannot be performed owing to pharmacological sedation or anaesthesia.

ICP monitoring was not initially started in this anaesthetised patient and EDH only became apparent later on after poor neurological status on weaning of sedation. Following surgical evacuation, ICP became elevated, with repeat CT showing recurrent EDH.

We suggest all head injury patients undergoing pharmacological sedation or anaesthesia in tertiary centres should undergo ICP monitoring.

Learning points

- ▶ Delayed extradural haemorrhage (EDH) after a normal CT is a rare but recognised entity.
- ▶ There should be a high index of suspicion for delayed EDH and repeat CT head imaging when poor neurological status exists following a normal CT head scan undertaken soon after initial primary injury.
- ▶ In tertiary trauma centres, all children with mild-to-moderate paediatric head injury should have intracranial pressure monitoring, even in the case of normal CT imaging, when serial neurological assessment is not possible, for example, because they are ventilated.

Competing interests None.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

- 1 Bullock MR, Chesnut R, Ghajar J, *et al.* Surgical management of acute epidural hematomas. *Neurosurgery* 2006;5:S7–15.
- 2 Maggi G, Aliberti F, Petrone G, *et al.* Extradural hematomas in children. *J Neurosurg Sci* 1998;42:95–9.
- 3 Borovich B, Braun J, Guilburd JN, *et al.* Delayed onset of traumatic extradural hematoma. *J Neurosurg* 1985;63:30–4.
- 4 Poon WS, Rehman SU, Poon CY, *et al.* Traumatic extradural hematoma of delayed onset is not a rarity. *Neurosurgery* 1992;30:681–6.
- 5 Kochanek P, Carney N, Adelson P, *et al.* Guidelines for the acute medical management of severe traumatic brain injury in infants, children and adolescents—second edition. Chapter 3: indications for intracranial pressure monitoring. *Pediatr Crit Care Med* 2012;13:S11–17.
- 6 Shapiro K, Marmarou A. Clinical applications of the pressure–volume index in treatment of pediatric head injuries. *J Neurosurgery* 1982;56:819–825.
- 7 Bruce DA, Raphaely RC, Goldberg AI, *et al.* Pathophysiology, treatment and outcome following severe head injury in children. *Childs Brain* 1979;5:174–191.
- 8 Blaha M, Lazar D, Winn RH, *et al.* Haemorrhagic complications of intracranial pressure monitors in children. *Pediatr Neurosurg* 2003;39:27–31.
- 9 Segal S, Gallagher AC, Sheffler AG, *et al.* Survey of the use of intracranial pressure monitoring in children in the United Kingdom. *Intensive Care Med* 2001;27:236–9.
- 10 Guidelines for the Management of Severe Traumatic Brain Injury. Brain Trauma Foundation. 2007.

Copyright 2013 BMJ Publishing Group. All rights reserved. For permission to reuse any of this content visit <http://group.bmj.com/group/rights-licensing/permissions>.
BMJ Case Report Fellows may re-use this article for personal use and teaching without any further permission.

Become a Fellow of BMJ Case Reports today and you can:

- ▶ Submit as many cases as you like
- ▶ Enjoy fast sympathetic peer review and rapid publication of accepted articles
- ▶ Access all the published articles
- ▶ Re-use any of the published material for personal use and teaching without further permission

For information on Institutional Fellowships contact consortiasales@bmjgroup.com

Visit casereports.bmj.com for more articles like this and to become a Fellow