Reverse brain herniation following ventriculoperitoneal shunt

INTRODUCTION

Cerebrospinal fluid (CSF) diversion procedures in patients with posterior fossa tumours and obstructive hydrocephalus carry the risk of reverse brain herniation (RBH) which is associated with significant mortality. RBH may aggravate hydrocephalus and cause hemorrhagic infarction of the brainstem and cardiorespiratory disturbances. We describe a patient with cerebellopontine (CP) angle tumour and hydrocephalus who underwent a ventriculoperitoneal (VP) shunt and developed RBH. This case emphasises the need for the prompt diagnosis of RBH and immediate interruption of the VP shunt in patients who deteriorate after the shunt. Also, early institution of mechanical ventilation and surgical decompression may improve the outcome even in severe cases of RBH.

CASE REPORT

A 45-year-old man presented with occipital headache, blurring of vision, and a tendency to fall, for six months. On examination, the patient was conscious with a pulse rate (PR) of 75/min and blood pressure (BP) of 190/110. The pupils were bilaterally equal and reacting to light. On fundus examination, papilloedema was present. There was sensory loss of the left half of the face and horizontal gaze-evoked nystagmus with fast component to the right. Gait was broadbased with swaying to the left. There were no motor deficits apart from mild spasticity. Magnetic resonance imaging (MRI) of the brain showed right CP angle tumour compressing the brainstem and extending upto the tentorium with severe hydrocephalus. An emergency VP shunt was planned. All other investigations were normal. In the operation theatre, the patient was premedicated with 100 µg of fentanyl and 0.2 mg of glycopyrrolate intravenously (IV). Standard monitors of the American Society of Anesthesiologists were used. After induction and intubation of the trachea with 300 mg of thiopentone sodium and 40 mg atracurium IV, anaesthesia was maintained with nitrous oxide, oxygen (50%:50%), and sevoflurane. A right-sided VP shunt (medium pressure) was done and clear CSF which was under high pressure was tapped. Intraoperatively, the BP was high (180–200 mmHg systolic) which was treated with intermittent bolus of 2 mg labetalol IV (total of 14 mg). After extubation, the patient was drowsy but responding to commands with no focal neurological deficits. Two hours after the VP shunt, there was sudden deterioration in the sensorium with both the pupils pinpoint and constricted. His PR was 64/min and BP was 140/90 mmHg. Within a few minutes, the patient became deeply comatose and apnoeic. After emergent reintubation and institution of mechanical ventilation, the shunt tube was blocked in the neck in the intensive care unit to stop further CSF drainage. An MRI scan was done which showed RBH of the midbrain and cerebellum. One hour later, the patient had regained regular spontaneous breathing.

Figure 1: Pre-operative magnetic resonance imaging (MRI). MRI of brain showed heterogeneously hypo on T1-weighted and hyper on T2-weighted sequences and a lesion measuring 4×3.5×3.5 cm with solid cystic contents occupying the right cerebellopontine angle, compressing and distorting the brainstem, and extending superiorly upto the tentorium and into the petrous bone, with severe hydrocephalus and periventricular oedema.

Figure 2: Post-operative magnetic resonance imaging. Reverse brain herniation.
respiration, his corneal reflexes were absent, and there was prominent downgaze with upgaze paresis tested by oculocephalic reflex. Noxious stimulation elicited decerebrate posture on the left and there was a paucity of movements on the right. The patient was taken up for emergency surgical decompression. Intraoperatively, the cerebellum was tense and the tumour was extending across the tentorium. Subtotal excision of the tumor was done. Postoperatively, sensorium of the patient continued to be poor. A tracheostomy was done on the third postoperative (PO) day. On the sixth PO day, the patient regained consciousness and from then on showed improvement. He was gradually weaned off the mechanical ventilation. At discharge on 37th PO day, the patient was conscious, obeying commands, and accepting nasogastric (NG) feeds with mobilisation on wheel chair.

**DISCUSSION**

The incidence of hydrocephalus in patients with posterior fossa tumours is quite high (72%).[3] CSF diversion may not only improve symptoms like vomiting but also stabilise intracranial contents providing a slack operative field at the time of definitive surgery. However, post-operative deterioration in the condition of the patient after VP shunt should alert the clinician to the possibility of RBH of the brain. RBH is the least understood of the brain herniation syndromes and is a rare complication of VP shunt with an incidence of 3%. A Cuneo et al.[1] reported that cerebellar mass (65%) is the commonest lesion associated with RBH, followed by lesions of CP angle (13%), the pons (11%), and the fourth ventricle. It usually occurs when the mass originates near the incisura, when drainage of the lateral ventricles relieves obstructive hydrocephalus, or when the opening in the tentorium is large. There is double blockage of CSF, both at the aqueduct below and at the prepontine and ambient cisterns above which aggravates hydrocephalus. The compression of the veins of Galen and Rosenthal causes haemorrhagic infarction of the brainstem. Direct compression of the brainstem and downward tonsillar herniation may be present. The clinical picture includes signs of pontine compression such as progressive obtundation, hyperventilation, decerebrate rigidity, and small fixed pupils. Midbrain involvement is suggested by the loss of upward gaze and pupils which may be fixed and dilated (indicating dysfunction of third cranial nerves) or small and unequal (suggesting dysfunction of the midbrain third cranial nuclei).[1] Compression of the brainstem nuclei causes severe bradycardia and asystole.[2] We offer a similar explanation for the refractory hypertension observed during the shunt procedure. The tumour was large with a tendency to prolapse into the supratentorial compartment, and a sudden decrease in the supratentorial pressure due to the shunt caused RBH. Signs of both pontine and midbrain compression were present. Interruption of VP shunt and prompt institution of mechanical ventilation immediately after clinical diagnosis of RBH may have reduced the extent of herniation. Though our patient was comatose for a long duration, the final outcome was favourable. Hence, surgical decompression should be undertaken as soon as possible even in cases of severe RBH.

The mortality associated with RBH is significant. In the same series by Cuneo et al,[1] only seven cases out of a total of 52 reviewed were diagnosed antemortem and the mortality was 100%. Cases reported later in the literature had a better outcome.[2,4,5] In about 25% of the patients, ventricular drainage is directly responsible for precipitation of the herniation. Hence, patients who undergo CSF diversion should be observed closely for neurological deterioration postoperatively.

This case report highlights the fact that VP shunt for expanding posterior fossa tumours may produce RBH. With prompt diagnosis, immediate interruption of the shunt, institution of mechanical ventilation, and early surgical decompression, the outcome in this condition may be improved which is otherwise associated with high mortality.

**REFERENCES**

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INTRODUCTION
Children undergoing radiological imaging studies often require sedation to avoid panic episodes and motion artifacts. According to the literature, up to 10% of all Magnetic Resonance Imaging (MRI) examinations cannot be completed or even started because of claustrophobia. [1] When medicamentous sedation for MRI is desired, Benzodiazepines are used in most MRI centres.[1] Dexmedetomidine (DEX) is a highly selective $\alpha_2$ adrenoceptor agonist that has sedative and analgesic effects. Intranasal DEX has shown to provide effective sedation when used prior to anaesthetic induction as premedication.[2] Intravenous DEX has been shown to provide a reliable and effective sedation to children undergoing diagnostic computed tomography imaging studies. [3]

Our prospective, quasi-experimental, pilot study aims to determine whether intranasal DEX 2 $\mu$g kg$^{-1}$ offered effective sedation in children posted for diagnostic MRI studies.

METHODS
The study was approved by institutional ethics committee and written informed consent was taken from the parents/guardian of children, aged up to 10 years prior to MRI procedure. Standard NPO guidelines were followed. Exclusion criteria were: Age >10 years, General contraindications for MRI (i.e. cardiac pacemakers, neurostimulators, ferromagnetic implants etc), known allergy to DEX, presence of otorhinological diseases and children with major respiratory and cardiac diseases. After securing venous access, all patients were administered with intranasal DEX 2 $\mu$g kg$^{-1}$ using tuberculin syringe in the presence of parents, 30 minutes before scheduled MRI scan. The time of administration and reaction of children were noted. To avoid interobserver's bias, same anaesthesiologist was involved in all the assessments. Children were observed in the holding area with standard monitors applied. The degree of sedation was assessed at 15 and 30 minutes by using University of Michigan Sedation Scale (UMSS)[Appendix 1].[4] A sedation score of 2 and above was considered satisfactory. At 30 minutes, the child was separated from its parent and was taken to the procedure room. The response to the child-parent separation was noted. Children with scores less than 2 and children with sedation scores more than 2 who became uncooperative during the procedure were labeled as failed cases and received rescue sedation in the form of intravenous midazolam in titrated doses. MRI image quality of each examination was assessed using the following five grade scale: Grade 0 or 1: Was applied if the examination was of no or very little diagnostic usefulness because of extensive motion artifacts. Examination classified as grade 2: Allowed us to make the diagnosis, but some motion artifacts were still present. Examinations graded as 3 and 4: Included a good or excellent image quality, with no or almost absent motion artifacts. Recovery time and recovery score were noted according to Modified Aldrete recovery score.[5]

RESULTS
Twenty eight children between age group one month to ten years received DEX as per above protocol for diagnostic MRI studies, with average weight 10.7±7.8 kgs. Majority of MRI studies consisted of Brain Imaging; only 2 examinations were for imaging

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