Tension pneumocephalus after neurosurgery in the supine position

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Tension pneumocephalus has been reported most frequently after posterior fossa surgery performed in the sitting position. We present a paediatric patient who developed tension pneumocephalus in the postoperative period after decompression of a craniopharyngioma performed with the patient in the supine position.

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Pneumocephalus (asymptomatic intracranial air) after craniotomy is a common occurrence.1,2 The incidence of pneumocephalus after supratentorial craniotomy has been reported to be 100%.3–4 However, transformation of pneumocephalus into tension pneumocephalus (symptomatic intracranial air) is a rare phenomenon. Tension pneumocephalus after posterior fossa surgery performed in the sitting position has been reported5–9 but we are not aware of tension pneumocephalus reported after craniotomy in the supine position.

We present the case of a paediatric patient who developed tension pneumocephalus in the early postoperative period after decompression of a craniopharyngioma in the supine position.

Case report

A 10-yr-old, 25-kg boy was admitted with symptoms of headache and vomiting of 1 yr duration. He had bilateral papilloedema but examination was otherwise normal. Haematological and biochemical indices were within normal limits. A CT scan of the head revealed a large mixed density attenuating suprasellar lesion with peripheral calcification and significant hydrocephalus. A diagnosis of craniopharyngioma with gross hydrocephalus was made.

Immediately after admission the child underwent a ventriculoperitoneal shunt under balanced anaesthesia. The intraoperative and postoperative course were uneventful. One week later, he was listed for surgical decompression of the craniopharyngioma to be performed in the supine position. The child was given diazepam 0.2 mg kg⁻¹ orally the night before and on the morning of surgery. Glycopyrrolate 0.1 mg and promethazine 0.5 mg kg⁻¹ were administered i.m., 1 h before induction of anaesthesia. In the operating theatre, an 18-gauge i.v. cannula was sited on the dorsum of the left hand. Continuous monitoring of the ECG, pulse oximetry and non-invasive arterial pressure was instituted. Thiopental 5 mg kg⁻¹ was used for induction of anaesthesia followed by vecuronium 0.2 mg kg⁻¹ to facilitate tracheal intubation. Anaesthesia was maintained with 66% nitrous oxide in oxygen, vecuronium and isoflurane. Pethidine 1 mg kg⁻¹ was administered to provide intraoperative analgesia. Invasive arterial pressure (cannulating the left radial artery), central venous pressure (through the right basilic vein) and core temperature (oesophageal temperature probe) were monitored continuously during the intraoperative period. End-tidal carbon dioxide partial pressure was maintained at 3.7–4.0 kPa (Datex AS3). Mannitol 1 g kg⁻¹ (125 ml) was infused to provide optimum brain relaxation.

Near total decompression of the craniopharyngioma was carried out with no complications. Surgery lasted 3 h. A total of 1000 ml of crystalloid solutions were given i.v. during the course of the procedure. Residual neuromuscular block was antagonized with neostigmine 50 µg kg⁻¹ and atropine 20 µg kg⁻¹. The child’s trachea was extubated when he was fully conscious, obeying verbal commands and moving all four limbs. He was transferred to the neurosurgical intensive care unit for postoperative management.

Three hours after surgery, the child’s conscious level deteriorated and he became unresponsive. However, he was maintaining his airway and ventilatory frequency was 20 bpm. Oxygen saturation was 97–99% and arterial pressure 110/70 mm Hg. The ventriculoperitoneal shunt was observed to be functioning well. A CT scan revealed a large frontoparietal pneumocephalus without any midline shift (Fig. 1). Frontal twist drill hole aspiration of the pneumocephalus was performed and air gushed out under pressure. Approximately 40 ml of air were drained. The child’s sensorium showed
It may manifest as deterioration of consciousness with or without lateralizing signs, severe restlessness, generalized convulsions or focal neurological deficit.

Cardiac arrest in the immediate postoperative period caused by tension pneumocephalus has been reported in a patient who had undergone posterior fossa surgery in the sitting position.

Several contributing factors have been implicated in the pathogenesis of tension pneumocephalus. They are: (1) nitrous oxide anaesthesia, (2) duration of surgery, (3) gross hydrocephalus, (4) a functional ventriculoperitoneal shunt and (5) intraoperative administration of mannitol.

We believe that nitrous oxide played no part in our patient as the child deteriorated 3 h after discontinuation of anaesthesia. Neither was surgery prolonged.

In gross hydrocephalus, a proportionately greater volume of cerebrospinal fluid can be drained during surgery and this can be replaced by air. A functioning ventriculoperitoneal shunt aids in continuous drainage of cerebrospinal fluid from the lateral ventricles into the peritoneal cavity throughout the surgical procedure and in the postoperative period, thereby creating even more space for intracranial air. Our patient presented with gross hydrocephalus because marked improvement immediately after frontal drill hole aspiration. He started responding to verbal commands. The remainder of the postoperative course was unremarkable and he was discharged 11 days after operation with no neurological deficits.

Discussion

Postoperative pneumocephalus is commonly observed after intracranial surgery. The amount of intracranial air may vary but it is usually benign in nature and takes approximately 2–3 weeks for complete reabsorption. The presence of pneumocephalus in a patient requiring surgery is of special concern to the anaesthetist because of the possible iatrogenic development of tension pneumocephalus secondary to the use of nitrous oxide, as nitrous oxide administration can lead to expansion of any trapped air loculi, thereby increasing intracranial pressure. It is likely that patients at highest risk of nitrous oxide-induced tension pneumocephalus are those who have recently undergone a craniotomy and who then must be returned to the operating room for emergency exploration. In these patients it is better to defer the use of nitrous oxide until the dura is opened.

Very rarely, however, a patient may develop tension pneumocephalus immediately after craniotomy or craniectomy. When our patient deteriorated 3 h after surgery we did not consider the possibility of tension pneumocephalus. Emergency CT scan was performed to rule out postoperative intracranial haematoma. But, to our surprise, the scan revealed intracranial air with compression of the frontal horns. This was confirmed further when the intracranial air gushed out under pressure during frontal drill hole aspiration and the child’s sensorium improved immediately.

Tension pneumocephalus may present in one of several ways. It may manifest as deterioration of consciousness with or without lateralizing signs, severe restlessness, generalized convulsions or focal neurological deficit.

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In retrospect, we believe that administration of mannitol may have enhanced the cerebrospinal fluid loss during the surgical procedure by reducing the brain volume and decreasing the production of cerebrospinal fluid. After completion of surgery, the shrunken brain starts re-expanding to its normal contour after rehydration, normocapnia, brain oedema and replacement of depleted cerebrospinal fluid.

To prevent accumulation of intracranial air, efforts must be directed to minimize cerebrospinal fluid loss during intracranial surgery. In the presence of gross hydrocephalus with a functioning ventriculoperitoneal shunt, temporary blockage of the shunt may minimize cerebrospinal fluid loss. Cerebral perfusion pressure should be maintained within the normal range by maintaining good hydration. After excision of the tumour, it is better to slowly increase end-tidal carbon dioxide partial pressure towards normal so that the brain can regain its preoperative contour.

Prompt detection of intracranial hypertension caused by tension pneumocephalus is aided by intracranial pressure monitoring. The benefits of intracranial pressure monitoring in the immediate postoperative period must be weighed against the associated risks and complications. The major complications of intracranial pressure monitoring are infection, the need to restrict patient movement and monitoring drift or artificially low readings.

In summary, a paediatric patient developed tension pneumocephalus after excision of a craniopharyngioma in the supine position. We believe that this was caused by a combination of contributing factors such as preoperative...
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Gross hydrocephalus with functioning ventriculoperitoneal shunt and intraoperative use of mannitol. Prompt diagnosis and immediate management help in salvaging such patients.

References
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