Tension pneumoventricle after placement of a ventriculoperitoneal shunt: a novel treatment strategy

Case report


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A case of pneumoventricle following insertion of a ventriculoperitoneal shunt for hydrocephalus is described. The pneumoventricle was associated with significant morbidity, which improved with treatment. The authors propose a rational treatment for this condition, which, as far as they know, has not previously been described. They also discuss potential mechanisms involved in the pathogenesis of pneumoventricle.

KEY WORDS • pneumoventricle • intraventricular pneumocephalus • postoperative complication • shunt

NEUMOCEPHALUS, the presence of air within the intracranial cavity, is usually a posttraumatic phenomenon. Iatrogenic causes are also well recognized and may be seen after intracranial surgical procedures or the insertion of a lumbar drain for treatment of CSF otorrhea or rhinorrhea.

We describe a case of postoperative intraventricular air that was associated with significant morbidity, which improved with treatment. We propose a rational treatment for this condition, which, to our knowledge, has not previously been described.

Case Report

History. This 47-year-old man was admitted to our institution for the removal of a large intraventricular meningioma, which had recurred 13 years after initial tumor removal (Fig. 1). Surgery was uneventful and total tumor removal was achieved. Three weeks later the patient presented with confusion and dysphasia. Computerized tomography scanning revealed hydrocephalus and a large cyst that communicated with the ventricle, as well as a pseudomeningocele (Fig. 2).

A ventriculoperitoneal shunt with a medium-pressure valve was inserted, using a preexisting gap in the bone above the cyst for catheter access. Postoperatively the patient appeared more drowsy and was mute. An immediate postoperative CT scan revealed the presence of massive intraventricular air (Fig. 3 left). The patient was placed in the right lateral position with his head tilted as far posteriorly as possible and the vertex slightly tilted toward the floor so the opening where the shunt catheter entered the brain was the least dependent point of the skull. Wrist and ankle weights were placed on the patient to prevent rotation, and the frontal horns to the most superior part of the skull. A 16-gauge intravenous cannula was attached to a 50-ml syringe containing irrigation fluid. The ventricle was filled with the irrigation fluid until overflowing. This procedure was repeated several times. Intermittently we gently manipulated the head in a rotational fashion to facilitate the rising and escape of air. Air was witnessed to bubble up through the fluid standpipe until no more air was seen to escape. Neither the proximal nor distal shunt catheters were revised.

Postoperative Care. The patient later layed return to his baseline level of function. That revision was uneventful and he has made a full recovery.

Operation. The patient was placed in the right lateral position with his head rotated approximately 45° to the right. His condition continued to improve, and by 2 weeks postoperatively the air had vanished from the ventricles (Fig. 4). The patient was discharged with persistent hydrocephalus and a pseudomeningocele (Fig. 5). He was asymptomatic and returned to his pre-morbid level of functioning.

Iatrogenic pneumoventricle is usually benign and usually rapidly resolved.

One study documented that intracranial air is present in all cases of pneumocephalus, the presence of air within the intracranial cavity, is usually a posttraumatic phenomenon. Iatrogenic causes are also well recognized and may be seen after intracranial surgical procedures or the insertion of a lumbar drain for treatment of CSF otorrhea or rhinorrhea. We describe a case of postoperative intraventricular pneumocephalus—pneumoventricle—which is less commonly reported in the literature. This case is unusual in that it occurred suddenly, had striking imaging findings, and was associated with significant clinical morbidity, which improved with treatment. We propose a rational treatment for this condition, which, to our knowledge, has not previously been described.

Abbreviations used in this paper: CSF = cerebrospinal fluid; CT = computerized tomography.
Operation. The patient was placed in the right lateral position with his head rotated approximately 45˚ to the right side and the vertex slightly tilted toward the floor so the opening where the shunt catheter entered the brain was the least dependent point of the skull. We kept the patient in this position for several minutes and would occasionally gently agitate and rotate his head in an attempt to mobilize air from the frontal horns to the most superior part of the skull. A 16-gauge intravenous cannula without the needle was inserted into the cyst immediately adjacent to the shunt, and the cannula was attached to a 50-ml syringe filled with warm irrigation fluid. The ventricle was filled with the irrigation fluid until overflowing. This procedure was repeated several times. Intermittently we gently manipulated the head in a rotational fashion to facilitate the rising and escape of the air. Air was witnessed to bubble up through the fluid standing in the extracalvarial space. We performed these maneuvers until no more air was seen to escape. Neither the proximal nor distal shunt catheters were revised.

Postoperative Course. The following day CT scanning demonstrated a marked improvement in the amount of intraventricular air and the patient was more alert (Fig. 3 right). His condition continued to improve, and by 2 weeks postoperatively the air had vanished from the ventricles (Fig. 4). The patient subsequently required another shunt revision for persistent hydrocephalus associated with a delayed return to his baseline level of function. That revision was uneventful and he has made a full recovery.

Discussion

Iatrogenic pneumocephalus is common, although it is usually benign and typically does not require treatment. One study documented that intracranial air is present in all cases following supratentorial craniotomy, and its incidence decreases by approximately 25% per week postoperatively as the air is eventually resorbed. Obviously, this incidence partially depends on the amount of pneumocephalus; if an extraordinarily large amount of air is present it may take months for it to resorb completely. Factors contributing to iatrogenic pneumocephalus include the following: site and duration of intracranial surgery; presence of gross hydrocephalus, functioning shunt or CSF drain, or a CSF fistula; intraoperative administration of mannitol; and nitrous oxide anesthesia. In our case, the main contributing factors were arguably the presence of hydrocephalus and the amount of CSF that was lost as taken back to the ventricles with fluidation was primarily present. We also believe air and more like-

![Image 1](image1.png)

![Image 2](image2.png)

![Image 3](image3.png)

![Image 4](image4.png)
after opening the pseudomeningocele. Theoretically, the influx of air into the intracranial cavity is greater in the presence of a noncompliant ventricular system because the ventricles do not collapse as the fluid is drained and more air is allowed to fill the ventricle. The presence of such large amounts of intraventricular air seen hours after shunt insertion indicates that the ventricular system was noncompliant and contributed to the amount of pneumoventricle.

It is possible that this complication could have been minimized using a frontal ventriculostomy to place the shunt, but this is speculation. We chose our insertion site based on the presence of an existing bone defect in the skull; here the catheter only had to pass through a thin layer of cortex, which had previously been violated at the time of tumor resection.

We hypothesized that gentle manipulation and rotation of the patient’s head would allow the air to redistribute itself to the least dependent portion of the skull, because air is less dense than CSF. After the air had been redistributed, we hypothesized that filling the ventricles with fluid would allow the fluid to displace the air, thus treating the pneumoventricle. Although it may seem obvious, to our knowledge this technique has not been described in the neurosurgical literature for intraventricular pneumocephalus, although it has been used for subdural pneumocephalus. In addition to literature searches covering more recent time periods, we conducted a Medline search for the period 1951 to 1965 and a Web of Science search for the period 1945 to 1960. No reports of this complication or of this method of treatment could be found, even during the era when pneumoencephalography was commonly performed.

Our case was very unusual because pneumoventricle developed immediately after placement of a shunt. There have been reports of pneumoencephalus in patients with shunts, but these cases usually presented in a delayed fashion and were associated with a cranial defect. The other unique feature of this case is the type of treatment we used for the pneumoventricle, which, to our knowledge, has not previously been described for this condition. Our treatment appeared to have worked, although the patient might well have improved on his own.

Conclusions

Pneumoventricle is an uncommon condition that may be seen following excessive CSF drainage in the presence of a noncompliant ventricular system. Positioning the patient so that the air is in the least dependent area and carefully filling the ventricles with irrigation fluid provides a reasonable and effective approach to the treatment of iatrogenic pneumoventricle not associated with a CSF fistula.

References


Manuscript received April 5, 2004. Accepted in final form October 4, 2004.

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