RHINORRHEA AND PNEUMOCEPHALUS

SURGICAL TREATMENT

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Cerebrospinal fluid rhinorrhea, or the discharge of cerebrospinal fluid from the nose, has been known for many years. Neurosurgeons and their otolaryngological colleagues have been aware of the potential dangers of rhinorrhea. Cerebrospinal fluid fistula may result in a meningitis or brain abscess. Though the mortality from these infections in recent years has been reduced by the administration of the antibiotics, there remains a significant risk. When rhinorrhea is present there must be a communication with the subarachnoid space or with one of the cerebral ventricles.

Rhinorrhea can result from (1) fractures of the skull in the vicinity of the paranasal sinuses, (2) postoperative defects, (3) erosions caused by tumors or infection, and (4) congenital anomalies. Spontaneous closure of these fistulae may occur. There are reported cases in which fistulae have persisted for years. Thomson15 reported the occurrence of rhinorrhea in a patient in whom it had persisted for several years. Plum19 described a case of fistula of 18 years’ duration. Many more fatal cases have been reported. Most all neurosurgeons now agree that chronic rhinorrhea requires surgical intervention. Grant13 attempted to close a cerebrospinal fluid fistula by an intracranial exposure. Dandy7 reported the first successful attempt to close such a fistula with fascia lata graft. Cushing6 reported the successful surgical treatment with fascial grafts in 3 patients in whom rhinorrhea developed following the removal of orbito-ethmoidal osteomas. Several others have reported patients cured by surgery: Rand,14 Cairns,3 Gissane and Rank,10 Adson,1 Campbell, Howard, and Weary,4 German,9 Dandy,8 and Adson and Uihlein.2

Pneumocephalus, or air within the cranial cavity, is sometimes seen in a patient with a cerebrospinal fluid fistula. Extradural and subgaleal collections of air arising from a communication through the outer wall of a cranial air sinus have been recognized for a century and a half, according to Dandy. Intracranial collections of air, however, had gone unrecognized until the advent of the x-ray, with the exception of the famous case reported by Chiari6 in 1884. At autopsy, he found air in a large cavity in the frontal lobe and in the ventricular system, and he found communication from an ethmoid

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sinus to the frontal fossa secondary to an infection. He explained the presence of the intracranial air as having been caused by the explosive force of sneezing. Luckett, in 1913, reported the first case of pneumocephalus visualized by x-ray. Dandy reviewed 25 cases which he found in the literature and added 3 of his own, in 1 of which he cured the patient by intracranial surgery. He stated: "There are two sources of intracranial air: (1) a break in the wall of the skull, through which air is forced from the exterior, and (2) the product of gas producing organisms after their entrance into the brain. After the initial cranial defect, air can be forced into the brain only through an opening in one of the paranasal sinuses or the mastoid cells, for here alone can the air be concentrated by swallowing, coughing or sneezing under a pressure greater than that within the cranial chamber." He indicated that the intracranial air can be located in (1) the subarachnoid space, (2) the subdural space, (3) the brain, and (4) the ventricles. Dandy felt that subarachnoid air must gain entrance through the cisternae at the base of the brain via the ethmoid or sphenoid sinus. Subdural air could occur from a communication with a frontal sinus. He found that the intracerebral cavity was most common and that with this cavity there is always a communication with a frontal or ethmoid sinus. Intraventricular pneumocephalus usually occurs secondary to intracerebral or subarachnoid collection of air. It seems likely that there must be some valve-like action in the fistulous opening. Dandy discussed this point at length and he stressed the danger of sneezing in the presence of rhinorrhea.

**MATERIAL**

In this report we are presenting 15 cases of chronic rhinorrhea and 12 cases of persistent pneumocephalus. All but one of these 27 patients were treated surgically during a 7-year period ending 1 year ago and cured of the rhinorrhea and pneumocephalus. Case 9 was not treated. The patient elected to return to Brazil to the surgeon who had originally operated on him for a suprasellar cyst.

**Rhinorrhea** (Table 1). Of the 15 cases, trauma was the etiological agent in 13, congenital nasal meningocele in 1, and postoperative craniotomy for suprasellar cyst in 1. In the traumatic group, 9 were cases of frontal fractures following auto or jeep accidents, and 4 were caused by shell or gunshot wounds, one of which was self-inflicted. At the time of surgery, the duration of rhinorrhea varied from 1 month to 5 years. Only 3 of these patients were known to have had meningitis (Cases 2, 10 and 15). Case 2 had had four attacks of meningitis.

At surgery, an opening communicating with the ethmoid sinus was found in 10 cases, and in 3 the opening communicated with the frontal sinus. In Case 12, there was a communication with both the right frontal and left ethmoid sinuses. The second fistula was not discovered until the second operation. Cases 5 and 13 required three surgical attacks before closure of the cerebrospinal fluid fistula was accomplished. Case 15 had to be operated up-
on twice before cure was effected. In Case 7 a wound infection developed, and the bone flap had to be removed because of osteomyelitis; the wound did not heal until a foreign body was removed. Case 10 was not operated upon.

Pneumocephalus (Table 2). Of the 12 cases, 10 were of traumatic origin, 1 (Case 21) occurred following removal of a sphenoid ridge meningioma and 1 (Case 17) was secondary to an osteoma of the frontal sinus. In the trau-
matic group, 6 sustained frontal fractures in auto accidents. Three cases resulted from gunshot wounds: 2 self-inflicted, and 1 accidentally incurred. Case 24 had a compound depressed frontal fracture caused by an industrial accident.

Intracranial air was first discovered from 1 week to 2 years after injury in the traumatic cases. Pneumocephalus was first detected in Case 17 (osteoma of frontal sinus) 1½ months after the onset of symptoms. In Case 21, in which a sphenoid ridge meningioma had been removed, pneumocephalus was first detected 2 months after surgery. Many of these patients were confused and disoriented when seen by us. Headache was a common complaint. Three of these patients were known to have had an episode of meningitis before surgery. A history of cerebrospinal fluid fistula (usually rhinorrhea) was obtained in all cases but one. Five of the 12 patients were known to have convulsions, whereas while under our care none of those in the rhinorrhea group was known to have convulsions. A communication with an ethmoid or a frontal sinus was found in all cases excepting Case 23. In this case, there was a cerebrospinal fluid fistula in the craniectomy wound in the left frontal region through which debridement of skull, dura mater, and brain had been accomplished elsewhere. At surgery, it was determined that this fistula was the site of entrance of the air; the dura mater had not been closed. The location of the air in these cases of pneumocephalus was most commonly within the substance of the frontal lobe. A pneumatocele was found in the frontal lobe in 10 cases. In 6 of these cases, there was also pneumoventricle. In 1 of

Fig. 1. Case 18 (Table 2). Pneumocephalus and pneumoventricle secondary to self-inflicted gunshot wound.
### RHINORRHEA AND PNEUMOCEPHALUS

#### TABLE 2

**Pneumocephalus (12 cases)**

<table>
<thead>
<tr>
<th>Case</th>
<th>Age</th>
<th>Etiology</th>
<th>Time Air Was First Detected*</th>
<th>Symptoms and Signs</th>
<th>Time Elapsed Before Surgery*</th>
<th>Sinus Involved</th>
<th>Location of Air</th>
<th>Result of Surgery</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.</td>
<td>J.L.</td>
<td>21</td>
<td>Osteoma</td>
<td>Headache, typing</td>
<td>2½ mos.</td>
<td>Lt. fr.</td>
<td>Brain ventricle</td>
<td>Subdural Cured</td>
<td>Rt. 3rd nerve since injury Bullet wound, convulsions Meningioma had been removed from sphenoid ridge</td>
</tr>
<tr>
<td>19.</td>
<td>R.C.</td>
<td>34</td>
<td>Auto accident</td>
<td>Rhinorrhea</td>
<td>4 mos.</td>
<td>Lt. fr.</td>
<td>Brain ventricle</td>
<td>Subdural Cured</td>
<td>Rt. 3rd nerve since injury Bullet wound, convulsions Meningioma had been removed from sphenoid ridge</td>
</tr>
<tr>
<td>22.</td>
<td>C.P.</td>
<td>61</td>
<td>Auto accident</td>
<td>Drowsiness, diabetes insipid., rhinorrhea, bitemporal hemianopsia</td>
<td>3 mos.</td>
<td>Lt. fr.</td>
<td>Subarachnoid ventricle</td>
<td>Cured</td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>C.J.</td>
<td>57</td>
<td>Gun shot</td>
<td>Confused, CSF fistula in wound, lethargy, vomiting Drowsy, headachy, Rhinorrhea, at time of injury</td>
<td>1½ mos.</td>
<td>None—fistula Brain communicated with Lt. fr. wound</td>
<td>Brain Cured</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.</td>
<td>O.W.</td>
<td>42</td>
<td>Depressed fracture at work</td>
<td>Headache, rhinorrhea, Blurred at time of injury</td>
<td>2½ mos.</td>
<td>Lt. fr.</td>
<td>Brain Cured</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Time elapsed since trauma or other etiological cause.

These cases, there was also subdural air. There was only 1 other case of subdural location of air. In Case 22, there was pneumoventricle and subarachnoid air. All but 1 of the patients with pneumocephalus were cured by one operation; in Case 16 a second operation was necessary to cure persistent rhinorrhea.

Either a bilateral coronal scalp incision or unilateral concealed frontal incision was made under general anesthesia. Unilateral frontal bone flap on the same side as the rhinorrhea was made in most cases. In 2 cases, the ex-
posure was accomplished through a previously existing frontal craniectomy defect. The exact surgical technique varied somewhat from case to case. When present, intracerebral aerocele was evacuated as soon as the exposure was made. Usually extradural exploration was done first, with exposure of the posterior table of the frontal sinus and the cribiform plate. The bony defect was usually filled with muscle, cauterized in place, and covered with gel foam. If the rent in the dura mater could be closed from this approach, this was done usually with fine silk sutures. It was usually necessary to use a fascial graft. Temporal fascia, galea, or pericranium were used. Most often, the defect in the dura mater was attacked intradurally and extradurally. When it was not feasible to suture the graft in place in a water-tight fashion, the graft was placed over the bone defect, tacking it in place with occasional sutures, often to the falx.

Comments. All 27 patients received antibiotic medication; in the earlier cases penicillin and sulfadiazine were given; the drugs were administered for a few days before surgery as well as postoperatively. The surgery usually was done under inhalation anesthesia and with tracheal intubation. Concentrated human albumin intravenously was used in occasional cases to shrink the brain for better exposure, especially in those cases of rhinorrhea without pneumocephalus. Twenty-six of the 27 patients were operated upon without mortality and without increasing the pre-existing neurological deficit. The remaining patient was not operated upon by us. Of these 26 patients, 21 were cured by one operation, 3 required two operations and 2 required three operations.*

DISCUSSION

With intracerebral pneumatocele, it seems logical to expect a laceration of the brain and pia arachnoid in the vicinity of the dural fistula. This has been true in all our cases. Rhinorrhea may subside when the pia arachnoid, brain, and dura mater become adherent about the fistulous tract. However, if the pneumatocele later communicates with a ventricle, profuse rhinorrhea can occur. Intracranial air can produce symptoms because of (1) the increased intracranial pressure, (2) irritating effect of the air, and (3) infection, acute or chronic.

Patients with pneumocephalus usually show some degree of confusion and are usually quite ill. When pneumoventricle and rhinorrhea are absent the intracranial pressure tends to be greater. Convulsions are often seen and in Case 17 hemiparesis could definitely be attributed to a pneumatocele.

Spontaneous closure of the fistula is known to have resulted in the cure of pneumocephalus and rhinorrhea. This is more likely to happen in cases in which intracranial pneumocephalus occurs immediately after injury and not when it is of delayed onset. There may be late recurrences of rhinorrhea with meningitis in cases of apparent spontaneous cure. We feel that surgery is in-

* The third operation in Case 13 was done successfully by Col. John Martin.
dicated when rhinorrhea or pneumocephalus has existed for 3 or 4 weeks. The surgical risk is not great.

Water-tight closure of the dural defect is most successful though not always possible. Overlooking a second fistula will almost surely result in failure to effect a cure. It is possible that in an occasional patient who is apparently cured, recurrence of rhinorrhea can develop in the future.

SUMMARY

Fifteen cases of chronic rhinorrhea and 12 cases of persistent pneumocephalus are presented. Twenty-six of these patients were operated upon. Successful obliteration of the fistulous tract was accomplished in all surgical cases, without mortality or added neurological deficit. Five patients required multiple attacks before cure was effected.

REFERENCES