VENTRICULOVENOUS ANASTOMOSIS IN OBSTRUCTIVE AND ACQUIRED COMMUNICATING HYDROCEPHALUS*

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(Received for publication April 7, 1960)

Following successes in controlling increasing intracranial pressure of infantile congenital hydrocephalus by shunting the cerebrospinal fluid from the lateral cerebral ventricle into the internal jugular vein, superior vena cava, and right cardiac auricular system, other types of cases presented themselves in which indications for palliative shunting procedures seemed to be present. Both the Holter valve, as advocated by Nulsen and Spitz, and the Heyer valve, introduced by Pudenz et al., were utilized as the conveying system in the cases in this series.

Falling into several categories, these cases may be broadly classified as inoperable lesions of the central nervous system producing progressive hydrocephalus. More specifically they may be divided into neoplastic or other lesions producing an obstruction in the flow of cerebrospinal fluid, and inflammatory or irritative lesions interfering with absorption of cerebrospinal fluid.

The use of a palliative shunting procedure in any given case brings up several serious considerations, an important one being that the patient be given a chance for a period of useful survival, without serious neurological deficit, as the direct result of the procedure. If the lesion can be successfully attacked directly, palliative shunting is contraindicated.

Certainly, if radiological and clinical evidence indicate the possibility of an obstructive lesion below the aqueduct of Sylvius exploration of the posterior fossa is indicated, since a number of operable lesions may occur in this location. Upon determination, however, that the lesion is inoperable, then a Torkildsen by-pass procedure or ventriculovenous anastomosis may be performed, whichever seems indicated by the type and location of the lesion. For example, a lesion such as adhesive arachnoiditis preventing proper circulation of cerebrospinal fluid into the absorbing area may be handled best by the latter procedure.

On the other hand, the fact must be faced that at the present time pontine and midbrain neoplasms are inoperable directly and the occasional relative obstructive atresia of the aqueduct of Sylvius does not lend itself to dilatation. If radiological and clinical evidence is conclusively in favor of an inoperable lesion between the fourth ventricle and posterior part of the third ventricle, palliative ventriculovenous anastomosis may be performed. Roentgen-ray therapy should then be given to the suspected neoplastic lesions without knowledge of the cell type in hopes that response to roentgen irradiation will occur.

Direct operative approach to neoplasms in the posterior part of the third ventricle carries a high mortality and a large degree of neurological deficit in many of the surgical survivors. Only certain of the lesions in this area are pinealomas, which may respond to roentgen ray. It would seem that palliative shunting instead of subtemporal decompression, as has been advocated, would be more effective for the control of increased intracranial pressure. It is hoped that the response of those patients with pinealomas sensitive to roentgen ray will justify the decision. It must be remembered, however, that

* Presented at the meeting of the Harvey Cushing Society, San Francisco, California, April 15, 1960.
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colloid cysts and other removable lesions do occur in the third ventricle, and direct exploration of this area may be indicated on suspicion of this type of lesion.

COMPARISON OF SYSTEMS AND GENERAL TECHNIQUES

We have had experience with both types of valves and in our opinion both systems are effective and must be considered important adjuncts to the treatment of progressive hydrocephalus. The Heyer valve has a more simple construction and is less bulky. Its installation, in adults at least, is a more simple procedure—yet the mere relative bulkiness of the Holter valve is secondary to a compressible pump. In infants with open fontanelles the clinical signs of a functioning system usually are obvious. However, in adults, the state of function of the system may at times be in doubt. In this situation, the presence of the pump is advantageous.

The location of a valve at the peripheral end of the system is said to be important in preventing possible reflux of blood. The peripheral end of the system should rest at least within the superior vena cava and if it be placed within the right cardiac auricle should not impinge upon the tricuspid valve or be allowed to enter the right cardiac ventricle. We feel that irritation of the tricuspid valve may predispose to its incompetence and to the development of thrombi which might become the seat of infection at the time of a transient bacteremia. It is possible that if the tip of a system becomes adherent to the tricuspid valve or to the auricular wall, thrombotic tissue might occlude the area of emergence of the cerebrospinal fluid and result in obstruction of the system. The entrance of the tip of a system into the right cardiac ventricle with periodic rises in systolic pressure could result in intermittent obstruction to the outflow of cerebrospinal fluid. Since the location of the cardiac end of the system seems so important, it has been our practice to measure on a previously made roentgenogram of the chest the distance between the lower border of the clavicle and the center of the right cardiac auricle. The tip of the system is inserted to the desired depth, adding the distance from the point of insertion in the jugular vein to the lower clavicular border. Filling the system with radiopaque substance, another roentgenogram is made on the operating table to then determine the exact location of the tip of the system. Since the junction of the superior vena cava and right auricle is seen readily and the tricuspid valve lies to the left of the vertebral column, it is felt that the tip of the system should be positioned to the right of the vertebral column. The inclusion of a radiopaque substance in the tip should simplify positioning. Recently Robertson et al. have suggested a unique technique for determining the location of the tip in relation to either the auricle or ventricle. Filling the system with normal saline and connecting it to a metallic tipped syringe, this combination is used as a lead of an electrocardiogram. Thus as the end of the system passes into the auricle, a characteristic diphasic or inverted p complex is recorded which is modified and becomes upright as the tip approaches the region of the tricuspid valve.

In using the internal jugular vein as a conducting tube for the peripheral end of a system, it would seem wise not to interrupt the flow of venous blood by ligating the vein centrally. In older patients the system may be introduced through the common facial vein and a ligature passed around the cuff of this vein.

The central end of a system presents few problems not solved by careful installation and fixation of the cerebral ventricular tube. Consideration should be given to the fact that decrease in ventricular size will take place as intracranial pressure is lowered and allowance must be made so that the cannular tip will not impinge upon the septum pellucidum or ventricular wall. Bits of brain tissue upon occasion have blocked the central end of the system. Careful irrigation before final connection should minimize the possibility of this complication.

In older patients the stretch or migration upward from the heart of a system caused by growth of the individual is not the important
consideration as it is in children. However, if it occurs in younger patients, this problem might be solved by reopening the central incision and inserting another segment of tubing, using available connectors.

**CONSIDERATION OF CASES**

We have performed a palliative shunting procedure either with or without exploration of the probable site of the lesion on 15 occasions in the past 3 years. These cases are diversified in type and are presented in Table 1.

There have been 5 deaths in the series, 1 being of a child with a medulloblastoma of the fourth ventricle who expired without redevelopment of symptoms or signs of increased intracranial pressure. He had been irradiated but the neoplasm apparently was radioresistant since at autopsy the mass was quite large. A patient with an unproven but probable glioma of the left frontal lobe expired in another city and the details of her death could not be determined. A patient with disseminated *Cryptococcus neoformans* with increased intracranial pressure did not survive. This palliative shunt was unsatisfactory. A child with a spongioblastoma of the pons lived for 1 month following a palliative shunt. Finally, an individual with a suspected neoplasm of the left thalamus expired after surviving for a period of 13 months with a functioning palliative shunt.

The patient received roentgen-ray therapy to the site of the lesion and two intracarotid injections of Thiotepa.

The others have survived for periods of 36 to 11 months, this latter individual being our most recent case in this series. All of these improved over their preoperative status and 8 of the 10 survivors may be considered as normally active.

Our initial case has been quite satisfactory, with the longest period of asymptomatic and useful survival—36 months (Figs. 1 and 2). It was felt that this deeply calcified lesion could not be removed without danger of serious neurological deficit. Consideration was also given to the possibility that this lesion might be parasitic in nature and that dissemination of infection might occur at the time of attempted removal.

A patient with cryptococcus meningitis, while under treatment with Amphotericin B, presented a problem in controlling intracranial pressure. He had received 580 mg. of Amphotericin B intravenously and 3 mg. intrathecally in divided doses over a 35-day period. Cultures of the lumbar spinal fluid had become negative. In spite of this, he became irrational, aphasic, and vomited frequently. Convulsions appeared and progressing papilledema developed. Ventriculography disclosed a dilated ventricular system with the fluid under increased pressure. Culture of the ventricular fluid was positive for

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**FIG. 1.** (left). Planigram showing midline calcified mass.

**FIG. 2.** (right). Lateral ventriculogram showing defect in posterior part of third ventricle produced by calcified mass.
### TABLE 1

<table>
<thead>
<tr>
<th>Name</th>
<th>Diagnosis and Adjunct Therapy</th>
<th>Type of Shunt</th>
<th>Complications</th>
<th>Duration and Status of Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A.S.</td>
<td>Calcified mass below 3rd vent. with obstruction</td>
<td>Holter</td>
<td>None</td>
<td>36 months—functioning</td>
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<td>3. E.J.</td>
<td>Post. fossa meningioma with obstruction</td>
<td>Holter</td>
<td>None</td>
<td>34 months—functioning</td>
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<td>4. F.O.</td>
<td>Probable glioblastoma multiiforme, left frontal, with increased intracranial pressure</td>
<td>Holter</td>
<td>None</td>
<td>1 month—expired. No autopsy</td>
</tr>
<tr>
<td>5. R.M.</td>
<td>Latent communicating hydrocephalus</td>
<td>Holter</td>
<td>None</td>
<td>30 months—functioning</td>
</tr>
<tr>
<td>6. R.R.</td>
<td>Cryptococcus meningitis with hydrocephalus</td>
<td>Heyer</td>
<td>None</td>
<td>26 months—functioning</td>
</tr>
<tr>
<td>7. P.S.</td>
<td>Spongioblastoma polare pons with obstruction</td>
<td>Heyer</td>
<td>None</td>
<td>1 month—expired. Autopsy</td>
</tr>
<tr>
<td>8. M.B.</td>
<td>Head injury, subarachnoid hemorrhage, hydrocephalus</td>
<td>Heyer</td>
<td>None</td>
<td>17 months—functioning</td>
</tr>
<tr>
<td>9. C.S.</td>
<td>Medulloblastoma pons with obstruction. Roentgen-ray therapy</td>
<td>Heyer</td>
<td>None</td>
<td>3 months—expired. Autopsy</td>
</tr>
<tr>
<td>10. D.V.</td>
<td>Probable medulloblastoma pons, with obstruction. Roentgen-ray therapy</td>
<td>Heyer</td>
<td>None</td>
<td>17 months—functioning</td>
</tr>
<tr>
<td>12. D.M.</td>
<td>Cryptococcus meningitis</td>
<td>Heyer</td>
<td>Incompetent valve—obstruction of central cannula</td>
<td>Unsatisfactory—expired</td>
</tr>
</tbody>
</table>
Cryptococcus neoformans. Prior to admission to the hospital, while still presenting an undiagnosed problem, the patient had rapidly lost all vision in his right eye. With imminent impairment of vision in the left eye it seemed imperative that decompression of the ventricles be performed and a valve system was introduced. Martin et al.2 had been confronted with a similar problem and had utilized for decompressive purposes an external ventriculostomy which was continued for 6 weeks. Our patient improved rapidly following the shunt. The papilledema subsided and vision in his left eye returned to normal. Cultures of the lumbar spinal fluid have remained negative. On two occasions organisms have been seen in the fluid but are apparently not viable since they cannot be cultured. Cultures of blood and urine did not become positive following the shunt.

It is known that in the parenteral use of Amphotericin B, no detectable level of the substance is obtained in the cerebrospinal fluid but that therapeutic levels are present in the blood stream. Actually it has not been determined whether or not it is necessary to have an appreciable concentration of the drug in cerebrospinal fluid in order to treat cryptococcus meningitis effectively.

It would be an attractive hypothesis that the diverting of infected cerebrospinal fluid into the blood stream where a therapeutic level of a drug to which the organism was sensitive was present, contributed to the patient's remission. However, other factors, such as the relief of increased intracranial pressure, must be considered. Suffice it to say up to the present time, some 2 years after the shunt, there has been no evidence of disseminated cryptococcus in this patient.

COMPLICATIONS

Anderson1 has described postoperative complications in a series of cases of both communicating and obstructive hydrocephalus. Frequently these patients are not particularly good operative risks and high morbidity and mortality can be expected.

Our complications have fallen into two categories depending on which end of the system was at fault. On two occasions the intracranial catheter apparently became impinging on the ventricular wall and required adjusting. In another case, the valve at the auricular location became incompetent and was replaced. A second revision in this case was necessary because of blockage of the central cannula with bits of brain tissue. Actually, this system could not be made to really function satisfactorily. The patient was critically ill with disseminated cryptococcus infection and expired. Permission for autopsy was refused. There were 2 cases of septicemia that required removal of the system; 1 of the patients expired. An autopsy on this patient revealed bacterial endocarditis of the tricuspid valve and lung abscesses secondary to Staphylococcus aureus. This represented an unfortunate complication since the patient’s obstructive neoplasm proved to be an astrocytoma in the posterior thalamus, periaqueductal in location, and measuring but 1½ by 1½ cm. With an adequately functioning system, uninfected, this patient conceivably could have survived many months.

Another individual required revision of the shunt because of malfunction, and at the procedure, bits of brain tissue were found occluding the valve. Subsequently there developed hemolytic Staphylococcus aureus septicemia requiring removal of the system. The same organism was cultured from the valve as was isolated from the blood stream. This case demonstrated the apparent effectiveness of the procedure over a critical period. Representing a probable pinealoma, roentgen therapy had been instituted, following the shunting procedure and prior to removal of the system. When the shunt was removed, the roentgen ray apparently had been effective in relieving the obstruction, for the patient’s intracranial pressure has remained under control for 3 years and the system has not had to be replaced (Fig. 3).

CONCLUSIONS

A series has been presented of ventriculovenous anastomosis in obstructive and acquired communicating hydrocephalus. These
anastomosis may be elected in hopes of allowing the patient a period of useful survival.

The various types of cases in the series have been discussed and consideration of the details of several apparently effective results following ventriculovenous anastomosis has been given.

Finally, complications occurring in the series have been presented.

REFERENCES

Fig. 3. Lateral ventriculogram showing defect in region of pineal gland.

were cases of inoperable neoplastic and other lesions producing an obstruction in the flow of cerebrospinal fluid, and inflammatory or irritative lesions interfering with absorption of cerebrospinal fluid.

The probability of surgical cure of an obstructive lesion without serious neurological deficit must be considered. If this seems improbable then palliative ventriculovenous