A Simple Strategy for Treating Persistent Subcutaneous Cerebrospinal Fluid (CSF) Collections Following Complex Neurosurgical Procedures

Abstract—Subcutaneous CSF (CSF “pseudocyst”) may occur following complex skull base operations. They may respond to a trial of compressive bandages and continuous lumbar drainage that can resolve over months. When this management strategy fails, reoperation is an option, which however would require complex reconstructive procedures at the base of the skull, and still have the chance of not resolving the problem.

We describe here a simple alternative treatment, consisting of a “pseudocyst”-peritoneal shunting using a flow-regulated unishunt system. This management strategy has been used successfully in two cases showing subcutaneous CSF collections following complex skull base surgery procedures which did not respond to a trial of conservative management. A prompt resolution of such a complication was achieved in all cases, which persisted during the follow-up (7 to 19 months, averaging 12 months). “Pseudocyst”-peritoneal shunting using a flow-regulated valve can be a very simple though effective management option for persistent CSF subcutaneous collections following major neuro-surgical procedures.

Skull base surgery procedures carry a negligible risk of postoperative CSF leak.^{2,11} Meticulous dural closure represents the best way for preventing this complication. When a watertight dural closure cannot be achieved, as frequently occurs in skull base surgery, several technical adjuncts may be helpful: the use of autologous fat grafts, muscle, fascia lata, or fibrin glue. Musculo-fascial and/or pericranial flaps are of great importance for sealing the dead space left by complex skull base operations and are mandatory in order to reinforce the techniques of dural closure.

CSF may leak into an air-containing cavity violated by a skull base surgery procedure or, if they have been properly sealed, into the subcutaneous space. In situations such as the latter, reoperation is an option which is mandatory in the presence of persistent external CSF leaks.

Continuous lumbar drainage is very helpful for controlling these complications and is often capable of leading to their resolution. However, when a valve-like mechanism has been established, subcutaneous CSF collection, i.e., “pseudocyst,” may be very difficult to control with continuous lumbar drainage.

We encountered a case of recurrent petroclival meningioma which developed a huge subcutaneous CSF collection that did not respond to continuous lumbar drainage and at a certain point started to show clinical deterioration in conjunction with lumbar CSF subtractions. We treated this case successfully with a pseudocyst—a peritoneal shunt using a flow-regulated unishunt system. We used this simple technique in other patients with Arnold-Chiari type I malformation associated with Syringomyelia in whom a subcutaneous CSF collection occurred following surgery, with prompt resolution of the complication, which persisted during the follow-up period. These cases are briefly reported.

MATERIALS AND METHODS

Case 1

C.N. a 67-year-old woman was operated on in 1971 and 1993 for a large left sphenopetro-clival meningioma (Fig. 1). The second postoperative course was particularly troublesome, and she recovered slowly and partially from postoperative right hemiparesis and was unable to walk unassisted since then. In 1994 she was admitted to the Division of Neurosurgery for progression of symptoms and clinical re-evaluation.

The patient was reoperated on by a complex lateral skull base approach, combining an orbito-zygomatic approach with an anterior petrosal approach. An extremely

firm avascular tumor was removed from the basilar artery and the brainstem.

However, as it was not feasible to dissect it safely from the superior cerebellar artery (SCA) and the V and VII cranial nerves, a significant portion of tumor was left untouched. Removal was judged to be approximately 50%.

Lateral middle fossa dura was absent. It was replaced with autologous fascia lata stitched to remnants of the basal dura covered by fibrin glue. Autologous fat grafts were placed to reinforce dural closure and fill the dead space. Five days postoperatively, a subcutaneous CSF collection developed (Fig. 2) which prompted continuous lumbar drainage. A CT scan did not show coexisting hydrocephalus. After a few days following discontinuation of drainage, the subcutaneous collection recurred. Repeated lumbar taps were not only ineffective, but also contributed to a continual loss of consciousness. A CT scan at the time of clinical deterioration following CSF subtraction showed only cerebral edema at the site of surgical operation.

This prompted us to perform several punctures of the operative site in order to evacuate CSF and to decompress the enormously distended cavity (Fig. 4). However, as a rule these procedures had a limited efficacy, lasting no more than 2–3 days.

Following 1 month of “wait and see” policy, we decided to submit the patient to operation, at which a flow-regulated unishunt system (Orbis-Sigma Valve) was placed between the subcutaneous CSF collection and the peritoneal space. We decided to put the shunt

Figure 1. (Case 1) MRI after i.v. Gd-DTPA shows a large sphenopetro-clival meningioma.

Figure 2. (Case 1) Postoperative CT scan shows a large subcutaneous CSF collection.

into the thecal sac since lumbar CSF subtraction did not affect the pseudocystic cavity and usually caused deterioration of consciousness.

Postoperative course was uneventful with prompt resolution of the CSF pseudocyst. MRI performed at 11 months and a CT at 17 months after shunt (Fig. 3) showed a disappearance of subcutaneous CSF collection. The patient is able to walk with the help of a cane.

FOLLOW-UP

The patient had no concomitant hydrocephalus, so we were not able to place a ventriculoperitoneal shunt. The placement of a cranioplasty on our advice could not have prevented the formation of the subcutaneous pseudocyst because it could not help achieve a "water-tight" closure. The placement of a subcutaneous shunt was necessary because compressive bandages were ineffective and continuous lumbar drainage constantly determined a deterioration of consciousness.

Case 2

M.F., a 48-year-old male was admitted to our Division complaining of a tetraparesis. MRI (see Fig. 4) showed an Arnold-Chiari type I malformation associ-

Figure 3. (Case 1) CT scan performed 17 months after shunting shows disappearance of subcutaneous CSF collection. The ventricular system is normal.

Figure 4. (Case 2) MRI shows an Arnold-Chiari Type I malformation with a syringomyelic cavity extending from the cervico-bulbar junction to T6.

ated with a syringomyelia extending from cervico-bulbar junction to T6.

The patient underwent operation via a suboccipital craniectomy plus C1-laminectomy. Dura mater was opened with arachnoid preserved by careful microdissection. However, a superior arachnoidal tear occurred which was coagulated. To help seal it, a viable autologous myofascial flap was placed to reinforce closure. Nevertheless, postoperatively the patient developed a suboccipital subcutaneous CSF collection (Fig. 5). An external lumbar CSF drainage was placed for 10 days but the collection failed to resolve. Since the patient and his family were very concerned about a reoperation and reluctant to approve it, we considered a minor procedure as an alternative. Therefore, 20 days after operation a PS Delta valve system was placed between the suboccipital subcutaneous space and the peritoneum.

The postoperative course was uneventful with complete resolution of the subcutaneous CSF collection. Follow-up MRI at 8 months demonstrated no recurrence of the "pseudocyst" (Fig. 6).

Figure 5. (Case 2) MRI performed after suboccipital craniectomy plus autologous duraplasty shows a subcutaneous suboccipital CSF collection.

FOLLOW-UP

No complications related to shunting were observed such as obstruction, infection, intracranial hypotension syndrome subdural hematoma or slit ventricle syndrome.

Figure 6. (Case 2) MRI performed 8 months after shunting shows no recurrence of the subcutaneous CSF collection.

Postshunting CT/MRI scans were performed from a minimum 8 months to a maximum 17 months (average 1 year) following the operations.

The patients showed no recurrence of the subcutaneous CSF collection.

The placement of a subcutaneous shunt was necessary because the patient and his family were reluctant to accept a reoperation and we considered the shunt as an efficacious minor procedure. The risk of a foreign material within the body was very low (we attended disappearance of blood in the CSF collection) and the risk of infection (prevented with antibiotic prophylaxis) is lower than serial direct subcutaneous or lumbar punctures.

SURGICAL PROCEDURE

As mentioned above, we used a flow-regulated, unishunt valve. All commercially available systems¹ may be used for treating the presently described complication.

A small curved incision is placed at approximately 5 cm from the margin of the subcutaneous collection. The incision was made in the neck in Case 1, for the purpose of potentially favoring the functioning of the valve both by gravity and by shortening the distance between the pseudocyst and the abdomen.

As it became clear that the valve functioned well anyway, in the second case we simply performed the proximal incision in the most convenient place, again at a distance of approximately 5 cm from the pseudocyst. The proximal part of the unishunt valve was then directed subcutaneously towards the CSF collection cavity until clear fluid escaped from it, and advanced another 2 to 3 cm to ensure it was well placed within the pseudocyst. The distal part of the system was then tunneled subcutaneously to the abdomen and placed in the peritoneal space.

DISCUSSION

Prevention of CSF Leaks

A postoperative CSF leak is an undesirable complication of neurosurgical procedures. This occurs more frequently following skull base operations due to the problematic and often impossible watertight closure of the basal dura mater.

Meticulous packing and proper sealing of all opened air-containing, mucosa-lined cavities at the base of the skull is a major concern for any craniobasal surgeon. Packing the dead space left by the removal of the pathology in point with either autologous graft material or with viable rotational flaps,^{3-6,8-10} microvascular free flaps,⁷ represent very important technical adjuncts in order to lessen the chances of CSF leak, and to favor the healing process of the postsurgical dural defect. Decreasing postoperative CSF pressure by lifting the patient's head and

using acetazolamide are universally accepted measures in order to lessen the risk of postoperative CSF leaks. The use of continuous lumbar drainage in the immediate post-surgical period is advocated as routine by some authors¹¹ but not by others (Al-Mefty, personal communication), because of undue potential complications, such as prolapse of the graft material into the operative cavity with consequent clinical deterioration.¹²

TREATMENT OF CSF LEAKS

When a CSF leak occurs postoperatively in spite of the above-mentioned measures, continuous lumbar drainage becomes mandatory. External CSF leak, if persisting, requires reoperation to prevent bacterial contamination and meningitis. Reoperation to seal dural defects is particularly difficult because of lack of tissue plans and scarring from previous surgeries. To rotate properly viable flaps is also more demanding in the presence of scarred tissue layers due to the previous surgical manipulations.

MANAGEMENT OF SUBCUTANEOUS CSF COLLECTIONS

The presence of a subcutaneous CSF collection should not warrant a reoperation since it does not carry, at least in its initial stage, a significant risk of bacterial contamination. A CSF pseudocyst can be managed with compressive bandages and lumbar drainage, provided the latter is effective in evacuating the pseudocystic cavity, a fact which indicates that CSF is freely circulating into the cavity in point. However, when a valve-like mechanism is established, and CSF is unidirectionally conveyed from the cranial cavity into the subcutaneous space, lumbar drainage becomes ineffective, if not dangerous. An example is Case 1. These situations are likely to be favored by disturbances of intracranial CSF circulation due to post-operative basal arachnoiditis following previous intracranial surgery without developing hydrocephalus.

CSF pseudocysts not responding to the above-mentioned treatment strategy can undergo reoperation. However, this would require very demanding skull base reconstructive procedures and still might not resolve the problem. To leave the pseudocyst untreated might be another option. However, as in Case 1, these subcutaneous collections may become so tense that their opening into an air-filled cavity and/or breaking the skin could represent a significant possibility.

RATIONALE FOR PSEUDOCYST-PERITONEAL SHUNTING

When we decided to shunt these cases, we ruled out a lumbo-peritoneal shunting because the patient consis-

tently showed clinical deterioration with lumbar CSF drainage. The mechanism of this occurrence remains conjectural. Perhaps the absence of anatomical barriers between the pseudocyst and the brainstem resulting from the craniobasal approach could have allowed the pseudocyst to exert undue pressure on the brainstem itself. In such a situation, CSF taps would exacerbate this phenomenon. After determining that the pseudocyst CSF was sterile, and there was no evidence of meningitis, we performed a pseudocyst-peritoneal shunting using a flow-regulated unishunt system. We used this strategy for the following reasons: (1) the cyst cavity collected CSF with a unidirectional valve-like mechanism, so shunting other intrathecal spaces other than the cavity itself would have been likely to be ineffective if not dangerous; (2) decreasing the intracavitary pressure would possibly stimulate the healing process of the cavity, now no longer distended by the CSF; and (3) a flow-regulated valve overcomes the problem of a low differential pressure between the pseudocyst and the abdomen, a fact which contraindicates the use of a shunting system whose functioning is primarily dependent on the existence of a differential pressure between the intrathecal space and the shunted compartment.

HIGH PROTEIN CONTENT DOES NOT AFFECT THE FUNCTIONING OF FLOW-REGULATED VALVES

We were concerned by the high protein content of the pseudocystic CSF, since this is a well-recognized negative factor for long-term functioning of traditional shunt systems. However, having no sound alternatives but a technically demanding reoperation, we shunted the patient. Our experience clearly suggests that our concern was not justified. This is in accordance with the results of very recent experimental studies on flow-regulated valves which showed that high protein CSF content does not prevent these systems functioning properly, provided that the fluid is not contaminated by either blood or bacteria.¹ These studies give a strong argument for the present strategy in treating CSF subcutaneous pseudocysts. Since CSF infiltrating the subcutaneous tissue layers is not freely circulating, it always increases its protein content. In addition, it is worthy to note that none of the patients ever complained of abdominal discomfort in relationship to the shunting procedure.

CONCLUSIONS

In conclusion, shunting a CSF pseudocyst into the peritoneal cavity using a flow-regulated valve is a sim-

ple and effective procedure. It is indicated in those cases not responding to compressive bandages and continuous lumbar CSF drainage. This simple management strategy overcomes the need for reoperation in the event of CSF subcutaneous collections occurring following complex neurosurgical procedures, provided that no external CSF leak is present. This simple procedure offers an excellent chance of curing such complications, as the present experience clearly indicates, and may be considered in the management of CSF subcutaneous collections not responding to an adequate trial of conservative management.

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