



Intraventricular reservoir application in neonates with progressive hydrocephalus

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Summary

Aim: Controlled removal of cerebrospinal fluid by serial tapping of ventricular reservoir, is an effective way to decompress the ventricular system while awaiting optimal conditions for permanent cerebrospinal fluid drainage through a ventriculo-peritoneal shunt. The aim of our study is to present our experience on patients for whom a ventricular reservoir was placed because of progressive hydrocephalus.

Material and Method: The record of 18 patients who were born between 2005-2009 and diagnosed with progressive hydrocephalus for whom a ventricular reservoir was placed was reviewed retrospectively. The indications and complications and the need for ventriculo-peritoneal shunt are documented.

Results: Among the 18 patients 13 were preterm (mean birth weight 1542±522 g; mean gestational age 29.9±3.4 weeks), 5 were determined as term (mean birth weight 3270±679 g; mean gestational age 38±0.7 weeks). The etiology of hydrocephalus was intraventricular hemorrhage in 11, meningomyelocele in 4, congenital hydrocephalus in 3 patients. Mean insertion time of the reservoir was 21,5 days (range 7-71 days) of birth, while the mean follow up period with reservoir was 31,5 days (range 7-122 days). Ventriculo-peritoneal shunt was placed to 16 infants (88 %). Complications related to the reservoir were skin infection in one patient and skin necrosis in one patient. Three babies with intraventricular hemorrhage and one baby with congenital hydrocephalus and muscular disease died due to aspiration pneumonia in the postneonatal period, and the other baby with congenital hydrocephalus died due to multiorgan failure.

Conclusions: Ventricular reservoir placement is an effective procedure for cerebrospinal fluid drainage in cases of progressive hydrocephalus. Our study demonstrates that ventricular reservoir is a better alternative than serial lumbar punctures to prevent permanent damage secondary to progressive hydrocephalus on brain parenchyme in those babies when ventriculoperitoneal shunt insertion is not possible. (*Turk Arch Ped* 2013; 48: 200-203)

Key words: Hydrocephalus, reservoir, newborn

Introduction

Hydrocephalus results from the imbalance between production and absorption of cerebrospinal fluid (CSF) (1). Since long term increased intracranial pressure and ventricular dilatation affect neuronal development negatively, timely intervention for neonatal progressive hydrocephalus decreases the morbidity and mortality rates (2). In preterm infants with intraventricular bleeding (IVB), drainage of the CSF is recommended when the ventricular diameter is 4 mm above the 97th percentile according to the ventricular index values developed by Levene (3). In infants in whom an indication for drainage of cerebrospinal fluid is found, different methods including serial lumbar punctures (LP), ventricular tap, extraventricular drainage,

subgleal shunt or subcutaneous ventricular reservoir are used in different centers with this objective (4,5,6,7,8,9,10). In our study, we evaluated the patients retrospectively to express our experience about subcutaneous ventricular reservoir which is one of the different treatment options and aimed to present complications related with the procedure and short-term results.

Material and Method

A total of 18 preterm and term patients who were followed up in Marmara University, Medical Faculty, Neonatal Intensive Care Unit and in whom subcutaneous ventricular reservoir was placed by the division of Pediatric Neurosurgery were examined retrospectively.

The demographic data of all the patients were recorded. Cranial ultrasonography, magnetic resonance imaging (MRI) or computerized tomography was performed in 18 patients who had congenital hydrocephalus, myelochisis and IVB. The indication for placement of reservoir was decided according to the increase in ventricular dilatation on cranial ultrasonography performed two times a week (a ventricular diameter 4 mm above the 97th percentile according to the "Levene" criteria) and/or findings of increased intracranial pressure and presence of periventricular edema which is the radiological indication for this (2).

In patient in whom reservoir was placed, removal of CSF from the reservoir (10-20 mL/kg) according to ventricular index (VI) measurements was performed every day on the initial days. After the amount which would be removed was decided the patients were monitored by cranial ultrasonography and ventricular index measurements performed two times a week. The frequency of removal of CSF was determined by evaluating VI, head circumference, fontanel tension and findings of increased intracranial pressure together. Before removing CSF from the reservoir the skin was cleaned with povidon iodide for three times. After putting on sterile gloves and a mask a butterfly needle was inserted subcutaneously initially. Afterwards, the needle was inserted into the reservoir and 10-20mL/kg CSF was removed. During the procedure, the heart rate, respiration rate and oxygen saturation were monitored. After the butterfly needle was removed the skin was mildly pressed with sterile gauze (3-5 minutes). Cellular count, biochemical examination (protein, sugar), gram staining and culture were performed for each sample of CSF. Blood electrolyte and albumin levels were closely monitored. Shunt surgery was performed in patients with progressive hydrocephalus who had a CSF protein of <1.5 g/L, whose body weight reached 2500 g and who had no finding of infection.

Results

Subcutaneous ventricular reservoir was placed in a total of 18 patients born between 2005 and 2009 13 of whom were preterm and 5 of whom were term (Table 1).

In our patients whose demographic properties are shown in Table 1, the mean birth weight was found to be 1542±522 g in preterm infants and 3270±679 g in term infants. The gestational age was found to be 29.9±3.4 weeks in preterm infants and 38±0.7 weeks in term infants. 7 of the patients were born in our hospital and 11 were born in an external center. 16 patients were born by cesarean section and 2 were born by vaginal delivery.

The indication for placement of reservoir are shown in Table 2. The most common indications for placement of reservoir included IVB (n=11), myelochisis (n=4) and congenital causes (n=3).

The most common causes of progressive hydrocephalus in our preterm patients included IVB (n=9), congenital causes (n=3) and myelochisis (n=1). Subcutaneous reservoir was placed in term infants because of myelochisis (n=3) and IVB (n=2) (Tablo 2). In two term patients with intraventricular bleeding, severe prenatal hypoxia and disseminated intravascular coagulation were present.

The mean time of placement of reservoir was 21.5 (7-71) days. The mean indwelling time was found to be 31.5 (7-122) days. Among patients in whom reservoir was placed, skin infection was found in one patient and skin necrosis was found in another patient. Central nervous system infection was not found in any patient.

Ventriculo-peritoneal (VP) shut was placed in 16 of the patients (88%) (IVB: 10 patients, myelochisis: 4 patients and congenital hydrocephalus: 2 patients). The mean time of placement of ventriculo-peritoneal shut was found to be 81 (25-155) days. Three patients with IVB in whom reservoir was placed after discharge, a patient with "Aquaduct" stenosis (because of aspiration pneumonia) and a patient with "Dandy-Walker" malformation (because of multiple organ failure) were lost. VP shut was placed in 4 of 5 patients who were lost and reservoir was placed in one patient.

Table 1. Demographic properties of the subjects

	Preterm	Term
Birth weight (grams)	1542±522	3270±679
Gestational age (weeks)	29.9±3.4	38±0.7
Gender (M/F)	7/6	3/2
Birth place		
MUMF	3	4
External center	10	1
Delivery mode		
C/S	11	5
NSD	2	0

Table 2. The etiology of hydrocephalus in the patients in whom reservoir placement was performed

Indications of reservoir placement	Preterm	Term
Intraventricular bleeding	9	2
*Congenital caused	3	0
Myelochisis	1	3

**Aquaduct" stenosis: 2, "Dandy-Walker" malformation: 1

Discussion

Hydrocephalus is related with a disorder in absorption or circulation of the cerebrospinal fluid. Hydrocephalus is divided into congenital and acquired forms. "Aquaduct" stenosis, "Dandy-Walker" malformation, Chiari Type 2 malformation and X-linked hydrocephalus may lead to congenital hydrocephalus. Neoplasms, posthemorrhagic hydrocephalus and hydrocephalus which develops following meningitis may lead to acquired hydrocephalus (1). While the most common indication for placement of reservoir was IVB in our patients, congenital causes and myelochisis followed this.

Monitoring of hydrocephalus is done by measurement of head circumference, examination of the fontanelle, neurological examination and ultrasonographic ventricular index measurements (11). Placement of reservoir was decided in patients whose head circumferences increased more than 2 mm daily, in whom progressive ventricular enlargement was found on cranial ultrasonography (a ventricular index 4 mm above the 97th percentile), who had findings of increased intracranial pressure (frequently apnea and bradycardia) and in whom shunt surgery was not appropriate (2).

In preterm infants in whom progressive hydrocephalus develops following IVB, shunt surgery can not be performed because of severe medical problems, increased CSF protein and rapid change in the height and cranial and peritoneal space volumes (12). Therefore, ventricular reservoir is a method which allows efficient CSF drainage before shunt surgery in progressive hydrocephalus.

Boynton et al. (13) performed ventriculo-peritoneal shunt in the early period in very small preterm infants who developed hydrocephalus following intraventricular hemorrhage. They reported that shunt revision was required during the period when the infants stayed in the intensive care unit in 26% of the patients and the rate of infection reached 50% after discharge. In this study, it was shown that early shunt placement was unsuccessful because of the immaturity of the immune system of the preterm infants who developed hydrocephalus following intraventricular bleeding and because of filling of the ventricles with blood.

Different treatment methods are performed to prevent excessive pressure on the brain parenchyma in newborns in whom shunt surgery can not be performed because of progressive hydrocephalus. These methods include serial lumbar punctures, ventricular tap, extraventricular drainage, subgaleal shunt and placement of subcutaneous ventricular reservoir (4,5,6,7,8,9,10). Serial lumbar puncture is not preferred currently because it does not provide adequate CSF drainage, is not efficient in obstructive hydrocephalus, is difficult to perform and the procedure is painful. For an efficient treatment in progressive hydrocephalus at

least 10-20 mL/kg CSF should be removed. It is difficult to remove high amounts with serial LPs (11). In addition, this technique is inefficient to change the prognosis of hydrocephalus (14,15).

Although it is easy to perform percutaneous ventricular puncture, it may be complicated with subdural, parenchymal or intraventricular bleeding. During repetitive punctures, the needle may harm the brain parenchyma and encephalomalacia and porencephaly may develop in the areas where the needle is inserted (6). Therefore, repetitive ventricular taps is not an acceptable method in treatment of progressive hydrocephalus.

Extraventricular drainage (EVD) which is performed by tunnel ventriculostomy is a method which is used commonly in treatment of progressive hydrocephalus (7,8). It has advantages including easy application, ability to control the intracranial pressure for a long time by continuous drainage and ability to allow inhibition or regression of hydrocephalus (7,16). Studies have reported the mean time between the beginning of treatment and placement of ventriculoperitoneal shunt to be three months (17). When it is predicted that hydrocephalus treatment will last longer than a few weeks because of obstruction (41%) and displacement (13%) of extraventricular drainage, this technique is preferred (7).

Subcutaneous ventricular reservoir which is another option allows adequate CSF drainage and is used as an alternative for serial LPs. However, subcutaneous ventricular reservoirs may lead to complications including meningitis, ventriculitis, skin necrosis, skin fistula and subdural hygroma. The rate of infection has been reported to be 7-27% with serial LP and the rate of ventriculitis has been reported to be 11-60% in EVD, while the rate of infection related with reservoir has been found to be 4-22% (5,7,16,18,19). In our study, meningitis related with reservoir was not found and skin infection was found in one patient. We did not lose any patient because of complications related with placement of reservoir. Two patients with congenital hydrocephalus (one because of multiple organ failure and one because of respiratory failure secondary to muscle disease (merosinopathy)) and three patients with IVB were lost because of progressive neurological problems.

In preterm infants who develop hydrocephalus because of intraventricular bleeding, shunt surgery is not performed because of high CSF protein and low weight of the infant. Therefore, efficient CSF drainage is provided with ventricular reservoir before shunt surgery in preterm infants. Thus, the rate of shunt revision decreases in preterm infants with IVB in whom ventricular reservoir is placed (17).

The mean time of placement of subcutaneous ventricular reservoir in our patient group was found to be 21,5 (7-71) days. Studies have found the mean time of

placement of subcutaneous ventricular reservoir to be 39 (9-184) days (12).

In the literature, the rate of requirement for shunt was found to be 43-88% in patients with ventricular reservoir, while the mean time of placement of VP shunt was found to be 2,9 months (6,8,17,20). In our patient, the rate of placement of shunt was similar to the ones reported in the literature (88%). While the mean time of placement of VP shunt in our patients was found to be 81 days (25-155), it was found to be 88 days (34-155) in preterm infants and 60 days (25-110) in term infants.

Conclusively, application of placement of ventricular reservoir is an alternative for lumbar puncture or extraventricular drainage in patients with progressive hydrocephalus who are not appropriate for shunt surgery.

Conflict of interest: None declared.

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