Negative Cultures for Cerebrospinal Fluid Samples taken from the Myelomeningocele Sac on the Day of Repair

Miguel Mayol, MD*; Eva F. Pamias, MD†; Joel Pellot, MD‡;
Juan Vigo, MD, FACS‡

Objective: Our goal was to evaluate the intraoperative laboratory analysis of cerebrospinal fluid (CSF) aspirated from the myelomeningocele (MMC) sac prior to the repair to determine if there was bacterial growth in the culture.

Methods: This was a retrospective analysis of the CSF cultures of 45 MMC patients operated on during the years of 2002 to 2013 at the University Pediatric Hospital. Before repairing the defect, the sac area was cleaned and three milliliters of CSF were drawn and sent for analysis for red blood cells, white blood cells, glucose level, protein level, chloride level, gram stain and culture. The CSF sample results were analyzed for irregularities in the values before proceeding with placement of a ventricular shunt.

Results: All the CSF samples that were studied had at least 1 abnormal value in their results, even though none grew any pathogens in the cultures analyzed.

Conclusion: Upon CSF analysis, we found increased levels of CSF protein and other abnormal values in this population; however, none of the cultures grew any pathogens. This finding is an important tool in the evaluation of the possible etiologies of and therapeutic approaches for future shunt problems in this group of patients. [*P R Health Sci J 2020;39:200-202*]

Key words: Myelomeningocele, Cerebrospinal fluid, White blood cells, Red blood cells, Cerebrospinal fluid culture

Spina bifida has an estimated incidence of 1 to 2 cases per 1,000, though that incidence is significantly greater in certain genetically predisposed populations. The birth incidence of the disease in the United States was reported to be 4.3 to 5.2 cases per 10,000 live births from 1980 to 1987 (1). Incidence rates vary by region; they are lower in the west than they are in the east with the highest rates found in Appalachia (2). Since the late 20th century, the rate of myelomeningocele (MMC) and other neural defects has decreased. These decreases are attributed both to improved nutrition in pregnant women and to the widespread availability of prenatal diagnostic services (3–5).

The risk for central nervous system infection is high in MMC cases, and this risk increases when repair is delayed more than 48 hours after birth (6). One of the major complications in patients with MMC is hydrocephalus, because in that condition, cerebrospinal fluid (CSF) flow is obstructed by anatomical anomalies and is also disrupted by sediment and debris created by the infectious organisms. If infection of the MMC sac occurs, all the structures containing CSF are in jeopardy. Ten to 15% of MMC patients need a ventricular derivation soon after birth due to overt hydrocephalus. This can be performed at the same day of the MMC repair or a few days later. The MMC sac can be aspirated to obtain CSF, and the laboratory analyses can be used to determine whether a shunt can be safely placed if no laboratory signs of infection are found (7). If a CSF shunt is placed in the presence of infected CSF, the chances of the shunt's malfunctioning are extremely high. Morbidity and mortality are significantly altered when infection is present (8–9). There is an 11% infection rate in uncomplicated initial CSF shunt placements (10). The most common pathogens for these shunt infections are staphylococci (75% of infections) and gram-negative bacilli (19% of infections) (11).

It is crucial that the CSF be sterile before proceeding with the placement of a shunt. If the patient does not have overt hydrocephalus, a shunt can be placed after the CSF laboratory analysis are completed. At our institution, we have made it a part of the protocol that before repairing the MMC, a sample of CSF must be taken for laboratory analysis. This sample can be used for diagnostic purposes and as a baseline measure to aid in the follow-up and disease management of MMC cases. As part of our protocol, under sterile conditions, 3ml of CSF are taken from the MMC sac by needle aspiration before the repair procedure starts. All the patients in our sample underwent repair surgery

*Section of Neurosurgery, University of Puerto Rico Medical Sciences Campus, San Juan, Puerto Rico; †Department of Neurosurgery, University of Pittsburgh Medical Center, Pennsylvania, USA; ‡Section of Neurosurgery, University of Puerto Rico Medical Sciences Campus, San Juan, Puerto Rico

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Address correspondence to: Miguel Mayol, MD, Section of Neurosurgery, University of Puerto Rico, Medical Sciences Campus, San Juan, Puerto Rico, Box 365067, San Juan, PR 00936-5067. Email: miguel.mayol@upr.edu

within 48 hours of his or her birth. Our goal was to describe the laboratory patterns of the fluid initially aspirated from the MMC sac under sterile intraoperative conditions prior to the repair surgery. We will use this information to determine whether a shunt can be inserted soon after the repair of the MMC.

Methods

We performed a retrospective descriptive study of data obtained from 2002 to 2013 at the University Pediatric Hospital. The patients operated for MMC during this period were gathered from the database of procedures for the Neurosurgery section and the results of the CSF analyses from the hospital laboratory database. Authorization from the Institutional Review Board was obtained before the data were gathered (protocol B1620318). The MMC repair was done in the first 48 hours. Before repairing the defect, each patient received general anesthesia and was prepared and draped in the usual sterile fashion. No antibiotics were given prior to the procedure. The sac area was cleaned with saline solution and iodine solution. With a 25-gauge needle, the epithelial membrane of the MMC was punctured at the site, where no important structures were visible. Three milliliters of CSF were drawn and sent for analysis for red blood cells (RBCs), white blood cells (WBCs), glucose level, protein level, chloride level, gram stain and culture. Afterwards, the repair procedure was completed. The CSF sample results were analyzed for irregularities in the values before proceeding with placement of a ventricular shunt. If the CSF values were abnormal, shunt placement was delayed.

The inclusion criteria for the patients were as follows: The patient had to have been diagnosed with MMC; the repair procedure had to have been performed within 48 hour of the patient's birth; an intraoperative CSF sample had to have been obtained from the MMC sac; and no prior CSF sampling could have been done by this or any other method. Patients were excluded if their sample data were incomplete, if there were sampling errors, or if the CSF had not been taken from the MMC sac.

Results

Our database contained 75 cases from which CSF samples had been taken from the MMC sac. Forty-five patients (23 males and 22 females) met the inclusion criteria for our study. The patient's CSF characteristics and normal values are shown in Table 1. Of the 45 cases, the CSF was turbid and yellow in 35.6% of the samples. The WBC count was from 0 to 25 /mm3 in 49% of the samples and more than 25 /mm3 in 51% of the samples. In 20% of the samples there was more than 50% of polymorphonuclear leukocytes. Eighty percent of the samples had WBC counts in the range of 1 to 100 /mm3. Forty-two percent of the samples had more than 200 mg/dL of protein. Glucose level was below 40 mg/dL in 36% of the samples. All gram stains were negative. We adjusted the CSF WBC count to account for increased RBCs, for each sample. Thirty samples (67%) had laboratory results suggestive of infection of the CSF (ratio>1 WBC per 1000 RBCs). Despite this finding, none of the final cultures had grown any pathogens.

Discussion

Open spinal dysraphism has 4 forms: MMC, myelocele, hemimyelomeningocele, and hemimyelocele, MMC being the most common (12). Infants with MMC are affected neurologically, physically, and mentally. The initial repair procedure in these patients has been well established and documented; however, controversies remain regarding early versus delayed shunt surgery. In the first days of life, infection is the most imminent danger, with the possibility of meningitis secondary to the colonization and subsequent infection of the exposed neural placode. Whether the CSF is infected determines if a shunt can be placed or a ventriculostomy needs to be performed until the infection has resolved. Sampling the CSF from the MMC sac is practical and necessary in order to decide whether a shunt can be placed simultaneously or shortly after the repair (7). An analysis of the CSF can provide us with enough information regarding proteins, appearance, cultures, and blood cells. It is widely accepted that the early closure of an MMC improves survival, and performing this repair is recommended. Hydrocephalus is even more evident after the repair of the MMC, as no further loss of CSF occurs after the repair. Since 80% of patients with MMC will develop hydrocephalus, optimal conditions are needed for the placement of a shunt for the CSF.

Our data show that the characteristics of the CSF of MMC patients is abnormal in terms of the amount of proteins and the WBC count. Contact with the amniotic fluid during gestation, early colonization, and an inflammatory process all lead to many of the alterations that we are observing in the CSF results. In this study, the patients were not followed to determine if they did develop an infection after placement of the shunt. More studies are needed to learn how to predict when the early or late placement of a shunt is indicated. MMC patients

Table 1.

Cerebrospinal fluid characteristics			Normal values
Total samples	45	% (n)	
Sex	Male	51% (23)	
CSF color	Yellow and turbid	35.6% (16)	Clear
WBC	>25 count/mm^3	51% (23)	<25 count/mm^3
RBC	<200 count/mm^3	64% (29)	<200 count/mm^3
Ratio (WBC/RBC)	< 1/1000 count/mm^3	33% (15)	<1/1000 count/mm^3
Polymorphonuclear leukocytes	>50%	20% (9)	0
Protein	>200 mg/dL	42% (19)	<200 mg/dL
Glucose	<40 mg/dL	36% (16)	>40 mg/dL

with ventricular shunts and hindbrain abnormalities undergo multiple surgeries during their lifetimes. The incidence of shunt revision in MMC patients may be similar to such an incidence in non-myelomeningocele patients with hydrocephalus (13). We cannot ignore the fact that there may be some unique features that we are overlooking in the CSF of these patients.

In our study, 80% of the samples had WBC counts in the range of 1 to 100 /mm3; however, no sample had a positive culture or gram stain. Early closure of the MMC diminishes the likelihood of an infection but does not predict the patient's risk for shunt revisions (6). Some surgeons place a ventriculosubgaleal shunt or place a reservoir and perform serial taps (14). We usually avoid these measures to reduce the patient's risk of requiring multiple procedures or developing infection of the CSF. Only 1 sample had significant leukocytosis suggestive of infection, but the gram stain and the culture were negative. The number of RBCs in the samples taken were abnormal, but we do not know whether this was a factor affecting the incidence of early shunt malfunction in our population. This question needs to be addressed separately. A high CSF protein level may cause shunt malfunction, and when this value is above 200 mg/dL it is usually necessary to wait for it to normalize before placing a shunt. Some authors have found that protein level is not a factor in shunt malfunction (15). Sixty percent of the samples of CSF had above 100 mg/dL of protein. We propose that a strict follow-up of a patient's protein values should be done before CSF shunting in order to decrease the incidence of shunt malfunction for this population. None of the CSF samples had pathogen growth. This information led us to advocate the early placement of shunts in patients developing hydrocephalus. In a future study, we plan to use the analyzed CSF values to determine their influence on potential shunt infections and revisions in MMC patients.

Conclusion

The protein levels and WBC count of the CSF aspirated from the MMC sac were elevated in half of the samples, but the cultures evidenced no bacterial growth. We advocate the early placement of a shunt in patients presenting hydrocephalus. It is our goal to develop a future study and correlate the findings reported herein with the incidence of shunt infection and shunt malfunction in this population.

Resumen

Objetivo: Nuestro objetivo era evaluar el análisis de laboratorio intraoperatorio del líquido cefalorraquídeo (LCR) aspirado del saco del mielomeningocele (MMC) antes de una reparación para determinar si había crecimiento bacteriano en los cultivos. Métodos: Análisis retrospectivo de los cultivos de LCR de 45 pacientes operados de MMC durante los años 2002-2013 en el Hospital Pediátrico Universitario. Antes de reparar el defecto, se limpió el área del saco y se extrajeron tres mililitros de LCR y se enviaron para análisis de glóbulos rojos, glóbulos blancos, nivel de glucosa, nivel de proteína, nivel de cloruro, tinción de gram y cultivo. Los resultados de la muestra de LCR se analizaron para detectar irregularidades en los valores antes de proceder con la colocación de una derivación ventricular. Resultados: Todas las muestras de LCR analizadas tenían al menos un valor anormal, pero en ninguna muestra crecieron patógenos en el cultivo. Conclusión: Se encontró un aumento de los niveles de proteínas en LCR y otros valores anormales en el análisis de LCR en esta población, sin embargo, ninguno de los cultivos creció patógeno. Este hallazgo es una herramienta importante en la evaluación de las posibles etiologías, y el enfoque terapéutico para los problemas futuros con la derivación en este grupo de pacientes.

References

1. CDC. Congenital malformations surveillance report: January 1982-December 1985. Atlanta, GA: US Department of Health and Human Services, Public Health Service; 1988.
2. Greenberg F, James LM, Oakley GP Jr. Estimates of birth prevalence rates of spina bifida in the United States from computer-generated maps. Am J Obstet Gynecol 1983;145:570-573.
3. Bowman RM, Boshnjaku V, McLone DG. The changing incidence of myelomeningocele and its impact on pediatric neurosurgery: a review from the Children's Memorial Hospital. Childs Nerv Syst 2009;25:801-806.
4. Williams LJ, Mai CT, Edmonds LD, et al. Prevalence of spina bifida and anencephaly during the transition to mandatory folic acid fortification in the United States. Teratology 2002;66:33-39.
5. Milunsky A, Jick H, Jick SS, et al. Multivitamin/folic acid supplementation in early pregnancy reduces the prevalence of neural tube defects. JAMA 1989;262:2847-2852.
6. Attenello FJ, Tuchman A, Christian EA, et al. Infection rate correlated with time to repair of open neural tube defects (myelomeningoceles): an institutional and national study. Childs Nerv Syst 2016;32:1675-1681.
7. Kaplan M, Ucler N, Bayrakli F, Duz B, Erol FS. Diagnosis of central nervous system infection by CSF sampling of the myelomeningocele sac as an alternative to ventricular tap. Neurocirugia (Astur) 2010;21:228-231.
8. Oktem IS, Menkü A, Ozdemir A. When should ventriculoperitoneal shunt placement be performed in cases with myelomeningocele and hydrocephalus? Turk Neurosurg 2008;18:387-391.
9. Machado, HR., Oliveira, RS. Simultaneous repair of myelomeningocele and shunt insertion. Childs Nerv Syst 2004;20:107-109.
10. Simon TD, Hall M, Riva-Cambrin J, et al.; Hydrocephalus Clinical Research Network. Infection rates following initial cerebrospinal fluid shunt placement across pediatric hospitals in the United States. Clinical article. J Neurosurg Pediatr 2009;4:156-165.
11. Odio C, McCracken GH Jr, Nelson JD. CSF shunt infections in pediatrics. A seven-year experience. Am J Dis Child 1984;138:1103-1108.
12. Batty R, Vitta L, Whitby EH, Griffiths PD. Is there a causal relationship between open spinal dysraphism and Chiari II deformity? A study using in utero magnetic resonance imaging of the fetus. Neurosurgery 2012;70:890-898.
13. Simon TD, Butler J, Whitlock KB, et al. Risk factors for first cerebrospinal fluid shunt infection: findings from a multi-center prospective cohort study. J Pediatr 2014;164:1462-1468.
14. Fulmer BB, Grabb PA, Oakes WJ, Mapstone TB. Neonatal ventriculosubgaleal shunts. Neurosurgery 2000;47:80-84.
15. Brydon HL, Bayston R, Hayward R, Harkness W. The effect of protein and blood cells on the flow-pressure characteristics of shunts. Neurosurgery 1996;38:498-505.