정상 만삭 분만된 3개월 미만 영아에서 발생한 수막염의 양상 변화: 2008년부터 2013년까지의 단일 기관 연구

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Early Infantile Meningitis Trends in Full-term Infants: A Korean Single-center Study, 2008–2013

Purpose: The characteristics of early infantile meningitis in full-term and previously healthy infants may differ from those in preterm or previously ill infants. However, full-term and previously healthy infant data remain scarce, and the recent trends are not well known.

Method: Full-term and previously healthy infants (<3 months old) diagnosed with meningitis in our hospital between January 2008 and December 2013 were enrolled. We retrospectively reviewed their clinical and laboratory data.

Results: A total of 162 full-term and early infants with meningitis (male, 55.6%; mean age, 45 days) were enrolled. Among them, 122 patients (75.3%) were diagnosed with viral meningitis (63 enterovirus-proven and 59 viral-suspected), and 40 patients (24.7%) were diagnosed with bacterial meningitis (18 bacteria-proven and 22 bacterial-suspected). The proportion of early infantile meningitis among all infants admitted (<3 months of age) increased significantly from 1.6% to 3.1%, and viral meningitis increased from 1.1% to 2.3% ($P<0.01$). Early infantile meningitis increased significantly at each 2-year interval. The seasonal viral meningitis peak shifted from July to June after 2012. Group B *Streptococcus* was the most common bacterial pathogen (88.9%) and usually caused late-onset meningitis (14 of 16). Coxsackie B viruses were most commonly isolated (59.3%) from the 54 patients with viral meningitis using available genotype data.

Conclusion: Early infantile meningitis in previously healthy full-term infants (<3 months old) increased significantly between 2008 and 2013, and most cases were viral meningitis. The seasonal viral meningitis peak shifted from July to June after 2012.

Key Words: Meningitis, Term birth, Neonates, Enterovirus, *Streptococcus agalactiae*

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Introduction

A cerebrospinal fluid (CSF) examination must be considered in febrile neonates and infants (<3 months old, as they are vulnerable to bacterial meningitis¹⁾. The incidence of bacterial meningitis in early infants is 0.21–0.72/1,000 live births, which is the highest among all age groups^{2,3)}. Mortality due to neonatal bacterial meningitis is as high as 10% in developed countries and 40–58% in

developing countries⁴). Although viruses are the most common cause of meningitis⁵, early empirical antibiotic administration is inevitably performed in infantile cases because the differential diagnosis of viral and bacterial meningitis is quite difficult due to their symptom overlap and different CSF reference ranges depending on postnatal age⁶. Byington et al. suggested an optimal cut-off of 14 cells/mm³ as the CSF white blood cell (WBC) count to diagnose meningitis in infants <90 days old⁷. Two studies reported 90–95th percentile values for normal CSF WBC counts of 19–22 cells/mm³ before 28 days and 9–15 cells/mm³ between 29 and 56 days^{8,9}. However, Garges et al. reported that 10% of neonates with bacterial meningitis have a CSF WBC count <3 cells/mm³¹⁰.

The clinical and laboratory characteristics of bacterial and viral meningitis in early infants can differ depending on the gestational or postnatal age of the infant, underlying disease, and the clinical setting. Nevertheless, most studies on early infantile meningitis included healthy full-term and preterm infants in intensive care units^{2,3}. Furthermore, previous studies mostly focused on bacterial meningitis and excluded viral meningitis. Enteroviruses are the major cause of viral meningitis⁵, and particular enterovirus serotypes are associated with specific symptoms: herpangina due to Coxsackie A viruses, hand-foot-and-mouth disease due to coxsackievirus A16 or enterovirus 71, and pericarditis/myocarditis due to Coxsackie B viruses¹¹. Although prevalent serotypes reportedly differ by age^{12,13}, the predominant enterovirus types have rarely been studied in early infantile meningitis. Epidemiological data for early infantile meningitis,

including prevalent bacteria or viruses (and their genotypes), ages when infants are vulnerable to specific pathogens, and the seasonal prevalence of viral meningitis, could help with the early differential diagnosis of viral from bacterial meningitis as well as in the selection of appropriate antibiotics for bacterial meningitis. Therefore, we analyzed the recent early infantile meningitis trend in full-term and previously healthy infants (<3 months old) in our hospital, including the proportion of meningitis cases among all admitted early infants and the characteristics of bacterial and viral meningitis.

Materials and Methods

Full-term and previously healthy infants <3 months old diagnosed with meningitis at Chonnam National University Hospital (CNUH) between January 2008 and December 2013 underwent a retrospective medical record review. We obtained the number of total early infants (<3 months old) admitted to CNUH during the same period to calculate the annual proportion of early infantile meningitis cases. Meningitis during early infancy was diagnosed based on the presence of appropriate clinical symptoms including fever and irritability, as well as positive results for causative agents in CSF, or an increase in the CSF WBC count (>14 cells/mm³)^{6,7}. Meningitis during early infancy was classified into four different types of bacteria-proven and bacterial-suspected meningitis (bacterial group), and enterovirus-proven and viral-suspected meningitis (viral

Table 1. Definitions of Meningitis Types in Early Infants (<3 Months Old)

Diagnosis	Definition
Bacterial group	
Bacteria-proven meningitis	Positive for CSF culture, bacterial antigen, or multiplex PCR test
Bacterial-suspected meningitis	CSF WBC >14 cells/mm ³ , Negative for bacterial and viral study in CSF, and One of the following: 1. Serum CRP ≥7.0 mg/dL or 2. Two or more abnormalities in CSF: CSF WBC >500 cells/mm ³ CSF protein >120 mg/dL CSF glucose <20 mg/dL
Viral group	
Enterovirus-proven meningitis	Negative for CSF culture, bacterial antigen, or multiplex PCR test, and Positive for enterovirus PCR test in CSF or Positive for enterovirus PCR test in stool and CSF WBC >14 cells/mm ³ and serum CRP <7.0 mg/dL
Viral-suspected meningitis	CSF WBC >14 cells/mm ³ and serum CRP <7.0 mg/dL, and Negative for bacterial and viral study in CSF, blood and stool, and Not classified as bacterial suspected meningitis

CSF, cerebrospinal fluid; PCR, polymerase chain reaction; WBC, white blood cell; CRP, C-reactive protein.

group). This classification was based on the CSF WBC count, glucose, protein, and serum C-reactive protein (CRP) levels, as well as the results of bacterial or viral tests in CSF, blood, and stool (Table 1)^{6,7,10,11,14,15}. Patients with CSF pleocytosis from other causes⁶⁾ (e.g., urinary tract infection) or insufficient clinical or laboratory data were excluded. However, patients who had suffered a traumatic lumbar puncture were included because other studies show traumatic lumbar puncture occurs very frequently in neonates (35–46%), and CSF abnormalities associated with bacterial meningitis are rarely obscured by blood contamination from a traumatic lumbar puncture^{6,16)}.

The CSF WBC count, red blood cell (RBC) count, protein, and glucose values at the initial diagnosis were analyzed. Corrected CSF WBC count and protein values were calculated by subtracting 3 WBC/mm³ per 10,000 RBC/mm³ and 1.3 mg/dL of protein per 1,000 RBC/mm³ from the original reported values in patients with traumatic lumbar puncture (i.e., >1,000 RBC/mm³ CSF)¹⁶⁾. The CSF bacterial tests reviewed included Gram staining, acid-fast bacillus staining, a bacterial antigen test using the latex particle agglutination, culture, and multiplex polymerase chain reaction (PCR) test. CSF multiplex PCR test identified the following pathogens: *Streptococcus pneumoniae*, *Haemophilus influenzae* type b, *Neisseria meningitidis*, group B *Streptococcus* (GBS), and *Listeria monocytogenes*¹⁷⁾. The enterovirus test results including the CSF and stool genotype reports, which were performed using reverse transcription PCR at CNUH and the Health and Environment Institute of Gwangju, were reviewed. Viral agents other than enterovirus were not included in the present study. Blood WBC count, serum glucose and CRP levels, blood culture, urinalysis, and urine culture were

considered to confirm the diagnosis, in addition to a review of the clinical course of disease in each patient. This study was approved by the ethics committee of CNUH (IRB number CNUH-2014-269). Linear-by-linear association analysis was used to analyze the trend in the incidence of meningitis. A $P<0.05$ was considered significant. SPSS ver. 21.0 software (SPSS Inc., Chicago, IL, USA) was used for all analyses.

Results

1. Proportion of early infantile meningitis among all admitted infants <3 months old

A total of 7,222 patients <3 months old were admitted to the Department of Pediatrics of CNUH between 2008 and 2013. After excluding patients who did not meet the inclusion criteria, 162 previously healthy full-term infants with early infantile meningitis were enrolled. The mean±standard deviation age of the early infants was 45±23 days (range, 1–90 days). Seven patients (4.9%) were ≤7 days old, 30 patients (18.5%) were 8–28 days old, and 124 patients (76.5%) were >28 days old. No sex difference was detected (90 male patients, 55.6%). Mean hospital stay was 10±8 days (range, 1–48 days), and traumatic lumbar puncture occurred in 19 patients (11.7%). Seven patients died and mortality rate of early infantile meningitis was 4.3%.

The proportion of early infantile meningitis among all admitted infants increased significantly over 6 years from 1.6% to 3.1% ($P<0.01$) and that of viral meningitis also increased significantly from 1.1% to 2.3% ($P<0.01$). However, bacterial meningitis did not increase significantly during this period ($P=0.15$). The mean

Table 2. Proportion of Early Infantile Meningitis Cases in Full-term and Previously Healthy Infants among All Early Infants (<3 Months Old) admitted to Chonnam National University Hospital (CNUH) between 2008 and 2013

Year	2008	2009	2010	2011	2012	2013	Total	P value*
Meningitis, n (%)	16 (1.6)	13 (1.2)	24 (2.1)	26 (2.1)	41 (3.0)	42 (3.1)	162 (2.2)	<0.01
Bacterial group, n (%)	5 (0.5)	3 (0.3)	7 (0.6)	6 (0.5)	8 (0.6)	11 (0.8)	40 (0.6)	0.15
Viral group, n (%)	11 (1.1)	10 (0.9)	17 (1.5)	20 (1.6)	33 (2.4)	31 (2.3)	122 (1.7)	<0.01
Total admitted†, n	1,025	1,105	1,165	1,223	1,370	1,334	7,222	

*Linear-by-linear association analysis was used to assess the early infantile meningitis trend in full-term and previously healthy infants.

†Total number of early infants admitted to CNUH each year.

Table 3. Number of Early Infants (<3 Months Old) with Each Meningitis Type

Year	2008–2009	2010–2011	2012–2013	Total
Bacterial group, n (%)	8 (27.6)	13 (26.0)	19 (22.9)	40 (24.7)
Bacteria-proven	3 (10.4)	7 (14.0)	8 (9.6)	18 (11.1)
Bacterial-suspected	5 (17.2)	6 (12.0)	11 (13.3)	22 (13.6)
Viral group, n (%)	21 (72.4)	37 (74.0)	64 (77.1)	122 (75.3)
Enterovirus-proven	7 (24.1)	21 (42.0)	35 (42.2)	63 (38.9)
Viral-suspected	14 (48.3)	16 (32.0)	29 (34.9)	59 (36.4)
Total, n (%)	29	50	83	162 (100.0)

number of meningitis cases increased significantly every 2 years: 14.5, 25, and 41.5 patients in 2008–2009, 2010–2011, and 2012–2013, respectively (Table 2). Among 162 patients, 122 (75.3%) were in the viral group (i.e., enterovirus-proven and viral-suspected meningitis) and 40 (25.3%) were in the bacterial group (i.e., bacteria-proven and bacterial-suspected meningitis). Enterovirus was proven in 63 patients (38.9%), and the causative bacteria was detected in 18 patients (11.1%) (Table 3). Viral meningitis peaked in June after 2012, although it peaked in July between 2008 and 2011 (Fig. 1).

2. Bacteria-proven meningitis

CSF bacterial culture or tests were performed in all 162 patients; CSF bacterial cultures were performed in 160 patients (98.8%), and CSF bacterial antigen or multiplex PCR was performed in 132 patients (81.5%). The causative bacteria were detected in CSF from 18 patients (11.1%), and the same organisms were isolated from the blood in four (22.2%). The mean age of the patients was 32 ± 23 days (range, 1–79 days), and 15 patients (83.3%) were ≥ 8 days old. The most common causative organism was GBS (88.9%), which usually caused late-onset meningitis (87.5%). *E. coli* was isolated from one 42-day-old

Fig. 1. Seasonal distribution of early infantile viral meningitis in full-term and previously healthy infants. Viral meningitis peaked in June after 2012, although it peaked in July between 2008 and 2011. March–May is spring, June–August is summer, September–November is autumn, and December–February is winter in Korea.

Table 4. Bacterial Meningitis Causative Organisms in Early Infants (<3 Months Old)

Year	2008–2009	2010–2011	2012–2013	Total
GBS, n (%) [*]	2	7	7	16 (88.9)
≤7 days old	1 [*]	0	1	2 (12.5) [†]
8–28 days old	0	3	3	6 (37.5) [†]
>28 days old	1	4 [*]	3 [*]	8 (50.0) [†]
Others, n (%)	1 [‡]	0	1 [§]	2 (11.1)
Total, n (%)	3	7	8	18 (100.0)

^{*}Four patients with Group B *Streptococcus* (GBS) meningitis (one <3 days old and three >35 days old) died.

[†]Data indicate the percentage of patients among 16 patients with GBS meningitis.

[‡]*Streptococcus pneumoniae* was cultured in one 3-day-old patient who died on the 4th day of admission.

[§]*E. coli* was isolated in one patient at 42 days of age.

Table 5. Enterovirus Positivity in Stool or cerebrospinal fluid in Early Infants (<3 Months Old) with Meningitis

Year	2008–2009	2010–2011	2012–2013	Total
Positive, n (%) [*]	7 (70.0)	21 (56.8)	37 (62.7)	65 (61.3) [†]
Stool	7 (70.0)	21 (56.8)	26 (68.4)	54 (63.5)
CSF	0 (0.0)	7 (43.8)	26 (52.0)	33 (49.3)
Tested, n (%)	10 (34.5)	37 (74.0)	59 (71.1)	106 (65.4)
Stool	10 (34.5)	37 (74.0)	38 (45.8)	85 (52.5)
CSF	1 (3.4)	16 (32.0)	50 (60.2)	67 (41.4)
Total number, n (%)	29	50	83	162 (100.0)

CSF, cerebrospinal fluid.

^{*}Percentage of patients with positive results among all patients who underwent the enterovirus test.

[†]Two patients with high serum CRP levels (>7 mg/dL) and positive enterovirus results only in stool were classified as bacterial-suspected meningitis.

patient without CSF pleocytosis (CSF WBC count, 8 cells/mm³). *S. pneumoniae* was cultured from one 3-day-old patient, who died on four days after admission (Table 4). Five patients died (27.8%) within 4 days of hospital admission. Four of them had GBS meningitis (one patient <3 days old and three patients >35 days old). All dead cases had low blood WBC counts (<5,000 cells/mm³) and were already in critical condition on admission. The mean WBC count in CSF was 4,214.9±5,624.9 cells/mm³ (range, 8–17,920 cells/mm³), mean protein level was 447.2±322.5 mg/dL (range, 63–1,181 mg/dL), and mean glucose level was 24.8±25.3 mg/dL (range, 1–82 mg/dL). Sixteen patients (88.9%) had high CSF protein levels (>120 mg/dL), and 11 patients (61.1%) had low CSF glucose levels (<20 mg/dL).

3. Enterovirus-proven meningitis

The enterovirus test was performed in 65.4% (106 of 162) of patients with early infantile meningitis. Among them, 65 patients (61.3%) were positive for enterovirus. After 2010, the enterovirus test was performed in >70% of patients. Except two patients with high serum CRP levels (≥7.0 mg/dL) and positive enterovirus results only in stool in 2012–2013, the remaining 63 patients were classified as having enterovirus-proven meningitis

(Table 5). Stool enterovirus and CSF positivity was detected 69.6% (n=32) and 47.8% (n=22) of 46 patients who underwent both stool and CSF testing, respectively. All 22 patients with positive CSF enterovirus results also had positive stool results.

The mean age of the 63 patients with enterovirus-proven meningitis was 46±23 days (range, 1–89 days). Two patients (3.2%) were ≤7 days old, 11 patients (17.5%) were 8–28 days old, and 50 patients (79.4%) were ≥28 days old. The mean hospital stay was 8±2 days (range, 1–15 days). High CSF WBC count (>500 cells/mm³) and high CSF protein levels (>120 mg/dL) were detected in 30.1% (n=19) and 7.2% (n=5), respectively. However, no patient had hypoglycorrhachia (CSF glucose <20 mg/dL); the lowest CSF glucose level was 37 mg/dL. Serum CRP levels were <3 mg/dL in all patients except one (98.4%) (Table 6). Two patients with coxsackievirus B1 meningitis died of myocarditis and one had leucopenia (WBC<5,000/mm³). The mortality rate in all patients with enterovirus-proven meningitis was 3.2%. Enterovirus isolated from stool or CSF was genotyped in 85.7% of cases (n=54). Coxsackie B viruses were predominant (59.3%, n=32), and the most common genotype was coxsackievirus B1 (25.9%, n=14) (Fig. 2).

Table 6. Laboratory Findings in 63 Patients* with Enterovirus-proven Meningitis

	Mean±SD [range]	Number (%)
CSF WBC (/mm ³)	481±556 [15–2,592]	
<100		20 (31.7)
100–500		24 (38.1)
501–1,000		7 (11.1)
>1,000		12 (19.0)
CSF protein (mg/dL)	87±28 [39–199]	
<60		11 (17.5)
60–120		47 (74.6)
>120		5 (7.9)
CSF glucose (mg/dL)	50±9 [37–91]	
<20		0 (0.0)
20–40		5 (7.9)
>40		58 (92.1)
Blood WBC (/mm ³)	11,097±3,806 [4,100–23,300]	
<5,000		2† (3.2)
5,000–20,000		59 (93.7)
>20,000		2 (3.2)
Serum CRP (mg/dL)	0.66±0.56 [0.05–3.27]	
<1.00		45 (71.4)
1.00–2.99		17 (27.0)
≥3.00		1 (1.6)

SD, standard deviation; CSF, cerebrospinal fluid; WBC, white blood cell; CRP, C-reactive protein.

*Corrected CSF WBC count and protein values were used in eight patients (12.7%) with traumatic lumbar puncture (>1,000 RBC/mm³ CSF).

†One patient with coxsackievirus B1 meningitis died from myocarditis.

Discussion

Our study on early infantile meningitis in full-term and previously healthy infants, revealed that the proportion of early infantile meningitis cases among all admitted infants <3 months

Fig. 2. Genotypes of viruses proven in stool or cerebrospinal fluid from the 54 tested patients with enterovirus-proven meningitis. CB1 was isolated from two patients who died because of associated myocarditis. CA, coxsackievirus A; CB, coxsackievirus B; E, echovirus; EV, enterovirus; n, number.

old increased significantly from 2008 to 2013. The proportion of viral meningitis cases increased significantly, and the number increased every 2-year period. The seasonal viral meningitis peak shifted from July to June after 2012, which may be attributable to the recent earlier summer season in Korea, as the incidence of enterovirus infections is high in summer and fall¹⁸. In this study, GBS was the most common type of causative organism and usually caused late-onset meningitis, consistent with previous reports in Korea^{19,20}. The low incidence of early-onset GBS meningitis may be due to the relatively low rate of maternal GBS colonization (<10%) in Korea compared to that in other industrialized countries (10–35%)^{21–23}.

The CSF WBC count cut-off for diagnosing early infantile meningitis in this study was 14 cells/mm³⁷. However, bacterial or virus-proven meningitis without CSF pleocytosis has been reported^{6,10,24}. In this study, one patient had *E. coli* meningitis with a CSF WBC count of only 8 cells/mm³. Even the large retrospective study of Garges et al. failed to determine a cut-off of CSF WBC count with optimal sensitivity and specificity for the differential diagnosis of early infantile bacterial meningitis; they suggested a CSF WBC count >21 cells/mm³ (79% sensitivity and 81% specificity), CSF protein level >120 mg/dL (76% sensitivity and 63% specificity), and CSF glucose level <20 mg/dL (44% sensitivity and 98% specificity)¹⁰. Furthermore, these cut-offs must be modified depending on gestational age⁶. Some studies have reported that CSF WBC count and protein level are higher in preterm infants than those in term infants^{6,25}. Serum CRP was recently suggested as another useful marker for the differential diagnosis of bacterial meningitis in febrile infants^{14,15}. The possibility of bacterial meningitis is quite low in cases with a low serum CRP level (<7 mg/dL)¹⁵.

Enterovirus infections during enteroviral season are responsible for approximately 65% of early infants (≤90 days old) hospitalized under suspicion of a serious bacterial infection²⁶. Enterovirus can be isolated from CSF with high specificity or stool with good sensitivity²⁷. Of our patients who underwent both stool and CSF tests, the rate of positivity was higher in the stool enterovirus PCR test than that in the CSF test (69.6% vs. 47.8%, respectively). Two patients with high serum CRP levels (≥7.0 mg/dL) and positive enterovirus results only in stool in 2012–2013 were not classified as enterovirus-proven meningitis because simple colonization of enterovirus in the stool could not be ruled out. Enteroviral meningitis mildly to moderately elevates the CSF WBC count¹⁸. However, some cases have a CSF WBC count >1,000/mm³ or no CSF pleocytosis^{18,24,28–30}. In the present study, high CSF WBC count (>500 cells/mm³) was observed in 30.1% of patients (CSF WBC count >1,000 cells/mm³

in 19.0% of patients), but no case occurred without pleocytosis. A high CSF protein level (>120 mg/dL) was noted in 7.2% of patients. However, hypoglycorrhachia (CSF glucose < 20 mg/dL) was not detected in any patient.

Coxsackie B viruses were the predominant genotype group (59.3%) in the present study in the 54 early infants with available genotype data. The most common genotype was coxsackievirus B1 (25.9%). Wikswo et al. reported increased coxsackievirus B1 activity among young infants and cases of severe illness and death in the United States³¹. In the present study, two patients with coxsackievirus B1 died due to myocarditis, and one had leucopenia. Although most early infants had benign clinical courses, enterovirus infection can be fatal in cases associated with myocarditis or hepatic necrosis with coagulopathy^{30,32}. Enterovirus 71 emerged in the late 1990s in East Asia as a neurovirulent virus that caused large meningitis outbreaks³³. Hyeon et al. analyzed surveillance data from the Korea CDC between 1999 and 2011 and reported that enterovirus 71 was the most common genotype during 2009–2011¹³. However, in this study of early infantile meningitis only, we found that coxsackie B viruses were the most common every year. Coxsackievirus B1 was the most common genotype in 2008, 2009, and 2013.

Our description of the recent trends and characteristics of early infantile meningitis is meaningful, because we analyzed bacterial and viral meningitis data only in full-term and previous healthy infants <3 months old. In addition, we effectively classified meningitis type based on a thorough literature review^{6,7,10,11,14,15}. We suggest the ideal combination of CSF parameters and serum CRP cut-off values to diagnose patients with negative CSF cultures, antigen, or multiplex PCR test results. A few limitations of our study should be addressed in future studies. First, this was not a nationwide cohort study representing the actual trends of early infantile meningitis in Korea. However, CNUH is the largest tertiary general hospital in metropolitan Gwangju. The Neonatal and Pediatric Neurologic Department of CNUH is a major neonatal referral center in Gwangju. The Neonatal Intensive Care Unit of CNUH was the only such center in Gwangju designated by the Ministry of Health and Welfare of Korea until 2012. Second, stool and CSF enterovirus tests were performed in only 65.4% of all patients, with varying percentages among years. This was inevitable because this was a retrospective study and availability of the enterovirus test improved during the study period. Future large prospective cohort studies are expected to overcome these limitations. Such studies should include other viruses causing meningitis in addition to enteroviruses.

In conclusion, early infantile meningitis, particularly viral meningitis, in full-term and previously healthy infants <3 months old increased between 2008 and 2013. Viral meningitis was responsible for approximately 75% of all meningitis cases and exhibited a shift in seasonal peak from July to June after 2012. Viral meningitis must be considered in addition to bacterial meningitis during early summer. An early differential diagnosis of viral meningitis using the CSF or stool enterovirus test could reduce antibiotic overuse and long-term hospitalization.

요약

목적: 만삭으로 분만된 평소 건강했던 영아에서 발생한 수막염의 임상적 특징은 미숙아나 과거 다른 질병을 가지고 있던 영아들에서와는 다를 수 있다. 그러나 만삭 분만된 평소 건강했던 어린 영아만을 대상으로 한 수막염에 대한 연구는 아직 많지 않아, 이에 대한 최근 동향에 대해 살펴보고자 하였다.

방법: 2008년부터 2013년 사이에 본원에서 수막염으로 진단되었던, 만삭 분만된 평소 건강했던 3개월 미만의 어린 영아들을 대상으로 임상 기록과 척수액, 혈액, 소변 및 대변에서의 검사 자료들을 후향적으로 검토하였다.

결과: 총 162명의 수막염으로 진단되어 입원하였던 만삭 분만된 어린 영아들(남자, 56%; 평균 연령 45일)이 대상이 되었으며, 이들 중 바이러스성 수막염군이 75.3%(엔테로바이러스-중명군 63명, 바이러스성-의심군 59명), 세균성 수막염군이 24.7%(세균-중명군 18명, 세균성-의심군 22명)였다. 3개월 미만의 전체 본원 입원 환자수 대비 수막염 환아수는 1.6%에서 3.1%로 조사 기간 동안 크게 증가하였고, 특히 바이러스성 수막염이 1.1%에서 2.3%로 유의하게 증가하였다($P<0.01$). 어린 영아에서 발생한 수막염 환아수는 2년마다 크게 증가하였다. 바이러스성 수막염은 2011년까지는 7월에 가장 호발하였으나, 2012년 이후에는 6월에 가장 빈번하게 발생하였다. B군 사슬알균이, 원인이 밝혀진 세균성 수막염의 88.9%를 차지해 가장 흔한 원인균이었으며, 이는 흔히 후기-발병 수막염을 일으켰다(16명 중 14명). 엔테로바이러스 유전형 분석이 가능하였던 총 54명의 바이러스성 수막염 환자들 중에서는 Coxsackie B 바이러스군이 59.3%에서 분리되어 가장 흔하였다.

결론: 만삭 분만된 평소 건강했던 3개월 미만의 어린 영아에서의 수막염은 2008년부터 2013년 동안 크게 증가하였으며, 대부분 바이러스성 수막염이 차지하였다. 바이러스성 수막염은 2012년 이후에는 6월에 조기 호발하는 양상을 보였다.

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