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Cohort Study

Epidemiology of findings of lumbar puncture among pediatric patients

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ABSTRACT

Objective: Lumbar Puncture (LP) is a common invasive procedure where cerebrospinal fluid is obtained for the diagnosis of neurological anomalies. The purpose of this study was to evaluate the results of CSF analysis in patients admitted to pediatric wards.

Methods: In this retrospective descriptive study, records of the pediatric patients (aged <18 years) who were referred to our centers for lumbar puncture were evaluated. A checklist was prepared for all the patients where demographic data, findings of CSF and blood analysis and clinical presentations were recorded. The data obtained was analyzed using SPSSv22.

Results: In this study a total number of 247 patients were included where 57.9% of the cases were of boys. 55.8% patients aged under 1 year and 62.3% of patients had a body temperature of 38 °C and above. 15.3% of the children were diagnosed with meningitis, 27.1% had febrile seizures, 9.3% had neonatal sepsis and for 48.2% cases other clinical diagnoses were made. There was a significant relationship between the diagnosis and the number of WBCs seen in CSF ($P < 0.001$). Also, there was a significant relationship between the diagnosis and amount of protein ($P < 0.001$) and glucose in CSF ($P = 0.005$). The age group and the type of fever and seizure were also significantly correlated, ($P < 0.001$).

Conclusion: Lumbar puncture is an important procedure for the diagnosis of several neurological diseases. Further studies including neuroimaging and therapeutic measures are recommended in this regard.

1. Introduction

Cerebrospinal fluid (CSF) plays a critical role in brain function where alterations in its composition, flow and pressure can impair brain function and indicate the pathology. Therefore, CSF analysis is one of the important lab procedures for the diagnosis of a number of neurological diseases including infections [1,2]. Lumbar puncture (LP) is a procedure that involves the extraction of CSF by inserting the needle between the lumbar vertebrae. The extracted CSF is analysis for the presence of infection, opening pressure, subarachnoid haemorrhage, autoimmune disease of central nervous system, neoplastic meningeal disease, and dementia [3].

LP is commonly performed in pediatric patients, presented with the sign of meningeal infection. According to the recommendation by American Academy of Pediatrics, LP should only be performed among pediatrics meningeal infection, history of intracranial infection or unknown history of immunization. It is not required among children with acute febrile seizures who are completely immunized [4]. Epidemiological studies in Tehran, Iran have shown that the incidence of sepsis is 9% in suspected neonates and 3.3% of neonatal sepsis cultures were CSF positive. In a child with a headache that is most severe immediately after onset, if the brain imaging is negative as an initial measure, LP should be performed, and in the presence of xanthochromia in the CSF, LP pressure and complete CSF analysis should be performed. When a patient presents with persistent seizures with fever, LP rarely shows CSF pleocytosis (96% of cases less than 3 nuclear cells) and glucose and protein are

Abbreviations: LP, Lumbar Puncture; CSF, Cerebrospinal fluid.

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normal. In a study among children under 18 years, fever of unknown origin with 20.4%, proximal conditions with 17.9%, meningitis with 13.6% and seizures with 11.2% were the most common cases associated with LP findings [5].

The aim of this study is to investigate the findings of lumbar puncture among pediatric patients referred to two federal hospitals in Khorramabad Iran. We also evaluate the correlation of these findings with clinical presentation in the children.

2. Methods

In this retrospective descriptive study clinical and epidemiological aspects in children referred to (XXX) 2014 to 2020 for lumbar punction were included. Children with incomplete data and congenital abnormalities were excluded from the study.

Necessary demographic and clinical information for all patients, including patient gender, age group, clinical symptoms, paraclinical findings and diagnosis were collected from the records of the two hospitals. The pediatric medicine references used in this study were considered in the age grouping due to the difference in normal values of CSF parameters at birth up to 4 weeks and 4–8 weeks with other ages, using Nelson's formula. A researcher-made form based on the sub-objectives of the research, the content validity of which was approved by 5 faculty members related to pediatrics and vital statistics, was prepared to collect information.

The data was computerized and entered in SPSSv22 for statistical analysis. Descriptive statistical methods such as frequency distribution table, mean indices, standard deviation, and percentage was used to measure the data. Chi-square and Fisher's exact test were used for comparison and correlation of the variables. A significance level of 0.05 was considered to be significant.

This study was approved by the Research Ethics Board of Lorestan University of Medical Sciences (**IR.LUMS.REC.1398.141**).

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The methods have been reported in line with STROCSS 2021 guidelines [6].

3. Results

247 patients were included in the study where 57.9% were males and the most common age group was 8 weeks to 1 year (38.9%) and 1–3 years (25.5%), respectively. 62.3% patients had an axillary fever of 38.5 °C and above and only 6.5% of patients had a fever of less than 37.8 °C. 59.8% patients had a fever for less than 7 days. Most patients (83.0%) had no symptoms of meningeal stimulation and nearly half of the patients, 50.2% were presented with seizures.

The lab findings of the patients are summarized in Tables 2 and 3.

Statistical analysis of data using Chi-square test with Monte Carlo simulation showed that there is a significant relationship between disease diagnosis and CSF white blood cell count ($P < 0.001$). The most common diagnoses were related to other diagnoses (57.1%) followed by fever and seizures (35.4%) and in cases of 4–99 WBC per microliter the most common diagnoses were other (37.3%) and meningitis (35.3%). Cases of white blood cell count 100 and above per microliter was the most common diagnosis of meningitis (90.5%). There was a significant relationship between disease diagnosis and CSF cell differentiation ($P < 0.001$) such that in cases of predominant neutrophils, most common diagnosis was meningitis (87.5%). In the cases of predominant lymphocytes, most of the diagnoses were related to other disease (51.1%), followed by fever and seizures (28.8%). In cases of white blood cell count less than 4 per microliter, the most common diagnosis was related to other diagnoses, followed by fever and seizures. In cases 4 to 99 WBC per microliter, the most common diagnoses were meningitis and others, and in cases of white blood cell count 100 and more per microliter, the most common diagnosis was meningitis (90.5%).

There was a significant relationship between the diagnosis of the disease and the amount of protein ($P < 0.001$), such that in cases of protein less than 20 mg/dl and more, 64.0% cases were related to others diagnoses and fever and seizures (31.5%), respectively. In cases of 20–40 mg/dl, most cases were related to others (46.7%) followed by fever and seizures (26.7%). In cases of 45–99 mg/dl, the most common diagnosis was others (35.1%) followed by meningitis (24.3%) and in cases of 100 mg/dl and more, most common diagnosis was meningitis (35.5%).

There was a significant relationship between disease diagnosis and CSF glucose level ($P = 0.005$) such that in cases of glucose less than 50 mg/dl, the most common diagnosis was others, and in cases of glucose 50 mg/dl and more the most common diagnoses were others with 51.5% and fever and seizures with 29.1%, respectively (Table 1).

There was a significant relationship between age group and fever ($P < 0.001$). In the age group of 1 day–4 weeks, 78.1% had a fever of 37.8–38.5 °C. In the age group of 4–8 weeks, 70.0% had a fever of 37.8–38.5 °C. In the age group of 8 weeks to 1 year, most patients (66.7%) had a fever of 38.5 °C and above, in patients 1 year to 18 years of age, the highest prevalence was related to fever 38.5 °C and above.

Furthermore, there was a significant relationship between age group and duration of fever ($P = 0.003$). Most patients (59.8%) had fever less than 7 days. In the group of fever less than 7 days, the most common age group was 8 weeks to less than 1 years and the similar was seen in the group of fever more than 7 days.

Age group of the patients was statistically correlated with meningitis symptoms ($P = 0.003$). The most common age group with no symptoms was 8 weeks to less than 1 year and 1 year and less than 3 years. Whereas the most common group of patients with meningitis symptoms were 8 weeks to less than 1 year. Age group and recurrent vomiting was also statistically significant, $p = 0.001$. The most common age group without and with vomiting was 8 weeks to less than 1 year, respectively. Similarly, age group was also significantly correlated with level of consciousness ($P = 0.007$). 53.1% of cases in the age group of 1 day–4 weeks, 90.0% in the age group of 4–8 weeks had no consciousness disorder. In group of 12 years and less than 18 years, 50.0% of patients had level of consciousness disorder. The age of the patients was not significantly related with increased WBC, $p = 0.566$, blood neutrophils, $p = 0.995$, ESR $p = 0.808$ and CRP $p = 0.324$, respectively.

The age of the patients was significantly associated with positive CSF culture, $p = 0.005$. In the age groups of 3 years to less than 6 years, and 12 years to less than 18 years, 100 patients did not have positive culture whereas in age group 4–8 weeks, 30% patients had positive culture (Table 2).

Increase in blood and CSF white blood cell were significantly correlated, $p = 0.046$. In both groups, increase in WBC and no change, the most prevalent group was that with less than 4 WBC in CSF. Increase in WBC in blood was not significantly associated with the type of white blood cell dominance, glucose and protein in CSF, $p = 0.13$, $p < 0.99$ and $p = 0.13$, respectively (Table 3).

Statistical analysis showed that there was a significant relationship between increased WBC and diagnosis ($P < 0.001$), such that in cases where WBC increased, the most common diagnosis was others (50.3%) followed by fever, seizures, and meningitis with 19.5% and in cases where WBC did not increase, fever and seizures with 48.4% and others with 43.5% were most prevalent (Table 3).

There was a significant relationship between increased neutrophils and CSF white blood cell count, $p = 0.002$. In patients with and without increased neutrophils in the blood, the most common group was of CSF with less than 4 WBCs. There was also a significant relationship between neutrophils in blood and type of WBC in CSF, $p < 0.001$. Increased blood neutrophil was not associated with protein in CSF, $p = 0.051$ and glucose $p > 0.99$. The type of diagnosis was significantly associated with increased neutrophils in blood, $p = 0.002$ (Table 4).

Increased ESR was significantly associated with CSF WBC, $p = 0.018$ whereas it was not associated with the type of WBC in CSF $p = 0.099$, protein in CSF $p = 0.078$ and glucose in CSF $p = 0.473$. Most of the

Table 1
Agreement table for the diagnosis of LP patients according to the number of CSF white blood cells, differentiation of CSF, amount of CSF protein and amount of CSF Glucose.

p-value	Total	Diagnosis					
		Other	Neonatal sepsis	fever Seizures	Meningitis		
0.001 >	175(100%)	100(57.1%)	12(6.9%)	62(35.4%)	1(0.6%)	4> microliter	Number of CSF
	51(100%)	19(37.3%)	10(19.6%)	4(7.8%)	18(35.3%)	4–99 μL	
	21(100%)	1(4.8%)	1(4.8%)	0(0.0%)	19(90.5%)	≥100 μL	
	247(100%)	120(48.6%)	23(9.3%)	66(26.7%)	38(15.4%)	Total	
0.001>	16(100.0%)	1(6.3%)	1(6.3%)	0(0.0%)	14(87.5%)	Dominant neutrophils	Cellular differentiation of CSF
	229(100.0%)	117(51.1%)	22(9.6%)	66(28.8%)	24(10.5%)	Dominant lymphocytes	
	245(100.0%)	118(48.2%)	23(9.4%)	66(26.9%)	38(15.5%)	Total	
<0.001	100%))89	)5764.0%)	)00.0%)	)2831.5%)	4(4.5%)	20 > Mg/dl	The amount of CSF protein
	90(100%)	)4246.7%)	(%11.1)10	)2426.7%)	)1415.6%)	20-4 Mg/dl	
	37(100%)	)1335.1%)	)821.6%)	)718.9%)	)924.3%)	45-9 Mg/dl	
	31(100%)	)825.8%)	)516.1%)	)722.6%)	)1135.5%)	≥100 Mg/dl	
	)247100%)	(%48.2)119	(%9.3)23	)6727.1%)	)3815.4%)	Total	
0.005	(%100)82	(%42.7)35	(%18.3)15	(%22.0)18	(%17.1)14	50 > Mg/dl	The amount of CSF Glucose
	(%100)165	(%51.5)85	(%4.8)8	(%29.1)48	(%14.5)24	50 < Mg/dl	
	(%100)247	(%48.6)120	(%9.3)23	(%26.7)66	(%15.4)38	Total	

Table 2
Agreed table of age group of LP patients according to Degree of fever, Duration of fever, Symptoms of meningeal stimulation, Seizure, Frequent vomiting, Disorder of the level of consciousness and Positive blood culture.

p-value	Total	Age group							
		12 year and less than 18 years	6 year and less than 12 years	3 year and less than 6 years	1 year and less than 3 years	8 weeks to less than 1 year	4–8weeks	1 day-4 week	
0.001 >	16(6.5%)	1(16.7%)	2(10.0%)	2(10.0%)	1(1.6%)	5(5.2%)	1(10.0%)	4(12.5%)	37.8> Degree of fever
	77 (31.2%)	0(0.0%)	1(5.0%)	3(15.0%)	14(22.2%)	27(28.1%)	7(70.0%)	25 (78.1%)	37.8–38.5
	154 (62.3%)	5(% 83.3)	17(%85.0)	15(%75.0)	48(%76.2)	64(%66.7)	2(%20.0)	3(%9.4)	38.5 ≥
	247 (100.0%)	6(100.0%)	20(100.0%)	20(100.0%)	63(100%)	96(100.0%)	10 (100.0%)	32 (100.0%)	Total
0.003	140 (59.8%)	1(16.7%)	5(26.3%)	10(55.6%)	34(58.6%)	59(64.1%)	7(77.8%)	24 (75.0%)	7day> Duration of fever
	94 (40.2%)	5(83.3%)	14(73.7%)	8(44.4%)	24(41.4%)	33(35.9%)	2(22.2%)	8(25.0%)	≥7day
	234 (100.0%)	6(100.0%)	19(100.0%)	18(100.0%)	58(100.0%)	92(100.0%)	9 (100.0%)	32 (100.0%)	Total
0.003	42) 17.0%)	3(50.0%)	8)40.0%)	4)20.0%)	13)20.6%)	13)13.5%)	)110.0%)	0)0.0%)	Yes Symptoms of meningeal
	205) 83.0%(	3)50.0%)	12)60.0%)	16)80.0%)	50)79.4%)	83)86.5%)	9)90.0%)	32) 100.0%)	No stimulation
	247) 100.0%)	6)100.0%)	20)%100.0)	20)100.0%)	63)100.0%)	96)100.0%)	10) 100.0%)	32) 100.0%)	Total
0.001>	124 (50.2%)	1(%16.7)	8(%40.0)	10(%50.0)	40(%63.5)	55(%57.3)	1(%10.0)	9(%28.1)	yes Seizure
	123(% 49.8)	5(%83.3)	12(%60.0)	10(%50.0)	23(%36.5)	41(%42.7)	9(%90.0)	23(% 71.9)	No
	247 (100.0%)	6(100.0%)	20(100.0%)	20(100.0%)	63(100.0%)	96(100.0%)	10 (100.0%)	32 (100.0%)	Total
0.001	71(% 28.7)	3(%50.0)	13(%65.0)	5(%25.0)	20(%31.7)	25(%26.0)	2(%20.0)	3(%9.4)	Yes Frequent vomiting
	176 (71.3%)	3(%50.0)	7(%35.0)	15(%75.0)	43(%68.3)	71(%74.0)	8(%80.0)	29(% 90.6)	No
	247 (100.0%)	6(100.0%)	20(100.0%)	20(100.0%)	63(100.0%)	96(100.0%)	10 (100.0%)	32 (100.0%)	Total
0.007	56 (22.7%)	3(%50.0)	5(%25.0)	5(%25.0)	9(%14.3)	18(18.8%)	1(%10.0)	15(% 46.9)	Yes Disorder of the level of consciousness
	191 (77.3%)	3(%50.0)	15(%75.0)	15(%75.0)	54 (% 85.7)	78(%81.3)	9(%90.0)	17(% 53.1)	No
	247 (100.0%)	6(100.0%)	20(100.0%)	20(100.0%)	63(100.0%)	96(100.0%)	10 (100.0%)	32 (100.0%)	Total
0.005	21(9.3%)	0(0.0%)	2(10.5%)	0(0.0%)	3(5.0%)	5(6.0%)	3(30.0%)	8(26.7%)	Yes Positive blood
	205 (90.7%)	5(%100.0)	17(89.5%)	18(100.0%)	57(95.0%)	79(94.0%)	7(70.0%)	22 (73.3%)	No cultur
	226(% 100.0)	5(%100.0)	19(%100.0)	18(%100.0)	60(%100.0)	84(%100.0)	10(% 100.0)	30(% 100.0)	Total

Table 3
Increase in white blood cells in LP patients according to CSF white blood cell count and diagnosis.

p-value	Total	Increased white blood cells			
		No	Yes		
0.046	175 (70.9%)	49(79%)	126 (68.1%)	4>	Number of white blood cells CSF
	(%20.6) 51	(21%)13	38 (20.5%)	4–99	
	17(6.9%)	0(0.0%)	17(9.2%)	100–499	
	4(1.6%)	0(0.0%)	4(2.2%)	≥500	
	247 (100.0%)	62 (100.0%)	185 (100.0%)	Total	
0.001>	38(15(%	2(3.2%)	36 (19.5%)	Meningitis	Diagnosis
	66 (26.7%)	30 (48.4%)	36 (19.5%)	Fever & seizure	
	23(9.3%)	3 (4.8%)	20 (10.8%)	Neonatal sepsis	
	120(48.6(	27 (43.5%)	93 (50.3%)	Others	
	247 (100.0%)	62 (100.0%(	185 (100.0%	Total	

Table 4
Increase in blood neutrophils in LP patients according to CSF white blood cell count, Differentiate CSF and diagnosis.

p-value	Total	Increased Neutrophils cells			
		No	Yes		
0.002	147 (68.7%)	87 (78.4%)	60 (58.3%)	4>	Number of white blood cells CSF
	46 (21.5%)	20(18.0	26 (25.2%)	4–99	
	17(7.9%)	3(2.7%)	14 (13.6%)	100–499	
	4(1.9%)	1(0.9%)	3(2.9%)	≥500	
	214 (100.0%)	111 (100.0%)	103 (100.0%)	Total	
0.001>	16(7.5(%	1(0.9%)	15 (14.6%)	Dominant neutrophils	Cellular differentiation of CSF
	197 (92.5%)	109)99.1 (%)	88 (85.4%)	Dominant lymphocytes	
	213 (100%)	110 (100%)	103 (100%)	Total	
0.002	(%17.3) 37	11(9.9%)	26 (25.2%)	Meningitis	Diagnosis
	24.3%)) 52	33.3%)) 37	15 (14.6%)	Fever & seizure	
	(%10.3) 22	10(9.0%(	12 (11.7%)	Neonatal sepsis	
	48.1%)) 103	47.7%)) 53	50 (48.5%)	Other	
	100.0%)) 214	100.0%)) 111	(%100) 103	Total	

patients with increased ESR had other diagnosis whereas those without increased ESR were presented with fever, $p < 0.001$ (Table 5).

Increased CRP was not significantly associated with WBC in CSF, $p = 0.192$, type of WBC in CSF $p = 0.607$, protein, and glucose in CSF, $p = 0.694$ and $p = 0.212$, respectively. Most common presentation among patients with increased CRP was other diagnosis, whereas those without increased CRP was fever, $p < 0.001$ (Table 6).

Most patients with fever and seizures (72.7%) had simple fever and seizures. The type of seizure and fever was not significantly correlated with WBC in CSF, $p = 0.999$, type of WBC in CSF, $p > 0.999$ and glucose content, $p = 0.354$, respectively. The type of fever and seizure was only significantly associated with protein content in CSF, $p = 0.045$ (Table 7).

Table 5
Increased ESR of LP patients in terms of CSF white blood cell count and diagnosis.

p-value	Total	Increased ESR			
		No	Yes		
0.018	174 (70.7%)	65 (81.3%)	109 (65.7%)	4>	Number of white blood cells CSF
	51 (20.7%)	12(15%)	39 (23.5%)	4–99	
	17(6.9%)	1(1.3%)	16(9.6%)	100–499	
	4(1.6%)	2(2.5%)	2(1.2%)	≥500	
	246 (100.0%)	80 (100.0%)	166 (100.0%)	Total	
0.001>	38 (15.4%)	5(6.3%)	33 (19.9%)	Meningitis	Diagnosis
	65 (26.4%)	38 (47.5%)	27 (16.3%)	Fever & seizure	
	23(9.3%)	6 (7.5%)	17 (10.2%)	Neonatal sepsis	
	120 (48.8%)	31 (38.8%)	89 (53.6%)	Other	
	246 (100.0%)	80 (100.0%)	166 (100.0%)	Total	

Table 6
Increased CRP of LP patients according to diagnosis.

p-value	Total	Increased CRP			
		No	Yes		
0.001>	38(15.5%)	(%13.7)13	25(16.7%)	Meningitis	Diagnosis
	65(26.5%)	45(47.4%)	20(13.3%)	Fever & seizure	
	23(9.4%)	5 (5.3%)	18(12.0%)	Neonatal sepsis	
	119 (48.6%)	32(33.7%)	87(58.0%)	Other	
	245 (100.0%)	95 (100.0%)	150 (100.0%)	Total	

Table 7
Type of fever and seizures in LP patients according to CSF protein content.

p-value	Total	Type of fever & seizure			
		Complex	Simple		
0.045	28 (42.4%)	7(38.9%)	21 (43.8%)	20 > Mg/dl	The amount of CSF protein
	24 (36.4%)	5(27.8%)	19 (39.6%)	20–44 Mg/dl	
	7(10.6%)	5(27.8%)	2 (4.2%)	45–99 Mg/dl	
	7(10.6%)	1(5.6%)	6(12.5%)	≥100 Mg/dl	
	66 (100.0%)	18 (100.0%)	48 (100.0%)	Total	

4. Discussion

Our study reports CSF analysis of pediatric patients referred to federal hospitals in Khorramabad. Most of the patients included in our study were male patients, which is also similar to the study by a study conducted by Vickers, Donnelly et al. in the United States in 2010, including 89106 children. The study reported that the most common cause of the LP in these children was fever of unknown etiology, meningitis and seizure. The study also showed that 64,849 children (73%) were under 5 years old [5].

In the study of Khakshour et al., that examined 91 children admitted to Imam Reza Hospital in who underwent LP, 57.1% of the patients were male and 42.9% were female, which was consistent with the current study [7]. In the present study, most patients were in the age group of 8

weeks to 1 year (38.9%) and 1–3 years (25.5%). In total, more than half of the patients (55.8%) were under one year old and 89.4% were under 6 years old. We reported that 93.5% of patients had fever, 17.0% meningeal symptoms, 50.2% seizures and 22.7% loss of consciousness. In a 2004–2005 study by Herbert et al. [8], examining the indications and results of 453 LP in East Africa, 85.4% had fever, 7.3% meningeal symptoms, 56.3% had seizures and 10.0% had loss of consciousness, the results of which were relatively consistent with the present study. In the study of Khakshour et al. [9], 79.1% of patients had fever, 9.9% vomiting, and 2.2% loss of consciousness, which were less common in all three symptoms compared to the current study. In the present study, 9.3% of patients had a positive blood culture. In the study of Khakshour et al., 4.4% of patients had sepsis, which was relatively consistent with the current study. In the present study, most patients (70.9%) had less than 4 WBC per microliter in the CSF, followed by 4–99 WBC per microliter with 20.6%. Indications and results of LP in East Africa showed that out of 453 children admitted to a hospital, 88.3% had less than 10 WBC in the CSF [8].

In the present study, in terms of protein content, 36.4% of cases had 20–44 mg/dl and 36.0% of cases had less than 20 Mg/dl and in general 72.4% had less than 45 Mg/dl of protein. In the study of Herbert et al. [8] 12.9% had protein less than 40 mg/dl (0.4 g/l). In the present study, in terms of glucose content, most cases (66.8%) had 50 mg/dl and more glucose. We reported a significant correlation between the diagnosis and WBC in the CSF. Farag et al. Studied 310 patients with meningitis at the Alexandria Hospital in Egypt [10], with a mean CSF white blood cell count of 121, which was consistent with the current study, in which meningitis had a CSF white blood cell count of 100 and above in 90.5% of cases. They also reported that CSF protein averaged 169 mg dl, which was consistent with the current study, i.e., 100 mg/dl protein in most meningitis cases. We also found a significant correlation between the type of WBC in CSF and diagnosis. In a study by Golestan et al. [11], all cases of fever and seizures had a predominance of lymphocytes, which was consistent with the current study.

Our study showed significant correlation between disease diagnosis and CSF glucose level. Farag et al. reported that in 310 patients with meningitis, the mean glucose level was 19 mg/dl, which was different from the current study in which most patients (63%) had glucose 50 mg/dl and above. We also reported singificnat correlation between age group and fever and increased WBC and type of presentation. In the study of Akhundian et al. [12],10 out of 15 patients with meningitis and 14 out of 45 patients with fever and seizures had WBC of 10,000 and more ($P = 0.015$), which is nearly consistent with the present study.

In a study by Aronson et al. [13], which examined 135 patients aged 60 days or less with bacteremia and bacterial meningitis, 63.7% had normal WBC, which is not consistent with our study.

Our study indicated a significant relationship between increased neutrophils and diagnosis which was not consistent with the study of Aronson et al. [13], where 110 patients out of 135 patients had normal neutrophils. We also showed a significant relationship between ESR increase and diagnosis. In Akhundian et al. [12] study, 4 out of 45 patients with fever and seizures and 4 out of 15 patients with meningitis had increased ESR ($P = 0.07$), which was not consistent with the current study.

Our study showed a significant relationship between CRP increase. In Akhundian et al.'s study [12], 3 out of 45 patients with fever and seizures and 7 out of 15 patients with meningitis had CRP increase ($P = 0.001$), which is somewhat consistent with the current study.

In the present study, most patients with fever and seizures (72.7%) had simple fever and seizures.

This was partially consistent with the study of Sfaihi et al. [14] where of 482 patients with fever and seizures in Tunisia, 55.5% of whom had simple fever and seizures. In e study of Shabir Hussain et al. conducted on 100 patients with fever and convulsions in Pakistan, 78% of patients had simple fever and seizures, which is consistent with the current study [15].

There was no significant relationship between the type of fever and seizures and the number of CSF WBC in our study. In the study of Amir Kimia et al. of 526 patients with fever and seizures, the CSF white blood cell count was on average 1 per microliter, which was consistent with the current study [16].

One of the important limitations of this study is the retrosceptive nature. Data regarding intervention and longterm outcomes are not evalauted in this study and due to the absence of control group, odds ratio could not be calculated.

5. Conclusion

The findings of our study reported that the clinical presentation of the patient is likely to be associated with the number and type of white blood cells and protein in CSF. We also reported that age is also significantly correlated with the symptoms. Increased ESR and CRP is signifcinalty correlated with the diagnostic findings. Evaluation of these parameters can be used to provide timely diagnosis and management to the patients, however, further prospective and case control studies are required in this area.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Ethical approval

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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Consent

Not applicable.

Credit author contribution

Dr. Golnaz Mahmoudvand: conceptualized and designed the study, drafted the initial manuscript, and reviewed and revised the manuscript.

Dr. Fariba Tarhani and Dr. Farzad Ebrahimzadeh: Designed the data collection instruments, collected data, carried out the initial analyses, and reviewed and revised the manuscript.

Dr. Behnaz Mahmoudvand: Coordinated and supervised data collection, and critically reviewed the manuscript for important intellectual content.

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Conflicts of interest

The authors deny any conflict of interest in any terms or by any means during the study. All the fees provided by research center fund and deployed accordingly.

Registration of research studies

1. Name of the registry: Research Registry.
2. Unique Identifying number or registration: researchregistry7290 https://www.researchregistry.com/browse-the-registry#home/registrationdetails/6175d837e270d30020349641/

Guarantor

Dr. Fariba Tarhani.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amsu.2021.103093.

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