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Research Article

COVID-19 and shunt dysfunction in pediatric patients: experience from the pandemic

COVID-19 ve pediatrik hastalarda şant disfonksiyonu: pandemiden edinilen tecrübe

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Abstract

Aim: Ventriculoperitoneal (VP) shunt surgery is the most widely accepted method for the treatment of hydrocephalus. Shunt dysfunction is a common complication with various etiologies. This study aimed to evaluate pediatric patients who underwent surgery due to shunt dysfunction during the pandemic period and were COVID-19 positive in the preoperative period.

Material and Methods: The findings of the patients who underwent surgical treatment with a preliminary diagnosis of shunt dysfunction between March 2020 and 2023 were examined in the present study. A retrospective cross-sectional design was adopted. Age, sex, date of COVID-19 positivity, symptoms at presentation, CSF findings, CSF culture, blood tests, and applied treatments of the patients were obtained from patient files and electronic records.

Results: Among 13 pediatric patients with VP shunt dysfunction and preoperative COVID-19 positivity, fever (61.5%) and decreased sucking/restlessness (62.5%) were the most frequent symptoms. Two patients had positive CSF cultures. Biochemical abnormalities were observed, including elevated D-dimer and transaminases.

Conclusions: COVID-19 may contribute to shunt dysfunction through gastrointestinal and peritoneal involvement, even in the absence of respiratory symptoms. Clinicians should maintain high suspicion for shunt malfunction in pediatric patients with COVID-19 and hydrocephalus.

Keywords: hydrocephalus, pediatric neurosurgery, shunt revision, SARS-CoV-2.

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Öz

Amaç: Ventriküloperitoneal (VP) şant cerrahisi, hidrosefali tedavisinde en yaygın kabul gören yöntemdir. Şant disfonksiyonu, farklı etiyolojilere sahip yaygın bir komplikasyondur. Bu çalışma, pandemi döneminde şant disfonksiyonu nedeniyle cerrahi uygulanan ve ameliyat öncesi dönemde COVID-19 pozitif olan pediatrik hastaları değerlendirmeyi amaçlamaktadır.

Gereç ve Yöntemler: Mart 2020 ile 2023 tarihleri arasında şant disfonksiyonu ön tanısıyla cerrahi tedavi uygulanan hastaların bulguları retrospektif kesitsel bir tasarım ile incelendi. Hastaların yaşı, cinsiyeti, COVID-19 pozitiflik tarihi, başvuru semptomları, BOS bulguları, BOS kültürü, kan testleri ve uygulanan tedaviler hasta dosyaları ve elektronik kayıtlar üzerinden elde edildi.

Bulgular: Ameliyat öncesi dönemde COVID-19 pozitif olan ve VP şant disfonksiyonu gelişen 13 pediatrik hastanın verileri değerlendirildi. Ateş (%61,5) ve emmede azalma/huzursuzluk (%62,5) en sık görülen semptomlardı. İki hastada pozitif BOS kültürü tespit edildi. Biyokimyasal anormallikler arasında D-dimer ve transaminaz yüksekliği gözlendi.

Sonuçlar: COVID-19, solunum semptomları olmasa bile gastrointestinal ve peritoneal tutulum yoluyla şant disfonksiyonuna katkıda bulunabilir. COVID-19 ve hidrosefali tanısı olan çocuk hastalarda, klinisyenler şant disfonksiyonu olasılığına karşı yüksek şüphe düzeyini korumalıdır.

Anahtar Kelimeler: hidrosefali, pediatrik beyin cerrahisi, şant revizyonu, SARS-CoV-2.

Introduction

Hydrocephalus is a medical condition characterized by pathological dilatation of the ventricular system of the brain and results from inadequate passage of cerebrospinal fluid from the point of production in the cerebral ventricles to the point of absorption into the systemic circulation. It might also occur because of excessive production of cerebrospinal fluid, malabsorption, or venous drainage insufficiency [1]. Many medical and surgical treatment modalities are employed in the treatment of hydrocephalus. Surgical methods are superior to other treatment modalities. Among surgical treatment modalities, the most widely adopted surgical procedure is the placement of a ventriculoperitoneal (VP) shunt [2,3]. As in other surgical treatments, shunt surgeries have certain complications such as shunt dysfunction, shunt obstruction, and exposure of the shunt tip [4-6].

The coronavirus disease 2019 (COVID-19) pandemic, which has been decreasing since January 2020, has caused many difficulties in healthcare services in the world as well as in our country. Access to healthcare services and timely diagnosis of patients were difficult during the pandemic period . Appropriate diagnosis is even more important in pediatric patients to avoid unnecessary surgical treatments. COVID-19 presenting symptoms include headache, fatigue, and fever. These symptoms must also suggest shunt dysfunction during presentation and in the differential diagnosis in patients with ventriculoperitoneal shunts [7-9]. Different studies in the literature report that children are less affected by severe acute respiratory syndrome-related coronavirus 2 (SARS-CoV-2) infection than adults and are more commonly asymptomatic. Although the presenting symptoms of COVID-19 infection are asymptomatic in children, some patients might face gastrointestinal complaints such as nausea, vomiting, and abdominal pain [10,11]. Examination findings might be sufficient to suggest the diagnosis of acute abdomen and a good anamnesis and appropriate laboratory tests are important in differential diagnosis [10,12,13]. Emerging data suggest that COVID-19 may present with gastrointestinal symptoms in children, and in rare cases, may involve the peritoneum, potentially impacting VP shunt function. These interactions remain underreported in the current literature.

The present study aimed to examine the clinical and laboratory features of pediatric patients who underwent surgery because of shunt dysfunction and who had COVID-19 infection in the preoperative period.

Materiel and Methods

The findings of the patients who underwent surgical treatment with a preliminary diagnosis of shunt dysfunction between March 2020 and 2023 were examined in the present study. A retrospective cross-sectional design was adopted. All patients were under the age of 18 and underwent nasopharyngeal swab test and SARS-CoV-2 Real-Time Reverse Transcriptase Polymerase Chain Test. Positive results were detected in all patients. Age, sex, date of COVID-19 positivity, symptoms at presentation, cerebrospinal fluid (CSF) findings, CSF culture, blood tests, and applied treatments were obtained from patient files and electronic records. Normal CSF findings in children are considered to be the absence of CSF leukocytes and erythrocytes, CSF glucose 60–80 mg/dL, and CSF protein 15-45 mg/dL. In our study, the normal range for liver transaminase (AST/ALT) tests was accepted as 60 U/L in boys under 18 months and 55 U/L in girls; 40 U/L in boys between 18 months and 5 years of age and 35 U/L in girls.

All patients were initially treated with external ventricular drainage (EVD) for shunt dysfunction in the present study, and when appropriate clinical conditions were met, a ventriculoperitoneal shunt was inserted again. In the follow-up of our patients, it was detected that only one patient died of non-neurosurgical causes.

The present study was approved by the Ankara Bilkent City Hospital, Ankara Yıldırım Beyazıt University Clinical Research Ethics Committee (E1-23-3690; 07/06/2023).

Results

A total of 1575 surgeries were performed in the hospital between March 2020 and March 2023 (32% were EVD and shunt surgeries, and 147 EVDs were placed in 84 patients). Also, 358 shunt surgeries were performed on 242 patients.

The data of 13 patients who had COVID-19 infection and were followed up with the diagnosis of shunt dysfunction were examined in the present study (Table 1). Four of the patients were male and the average age was 17 months (2-72 months). It was detected that the COVID-19 PCR test was positive when the patients were evaluated with the preliminary diagnosis of shunt dysfunction. Among the complaints on admission, fever was present in eight of the 13 patients. This complaint was most frequently followed by decreased sucking and restlessness. (62.5%) The oldest patient among our patients, who was 72 months old, described headaches. More than 10 leukocytes were detected in five patients, and no cells were detected in the CSF examination of the other patients in the direct unstained microscopy results of the CSF examination of the patients. Mean CSF glucose was found to be 41.27 mg/dl (15-74 mg/dL), mean CSF protein was 1703.72 mg/dL (46-6960 mg/dL), no leukocytes or microorganisms were observed in CSF gram staining, but only two patients had growth in CSF culture (Staphylococcus epidermidis). The mean blood white blood cell count of the patients was 11500/µL (6900-20030/µL), the mean blood neutrophil count was 6880/µL (1750-15980/µL), and the mean blood C-Reactive Protein value was 0.15 (0-0.005). The mean aspartate aminotransferase (AST) value of the patients was found as 40.92 (18-82), the mean alanine aminotransferase (ALT) value was 31.82 (14-63), the mean lactate dehydrogenase (LDH) value was 348.84 (246-579), and the mean D-dimer value was 7.2 (2.2-35.12) (Table 2).

Table 2. Mean values of laboratory tests.

	N	Mean±sd
CSF glucose (mg/dl)	13	40,3±19,18
CSF protein (mg/dl)	13	2047± 2771
White blood cell (/µL)	13	11780±4529
Neutrophil count (/µL)	13	6914±5250
Lymphocyte count (/µL)	13	6693±3961
Aspartate aminotransferase (IU/L)	13	40,92±22,30
Alanine aminotransferase (IU/L)	13	31,84±18,08
Lactate dehydrogenase (U/L)	13	348,84±84,15
D-dimer (mikrogram/mL)	9	542,11±1139

Abbrev.; CSF: cerebrospinal fluid

Table 1. Clinical and laboratory characteristics of the patients

No	Age (M)	Sex	F	DSR	WBC count (4500-11000/µL)	Lymphocyte count (1000-4800/µL)	AST	ALT	LDH (100-300 U/L)	D-dimer (0-0.5 mikrogram/mL)
1	18	G	+	-	9200	7220	72	63	312	7.26
2	11	B	+	+	16500	3190	18	18	431	
3	6	G	+	+	6900	4830	82	62	347	2.45
4	72	B	-	-	16700	4500	33	25	246	
5	2	G	+	+	9100	5720	20	14	282	2.2
6	12	B	-	+	11400	2980	36	40	579	3.18
7	4	B	+	+	8800	7050	81	60	396	35.12
8	13	G	+	-	8600	6670	32	24	346	3
9	2	G	+	-	9200	1980	35	20	335	2.1
10	9	B	-	+	18120	11320	31	18	320	
11	30	B	+	-	20030	15980	38	24	310	2.9
12	28	B	-	+	6500	4590	22	20	285	
13	23	G	-	-	12100	10980	32	26	346	3

Abbrev.; M: Month, G: Girl, B: Boy, F: Fever, DSR: Decreased sucking - restlessness, AST: Aspartate Aminotransferase ALT: Alanin Aminotransferase LDH: lactate dehydrogenase

Discussion

The strength of this study lies in its focus on a unique pediatric population with VP shunt dysfunction potentially linked to COVID-19–related peritoneal inflammation. While many reports describe appendicitis and abdominal manifestations of COVID-19 [14-16], few have explored its role in shunt obstruction. This case series provides early clinical insight into that association.

The dysfunction epidemiology in VP shunts used in the treatment of hydrocephalus is not fully known. Shunt complications are detected in 24-47% of all cases [17,18] and are often seen with obstruction of the ventricular end. Rarely, the distal end might become obstructed within the peritoneum and cause dysfunction [19]. According to the results of different studies, it is estimated that approximately 50% of complications are detected at the proximal end, 14% at the distal end, and 10% are directly associated with the valve within 2 years following VP shunt surgery [18]. Clinical conditions such as intestinal perforation and peritonitis might cause obstruction of the peritoneal end of the shunt [20] and bacterial agents might cause dysfunction, as well as viral infections.

One of the target organs of SARS-CoV-2 is the organs in the gastrointestinal system such as the intestines, liver, and peritoneum. It was proven that angiotensin-converting enzyme-2 and protease-like transmembrane serine protease-2, which are necessary receptors for the virus to bind to the cell and invade, are present in the gastrointestinal system [21,22]. The frequency of gastrointestinal symptoms such as diarrhea, nausea, vomiting, and abdominal pain varies according to age and underlying diseases. Compared to adults, gastrointestinal system (GIS) symptoms are more likely to occur in children [23]. When gastrointestinal symptoms are seen, the disease is more severe, and follow-up in intensive care and mortality rates increase [24,25]. Clinical manifestations such as appendicitis, diffuse mesenteric inflammation, and terminal ileitis with GIS involvement were reported in the first and second waves of the pandemic [14-16]. In a previous study that included 54 centers in Italy, the data of 685 children who were diagnosed with COVID-19 were evaluated and it was reported that 257 pediatric patients had symptoms associated with GIS. Also, peritonitis findings were detected in 64.6% of the patients, and complicated peritonitis and perforation were detected in eight patients [26].

In a case-control study conducted with adults in 62 centers, the revision rates, mortality, intensive care unit admission, acute renal failure, and seizure-related complications within 90 days were compared with patients who had shunts and COVID-19 infection and those who did not have COVID-19 infection. According to the results, revision was required 4.94 times more in individuals who had COVID-19 infection before. Also, other complications such as intensive care unit admission, mortality, and sepsis were statistically and significantly higher in the case group [25]. In this

study, it was concluded that the increased revisions might have occurred directly because of the associated increases in intracranial pressures resulting from COVID-19 infection associated with viral neuroinvasion, toxic-metabolic changes, multi-inflammatory syndrome, coagulopathy, or hypoxic-ischemic injury [27].

Limitation of the study

A limitation of the present study was the lack of data on the findings of the patients in the first days of COVID-19 infection. Another limitation was the lack of histopathological evidence for the diagnosis of peritonitis. Also, it is difficult to define the findings associated with the respiratory system because of their young age. The strength of the present study was that when the literature was reviewed, although there were findings that peritonitis might occur during COVID-19 infection, there was no study that reported that it caused shunt dysfunction. With the clinical observation in the present study, findings in favor of dysfunction were detected in the 13 patients who had VP shunt, and revision surgery was performed with the appropriate surgical procedure.

In conclusion, although COVID-19 infection is generally mild in children, it can lead to atypical and clinically significant complications in special pediatric populations. This study highlights a potential link between COVID-19-related peritoneal inflammation and VP shunt dysfunction, a relationship that remains underrecognized. In the context of a waning pandemic, it is essential for clinicians to remain vigilant for such indirect effects in vulnerable neurosurgical patients. Timely recognition of shunt-related complications during viral infections can improve outcomes and reduce the need for emergent surgical interventions.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

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Ethics approval

The study was approved by the Ankara Bilkent City Hospital, Ankara Yıldırım Beyazıt University Clinical Research Ethics Committee (E1-23-3690; 07/06/2023).

Authors' contribution

HK: Conception, design, resources, materials, data collection and processing, analysis and interpretation, literature search, writing manuscript, critical review. MEÖ: Data collection, literature search. HD: Supervision, design, critical review. BD: Data collection, analysis and processing. YK: Data collection, resources. PÖ: Supervision, conception, design, analysis and interpretation, writing manuscript, critical review.

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