A descriptive study on acute gastroenteritis with convulsion: 1-year analysis

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Introduction
Several etiologies explain the occurrence of seizures with acute gastroenteritis, such as electrolyte abnormalities and dehydration, a high fever, infectious fragments of pathogens crossing blood-brain barrier and causing significant central nervous system damage, septicemia, intracranial hemorrhage, and hypoglycemia. The aim of this study was to detect the frequency and etiology of convulsion in children with acute gastroenteritis admitted to Assiut University Children Hospital during 1 year from January 2017 to the end of December 2017.

Patients and methods
This is a one-year descriptive study that was carried out on 130 patients having acute gastroenteritis with convulsion, aged from 1 month to 5 years. Patients were divided according to the age into two groups: group 1, from 1 to 12 months of age, and group 2, from more than 1 to 5 years. All cases were subjected to full history, complete physical examination, and investigations, which included complete blood count, serum electrolytes, renal function tests, arterial blood gases, random blood sugar, and blood culture, which was done only when sepsis is suspected.

Results
The results show that the frequency of convulsion was 4.6%. The most common cause was electrolyte disturbance, which was noticed in 106 (81.5%) cases, followed by central nervous system infection, which was noticed in 39 (30%) cases, then septicemia and hypoglycemia, which were noticed in 13 (10%) cases each, then febrile convulsion, which was noticed in 11 (8.5%) cases [regarding febrile convulsions, there was a statistically significant difference between the two age groups (P = 0.027)], and lastly, intracranial hemorrhage, which was noticed in five (3.8%) cases.

Conclusion
Convulsion is one of the most serious complications associated with acute gastroenteritis. A younger age group (1–12 months) is more susceptible to complications than the older age group. Electrolyte disturbance is still a major cause of convulsion with acute gastroenteritis.

Keywords:
convulsion, acute gastroenteritis, children

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Introduction

Acute gastroenteritis remains a major cause of pediatric morbidity and mortality around the world, accounting for 1.34 million deaths annually in children younger than 5 years, or roughly 15% of all children deaths [1]

It is generally defined as a decrease in the consistency of stools (loose or liquid) and/or an increase in the frequency of evacuations, with or without fever or vomiting; however, a change in stool consistency vs previous stool consistency is more indicative of diarrhea than stool number, particularly in the first months of life. Acute diarrhea typically lasts less than 7 days and not greater than 14 days [2].

Convulsion is commonly association with acute gastroenteritis, but its etiology is multifactorial. It may be owing to a high fever (>39°C), which sometimes accompanies diarrheal syndromes that may induce convulsions, particularly in infants and toddlers who are highly susceptible to febrile stimuli owing to the immaturity of their central nervous system (CNS) [3].

Electrolyte abnormalities (hyponatremia, hypernatremia, and hypocalcemia) and dehydration owing to the severe loss of electrolytes and water in stools or vomitus may induce neurological symptoms [4]. Electrolyte abnormalities can cause convulsions by different mechanisms, such as first, hyponatremia, which leads to cerebral edema; second, hypernatremia, which leads to loss of water from brain cells, causing

shrinkage of the brain and an increase in intracellular brain cell osmolality; and also third, hypocalcemia, which may increase excitability in the CNS [5]. Intracranial hemorrhage and microvascular thrombi may also occur as a complication of acute gastroenteritis as a part of disseminated intravascular coagulation [6]. Hypoglycemia in children with acute gastroenteritis and dehydration involves the depletion of glycogen stores owing to the inability to consume substrate without vomiting. The longer a child is effectively nothing per oral (NPO), the more likely the child will become hypoglycemic, which can result in seizures owing to inadequate supply of glucose to the brain, resulting in neuroglycopenia. When brain glucose levels are sufficiently low, seizures may result [7]. However, still some patients may convulse during gastroenteritis (GE) in the absence of an obvious cause. This is called benign convulsion with gastroenteritis [8].

Aim

The aim of the study was to detect the frequency and etiology of convulsion in infants and children with acute gastroenteritis admitted to Assiut University Children Hospital during a period of 1 year.

Patients and methods

This is a 1-year descriptive study on infants and children having acute gastroenteritis with convulsion admitted to Gastroenterology and Hepatology Unit of Assiut University Children Hospital during the period from January 2017 to the end of December 2017.

Inclusion criteria

All children aged from 1 month to 5 years with acute gastroenteritis and convulsion admitted during the study period were included.

Exclusion criteria

All cases with in-born error of metabolism, neurologic illnesses such as cerebral palsy and mental retardation, or having any neurological deficit were excluded.

All cases were subjected to the following:

(1) Full history: name, age, sex, residence, consanguinity, family history of similar condition, diarrhea (amount, frequency, duration, consistency, and whether bloody or not), vomiting (frequency, duration, color, and whether projectile or not), fever (low grade or high grade), convulsions (type, distribution, duration, frequency, and conscious level between attack), abdominal distension, abdominal pain and cramping, thirst (drink normal, eagerly, poor, or unable to drink), and urine output (normal, oliguria, or anuria).
(2) Examination: general appearance of the patient, conscious level (alert, irritable, or disturbed), pallor, eyes (sunken or not), vital signs (temperature, heart rate, blood pressure, and respiratory rate), tongue (moist, dry, or parched), skin pinch (delayed or not), anterior fontanel (depressed or not), and anthropometric measurements (weight and height).
(3) Investigations: complete blood count, serum electrolytes (Na, K, and Ca), renal function tests, arterial blood gases, random blood sugar, and stool analysis. Blood culture was done only when sepsis is suspected. Lumbar puncture, EEG, and computed tomography brain also were done when indicated.

Patient classification

Patients were divided according to the age into two groups. group 1, from 1 to 12 months of age, and group 2, from greater than 1 to 5 years of age.

Statistical analysis

The data were entered and analyzed using a statistical computer program IBM SPSS 20.0 software (IBM: International Business Machines Corporation, United state America in Armonk, New York,). Categorical variables were described by number and percentage. χ^2- test is used to compare between categorical variables. A two-tailed P less than 0.05 was considered statistically significant.

Ethical consideration

A review of the study proposal was carried out before starting, and approval was obtained from the Ethical Committee of Faculty of Medicine, Assiut University.

The aim of the study was explained to each patient before beginning of the process. Written consent was obtained from those who were welcome to participate in the study.

The participants were assured of privacy and confidentiality of all the data.

Results

The present study included 130 children having convulsions with acute gastroenteritis admitted to Gastroenterology and Hepatology Unit of Assiut University Children Hospital during the period from January 2017 to the end of December 2017. During

this period, 2845 patients from 1 month to 5 years were admitted, and 130 of them had convulsion (4.6% of admitted cases). It was noted that in some patients the same patient had more than one cause for convulsion with acute gastroenteritis.

Table 1 shows the demographic data of the studied cases.

There were 78 (60%) cases in the age group 1–12 months (group 1) and 52 (40%) cases in the age group greater than 1–5 years (group 2). According to sex distribution, there were 68 (52.3%) females (41 in group 1 and 27 in group 2 patients) and 62 (47.7%) males (37 in group 1 and 25 in group 2), with no statistically significant difference between the two age groups.

Table 2 shows the frequency and pattern of diarrhea and dehydration among the studied cases.

Table 3 shows the types and frequency of convulsion among the studied cases.

As shown in Table 3, the most common type of convulsion was generalized tonic-clonic convulsion, which was observed in 69 (53.1%) cases (43 cases in group 1 patients and 26 cases in group 2 patients), followed by generalized tonic type, which was observed in 51 (39.2%) cases (32 cases in group 1 patients and 19 cases in group 2 patients), and finally 10 (7.7%) cases had focal convulsion (three cases in group 1 patients and seven cases in group 2 patients). Moreover, most cases had repeated attacks of convulsions, which was observed in 102 (78.5%) cases (59 cases in group 1 patients and 43 cases in group 2 patients).

Table 4 shows the comparison of laboratory investigations among the studied cases.

Table 5 shows the comparison of elements of blood picture among the studied cases.

Table 6 shows the causes of convulsion with gastroenteritis in the studied cases.

As shown on Table 6, the most common cause of convulsion with gastroenteritis was electrolyte disturbance, which was noticed in 106 (81.5%) cases (67 cases in group 1 patients and 39 cases in group 2 patients), followed by CNS infection, which was noticed in 39 (30%) cases (24 cases in group 1 patients, and 15 cases in group 2 patients), then septicemia, which was noticed in 13 (10%) cases (seven cases in group 1 patients, and six cases in group 2 patients), and hypoglycemia, which was noticed in 13 (10%) cases (nine cases in group 1 patients and four cases in group 2 patients), then febrile convulsion, which was noticed in 11 (8.5%) cases (three cases in

Table 1 Demographic data of the studied cases

Age	1-12 months (group 1)	>1-5 years (group 2)
Number and percentage	78 (60)	52 (40)
Mean±SD (months)	7.08±3.14	26.1±11.7
Median (IQR)	7 (4-9.25)	22.5 (17-36.0)
Range	2-12	13.0-55.0
Sex [*n* (%)]		
Male	37 (47.4)	25 (48.1)
Female	41 (52.6)	27 (51.9)
Residence		
Urban	25 (32.1%)	24 (46.2%)
Rural	53 (67.9%)	28 (53.8%)

Regarding of the age of the studied cases in mean±SD is 14.69±12.16 months, median (IQR) is 11 (6–19) months, and range is 2–55 months. Test: χ^2. IQR, interquartile range.

Table 2 Frequency and pattern of diarrhea and dehydration of the studied cases

	1-12 months (*n*=78) [*n* (%)]	>1-5 years (*n*=52) [*n* (%)]	*P*
Dehydration			
Moderate dehydration	30 (38.5)	17 (32.7)	0.537
Severe dehydration	48 (61.5)	35 (67.3)	0.415
Diarrhea			
Watery diarrhea	71 (91.0)	43 (82.7)	0.132
Bloody diarrhea	7 (9.0)	9 (17.3)	0.164

Test: χ^2

Table 3 Types and frequency of convulsion among the studied cases

	1-12 months (*n*=78) [*n* (%)]	>1-5 years (*n*=52) [*n* (%)]	*P*
Types of convulsion			
Generalized			
Tonic-clonic	43 (55.1)	26 (50)	0.696
Tonic	32 (41)	19 (36.5)	0.740
Focal	3 (3.9)	7 (13.5)	0.095
Frequency			
Once	19 (24.4)	9 (17.3)	0.455
Repeated	59 (75.6)	43 (82.7)	0.455

Test: χ^2.

Table 4 Comparison of laboratory investigations among the studied cases

	1-12 months (*n*=78) [*n* (%)]	>1-5 years (*n*=52) [*n* (%)]	*P*
Isonatremia (130-145 mEq/l)	27 (34.6)	19 (36.5)	0.822
Hypernatremia: >145 mEq/l	40 (51.3)	27 (51.9)	0.943
Hyponatremia: <130 mEq/l	11 (14.1)	6 (11.5)	0.671
Hypokalemia: <3.5 mEq/l	29 (37.2)	17 (32.6)	0.600
Hypocalcemia: <8.5 mg/dl	36 (46.2)	19 (36.5)	0.277
Hypoglycemia (<50 mg/dl)	9 (11.5)	4 (7.7)	0.474
Metabolic acidosis (pH<7.35)	52 (66.7)	30 (57.7)	0.299
Metabolic alkalosis (pH>7.45)	8 (10.3)	9 (17.3)	0.243
Raised serum urea (>20 mg/dl) and serum creatinine (>1 mg/dl)	7 (9.0)	10 (19.2)	0.089
Positive blood culture	7 (9.0)	6 (11.5)	0.744

Test: χ^2.

Table 5 Comparison of elements of blood picture among the studied cases

	1-12 months (*n*=78) [*n* (%)]	>1-5 years (*n*=52) [*n* (%)]	*P*
Anemia (Hb <11 g/dl)	51 (65.4)	41 (78.8)	0.098
White blood cells			
Normal (4×10^3-11×10^3 cells/mm^3)	13 (16.7)	10 (19.2)	0.707
Leukocytosis (>11×10^3 cells/mm^3)	62 (79.4)	40 (76.9)	0.728
Leucopenia (<4×10^3 cells/mm^3)	3 (3.9)	2 (3.9)	1.000
Thrombocytopenia (<150×10^9/l)	14 (17.9)	12 (23.1)	0.474

Test: χ^2. Hb, hemoglobin.

Table 6 Causes of convulsion with acute gastroenteritis in the studied cases

	1-12 months (*n*=78) [*n* (%)]	>1-5 years (*n*=52) [*n* (%)]	*P*
Electrolyte disturbance	67 (85.9)	39 (75.0)	0.117
CNS infection	24 (30.8)	15 (28.8)	0.815
Septicemia	7 (9.0)	6 (11.5)	0.633
Febrile convulsion	3 (3.8)	8 (15.4)	0.027*
Intracranial hemorrhage	3 (3.8)	2 (3.8)	1.000
hypoglycemia	9 (11.5)	4 (7.7)	0.682

Test: χ^2. CNS, central nervous system. *Statistically significant *P*<0.05.

group 1 patients and eight cases in group 2 patients), and lastly, intracranial hemorrhage was noticed in five (3.8%) cases (three cases in group 1 patients and two cases in group 2 patients).

Discussion

The present study showed that 60% of cases are in group 1 and 40% of cases are in group 2, with a median age of 11 months. Our results are different from a study conducted by Armin *et al.* [9], who mentioned that the median of age is 36 months, and also different from a study conducted by Ghorashi *et al.* [10], who stated that the mean age is 2.34 ± 1.67 years (5 months to 7 years). This difference may be owing to that our study was conducted in a tertiary level hospital, which receives only severe and complicated cases, and also younger age group may be more susceptible to complications than those in the older age group.

In the present study, 52.3% were females and 47.7% were males. The results of the present study are in concordance with Uemura *et al.* [8] who mentioned that the sex of the cases in their study represented 56 (53.3%) girls and 49 (46.7%) boys, and there is no sex difference between the cases.

Regarding the frequency and pattern of dehydration, we found that 63.8% of cases had severe dehydration and 36.2% of cases had moderate dehydration. This is different from a study done in the Department of Pediatrics, Tabriz University, by Ghorashi *et al.* [10], who stated that the most frequent degree of dehydration is moderate dehydration (68%) followed by mild dehydration (18%) and then severe dehydration (14%). This difference may be owing to that our study was conducted in a tertiary level hospital, which receives severe and complicated cases.

In the present study, we found that most cases (87.7%) had watery diarrhea and 12.3% had bloody diarrhea. This is in agreement with a study by Wong [11], who found that watery diarrhea was present in 80.9% of cases, followed by bloody diarrhea in 19.1%.

Regarding the type and frequency of convulsion among the studied cases, we found that 69 (53.1%) cases had generalized tonic-clonic type and 51 (39.2%) cases had generalized tonic type, and 10 (7.7%) cases had focal convulsion. This is in agreement with a study done by Zerr *et al.* [12] and with the study done by Kimia *et al.* [13], who mentioned that most common type of convulsion was generalized tonic-clonic.

Moreover, we found that 102 cases had recurrent attacks of convulsion (78.5%), and a single attack of convulsion was present in 28 (21.5%) cases. This is in agreement with the study done by Uemura *et al.* [8], who mentioned that multiple convulsions were present in 75% of cases, and also with Abe *et al.* [14], who found that multiple convulsions were present in 78% of cases.

Regarding the laboratory investigation, it was observed that hypernatremia was present in 67 (51.5%) cases, and hyponatremia was present in 17 (13.1%) cases. This is different from a study done by Vafaei *et al.* [15] about determinant factors in seizure following gastroenteritis, who found that hypernatremia was present in 10.44% of cases and hyponatremia was present in 24.1% of cases. This is also different from a study done by Ghorashi *et al.* [10], who stated that hypocalcaemia was present in 10% of cases. This difference may be owing to that most of our cases had severe dehydration.

In the present study hypoglycemia was present in 13 (10%) cases. There are few literature studies describing hypoglycemia as a complication of dehydration owing to acute gastroenteritis; a study by Reid *et al.* [16] about hypoglycemia complicating dehydration owing to acute gastroenteritis mentioned that hypoglycemia was present in 33.7% of cases.

In the present study, metabolic acidosis was present in 82 (63.1%) cases and metabolic alkalosis was present in

17 (13.1%) cases. This is different from a study done by Vafaei *et al.* [15], who stated that acidosis and alkalosis were found in 37.88 and 10.61% of cases, respectively.

Regarding the elements of blood picture, it was found that anemia was present in 92 (70.8%) cases. This is different from a study done by Howard *et al.* [17], which investigated the prevalence of anemia with cases of diarrhea and observed that the prevalence of anemia was 50%, and also different from a study done by Laham *et al.* [18] about possible hematological changes associated with acute gastroenteritis among Kindergarten children in Gaza, which observed that anemia was present in 21.8% of cases.

Leukocytosis was present in 102 (78.5%) cases, leukopenia was present in five (3.8%) cases, and thrombocytopenia was present in 26 (20%) cases. This is different from a study done by Ghorashi *et al.* [10], who mentioned that the leukocytosis was present in 46% of cases, and also from the study by Wong [11], who mentioned that the leukocytosis was noticed in 28% of cases.

Regarding the etiology of convulsion, we found that the etiology of convulsion is multifactorial, and the most common cause of convulsion with gastroenteritis was electrolyte disturbance, which was noticed in 106 (81.5%) cases, followed by CNS infection, which was noticed in 39 (30%) cases, then septicemia, which was noticed in 13 (10%) cases and hypoglycemia with the same percentage (10%), then febrile convulsion which noticed in 11 (8.5%) cases [there was a statistically significant difference between two age group (P = 0.027) regarding febrile convulsion], and lastly, intracranial hemorrhage, which was noticed in five (3.8%) case. This is in agreement with a study conducted by Vafaei *et al.* [15] about determinant factors in seizure following gastroenteritis in children and found that electrolyte disturbance was noticed in 52.2% of cases. Several studies have reported various frequencies of CNS involvement in children with acute gastroenteritis, most of them about CNS infection following acute gastroenteritis, and the frequencies were 2% in Germany [19], 2.6% in Japan [14], 3.7% in the USA [20], and 5.7% in Hong Kong [11]. Another study analyzed the incidence of CNS infection in cases of acute gastroenteritis with convulsions associated with either a bacterial infection or a rotavirus infection and found that the incidence was 3 and 5.7%, respectively [11]. A study conducted by Watson *et al.* [21] found that seizure occurs in 27.1% of cases with sepsis. A study conducted by Kang *et al.* [22] about comparison between febrile and afebrile seizures associated with gastroenteritis mentioned that febrile seizures was present in 2.2% of cases.

Conclusion and recommendation

Convulsion is one of the most serious complications associated with acute gastroenteritis. A younger age group (1–12 months) is more susceptible to complications than those in the older age group. Electrolyte disturbance is still a major cause of convulsion associated with acute gastroenteritis.

Early detection and good management of cases of convulsion associated with acute gastroenteritis is mandatory, as most cases can be managed with good outcome. Pediatricians must keep in consideration that in spite of hypoglycemia being a rare complication of gastroenteritis, it can occur in infants and children with poor oral intake and can cause convulsion.

Further studies are needed to determine the causative organisms (bacterial, viral, parasitic, and fungal) associated with convulsion and gastroenteritis in our locality and how to manage them.

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Conflicts of interest

There are no conflicts of interest.

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