Tropical Biomedicine 38(1): 50-56 (2021)
https://doi.org/10.47665/tb.38.1.009

RESEARCH ARTICLE

Intestinal protozoan infections among Egyptian neutropenic patients with acute leukemia

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ARTICLE HISTORY

Received: 19 August 2020
Revised: 7 November 2020
Accepted: 10 November 2020
Published: 25 March 2021

ABSTRACT

Several enteric protozoan species are linked to diarrhea in humans, with some causing debilitating illnesses, essentially in immunocompromised and neutropenic patients as in acute leukemias. The aim of this study was to detect intestinal protozoa in Egyptian neutropenic patients with acute leukemia. The study comprised two groups; 40 newly diagnosed neutropenic acute leukemia patients and 30 controls. Stool samples were collected from all participants and subjected to routine microscopic examination, special staining and detection of copro-antigen using rapid diagnostic test (RDT) RIDA®QUICK *Entamoeba/ Giardia/ Cryptosporidium* Combi. Cases were tested post-chemotherapy at the nadir of neutropenia (absolute neutrophil count ANC≤ $0.5x10^9$/L) and 19 cases were also tested initially prior to chemotherapy. Of examined patients, 15/40 (37%) were positive for *Blastocystis hominis* by wet mount, 10/40 (25%) had microsporidia using modified trichrome stain and only 2 cases (5%) of *Cryptosporidium* spp. by Ziehl-Neelsen stain. By RDT, 8/40 cases (20%) were positive compared to entirely negative controls. The positive cases included 4 patients with *G. intestinalis* 2 with *Entamoeba* and 2 with *Cryptosporidium*.19/40 cases were tested both pre- and post-chemotherapy. microsporidian spp. was diagnosed in 6/19 cases at the nadir of neutropenia compared to none of the cases pre-chemotherapy and the difference was statistically significant (p= 0.031*). Intestinal protozoa in acute leukemia patients post-chemotherapy are common especially *B. hominis*. Furthermore, RDT might be helpful for diagnosing intestinal protozoa in acute leukemia. Attention is highly required as intestinal protozoa infection can emerge after chemotherapy such as microsporidia.

Keywords: Intestinal protozoa; acute leukemia; post-chemotherapy; neutropenia.

INTRODUCTION

Gastrointestinal (GI) manifestations of leukemia are encountered in up to quarter of the patients at autopsy generally during relapse. Their occurrence differs according to the type of leukemia and has been declining as chemotherapy improved over time (Ellen & Klaus, 2012).

Parasitic diseases remain a major cause of morbidity and mortality, with greater than three billion individuals infected worldwide. Many of the parasitic infections occur in the developing world in a segment of population including the malnourished, those with acquired or congenital immuno-deficiencies, as well as patients receiving diverse immunosuppressive regimens, including corticosteroids, and the ever growing list of increasingly aggressive immunosuppressive agents (Evering & Weiss, 2006).

Specific host defense derangements are associated with increased susceptibility to infection to different pathogens including parasitic infections (Michael *et al*., 2010). Immune compromise can modify the severity and manifestations of some parasitic infections (Evering & Weiss, 2006). Immunosuppression, either at the humoral or cellular level, has various consequences for the host depending on its magnitude, and will change the range of pathogens to which they are vulnerable (Evering & Weiss, 2006; Michael *et al*., 2010).

Immune compromise state can alter the severity and manifestation of some parasitic infections. The extensive use of novel immunosuppressive therapies inducing profound neutropenia, the increasing population of individuals with immunocompromised states together with the lengthened survival of these patients have changed the pattern of parasitic infection (Evering & Weiss, 2006).

In patients with immunosuppression developing parasitic infections, changes often take place in favor of the pathogen. The advantage to the pathogen relies on the component of the immune system that is defective (Stark *et al*., 2009).

The aim of this study was to detect the frequency of intestinal protozoan infections in neutropenic patients with acute leukemia and its relation to the clinical manifestations of the patients.

MATERIALS AND METHODS

This case- control study was conducted on 70 subjects recruited during the period from May 2018 to April 2019 and divided into two groups as follows:

Group I: 40 Neutropenic acute leukemia patients undergoing induction chemotherapy admitted to the Hematology Unit, Internal Medicine Department, Alexandria Main University Hospital and Hematology Department, Medical Research Institute.

Out of these 40 patients, 19 patients were examined pre and post-chemotherapy. Stool samples could not be taken prior to chemotherapy in the remaining cases owing to different causes including constipation due to anorexia, malnourishment or dehydration, malaise or patients' refusal to provide a stool sample.

Group II: 30 Non-neutropenic age- and sex-matched individuals with diarrheal illness.

Inclusion criteria:
Patients $\geq$ 18 years old. Gender: both, Patients newly diagnosed with acute myeloid leukemia or acute lymphoblastic leukemia undergoing standard conventional induction chemotherapy. Neutropenic patients should have an absolute neutrophil count (ANC) $\leq$ $0.5x10^9$/L. Non neutropenic age- and sex-matched individuals with diarrheal illness should have an ANC of $\geq$ $1.5x10^9$/L.

Exclusion criteria:
Patients' <18 years old, Patients with other hematological or non-hematological malignancies e.g. CML, CLL or solid tumors. Neutropenia due to other causes (immune causes, splenic pooling, bone marrow infiltration by metastasis, or aplastic anemia), Neutropenic patients with ANC between 0.5–$1.5x10^9$/L, Patients non eligible for standard conventional induction chemotherapy protocols e.g. significant co-morbidities (Renal, hepatic, cardiac, pulmonary or collagen disorders).

Ethical considerations:
All subjects enrolled in the study signed a written informed consent and approvals of Research Ethics Committees of Faculty of Medicine and Medical Research Institute, University of Alexandria were obtained prior to the study.

All subjects were subjected to thorough history taking and clinical examination as well as Routine work up including complete blood count (CBC) with total and differential counts. Bone marrow examination and immune-phenotyping were done to all acute leukemia patients to establish the diagnosis.

Microscopic examination of stool samples: Stool samples were examined using saline and iodine wet mounts, formalin ethyl-acetate sedimentation technique and permanent staining with modified trichrome and modified Ziehl-Neelsen acid fast stains (Garcia, 2007).

Stool examination was done to cases and control groups. All cases were tested post chemotherapy (the 40 patients) during el Nadir when the absolute neutrophil count (ANC) was less than or equal $0.5x10^9$/L (13±1.95 days post chemotherapy) and whenever possible.

Immunochromatographic rapid diagnostic tests (RDTs): This rapid assay is a single-step immunochromatographic lateral-flow test, where an interaction occurs between the parasite antigen and immobilized IgG monoclonal antibodies prepared against this antigen. About 50 mg of each fresh stool sample was used for the detection of *Cryptosporidium parvum, G. intestinalis* and *E. histolytica/dispar* antigens using (RIDA®QUICK *Cryptosporidium/ Giardia / Entamoeba* Combi) according to manufacturer's instructions.

Statistical analysis
Data were fed to the computer and analyzed using IBM SPSS software package version 20.0 (Armonk, NY: IBM Corp). Qualitative data were described as frequencies and percent. Quantitative data were described using mean, standard deviation and median. Significance of the obtained results was judged at the 5% level. Fisher Exact, Monte Carlo and McNemar tests were used.

RESULTS

The mean age was 41.85 ± 12.76 years for acute leukemia patients and 38.53 ± 15.98 years for control group. Acute myeloid leukemia (AML) formed 25⁄40 (62.5%) of the cases and acute lymphoblastic leukemia (ALL) formed 15⁄40 (37.5%). The mean ANC for the cases at the nadir of neutropenia was 0.19 ± $0.15x10^9$/L and it was reached at a mean of 13 ± 1.95 days post-chemotherapy.

Blastocystis spp. was detected by wet mount in 15.8% of patients tested before chemotherapy (n=19), compared to 37.5% of patients tested after chemotherapy (n=40) and 20% of control subjects. *Blastocystis* was frequently found in post chemotherapy patients than pre-chemotherapy patients and controls however, this didn't reach level of significance. (p>0.05). *Crytposporidium* spp. were detected by Ziehl-Neelsen in 0%, 5%, and 0% of studied subjects pre chemotherapy, post chemotherapy and control, respectively with no statistically significant difference. Microsporidia were detected by modified trichrome stain in 0%, 25%, and 20% of studied subjects pre chemotherapy, post chemotherapy and control, respectively with no statistically significant difference (Table 1).

Comparison between 19 cases who were tested pre- and post-chemotherapy showed that *B. hominis* using wet mount was positive in 15.8% of pre-chemotherapy samples compared to 21.1% of post-chemotherapy samples with no statistically significant difference p>0.05. *Cryptosporidium* spp. using Ziehl-Neelsen was positive in 0% of pre-chemotherapy samples 10.5% among post-chemotherapy samples with no statistically significant difference p>0.05. Microsporidia using modified trichrome stain was positive in 0% of pre-chemotherapy samples compared to31.6% among post-chemotherapy samples and the difference was statistically significant (p=0.031) (Table 2).

Comparison between group I (post-chemotherapy patients) and group II (controls) using the rapid diagnostic test (RDT) showed that 20% of group I patients were positive for intestinal protozoa using RDT as a diagnostic method compared to none among group II. This difference was statistically significant (p=0.009) (Table 3).

When using wet mount method for *B. hominis* 24% (6⁄25) were positive among AML cases while 60% (9/15) were positive among ALL showing statistical significance (p=0.023). Ziehl-Neelsen stain for *Cryptosporidium* showed no positive

Table 1. Comparison between the studied groups as regard intestinal protozoa

Intestinal protozoa	Cases				Control (n = 30)	
	Pre chemotherapy (n = 19)		Post chemotherapy (n = 40)			
	No.	%	No.	%	No.	%
Wet mount						
Negative	16	84.2	25	62.5	24	80.0
Positive (*B. hominis*)	3	15.8	15	37.5	6	20.0
$p_{Control}$	**1.000**		**0.187**			
Ziehl-Neelsen						
Negative	19	100.0	38	95.0	30	100.0
Positive (*Cryptosporidium* spp.)	0	0.0	2	5.0	0	0.0
$p_{Control}$	–		**0.503**			
Modified trichrome						
Negative	19	100.0	30	75.0	24	80.0
Positive (microsporidian spp.)	0	0.0	10	25.0	6	20.0
$p_{Control}$	**0.069**		**0.622**			

Table 2. Comparison between pre and post chemotherapy stool samples regarding intestinal protozoa (n=19)

Intestinal protozoa	Cases				^{McN}p
	Pre chemotherapy (n = 19)		Post chemotherapy (n = 19)		
	No.	%	No.	%	
Wet mount					
Negative	16	84.2	15	78.9	**1.000**
Positive (*B. hominis*)	3	15.8	4	21.1	
Ziehl-Neelsen					
Negative	19	100.0	17	89.5	**0.500**
Positive (*Cryptosporidium* spp.)	0	0.0	2	10.5	
Modified trichrome					
Negative	19	100.0	13	68.4	**0.031***
Positive (microsporidian spp.)	0	0.0	6	31.6	

Table 3. Comparison between the two studied groups according to intestinal protozoa detected by rapid diagnostic test (RDT)

Intestinal protozoa	Group I (n = 40)		Group II (n = 30)		χ^2	^{FE}p
	No.	%	No.	%		
RDT						
Negative	32	80.0	30	100.0	6.774*	0.009*
Positive	8	20.0	0	0.0		

cases among AML while 13.3% (2/15) were positive among ALL cases. Using modified trichrome method for Microspridia spp., 36% (9/25) of AML cases were positive while 6.7% (1/15) of ALL cases were positive.

As for RDT, positive cases represented 12% (3/25) and 33.3% (5/15) of AML and ALL cases, respectively. As for type of intestinal protozoa detected using RDT, 12% in AML and 6.7% in ALL were positive for *G. intestinalis* None were positive for *Entamoeba* or *Cryptosporidium* among AML cases, however among ALL patients 13.3% were positive for *Entamoeba* and 13.3% were positive for *Cryptosporidium*. Yet no statistically significant difference was noted between AML and ALL regarding protozoa detected by Ziehl-Neelsen, modified trichrome stains nor RDTs (p>0.05) (Table 4).

As regard the relation between ANC and intestinal protozoal infection in acute leukemia patients at the nadir of neutropenia, no significant relation was noted between ANC and the various protozoa using any of the detection methods (p>0.05) (Table 5).

The relation between common GI symptoms and the type of intestinal protozoa detected was not statistically significant except for diarrhea in patients with *B. hominis*

Table 4. Comparison between the two studied subgroups (AML and ALL) of group I post chemotherapy regarding intestinal protozoa

Intestinal protozoa	Diagnosis				χ^2	P
	AML (n=25)		ALL (n=15)			
	No.	%	No.	%		
Wet mount						
Negative	19	76.0	6	40.0	5.184*	0.023*
Positive (*B. hominis*)	6	24.0	9	60.0		
Ziehl Neelsen						
Negative	25	100.0	13	86.7	3.509	FEp=0.135
Positive (*Cryptosporidium*)	0	0.0	2	13.3		
Modified Trichrome						
Negative	16	64.0	14	93.3	4.302	FEp=0.060
Positive (Microsporidia)	9	36.0	1	6.7		
RDT						
Negative	22	88.0	10	66.7	2.667	FEp=0.126
Positive	**3**	**12.0**	**5**	**33.3**		
Giardia intestinalis	3	12.0	1	6.7	0.296	FEp=1.000
Entamoeba	0	0.0	2	13.3	3.509	FEp=0.135
Cryptosporidium spp.	0	0.0	2	13.3	3.509	FEp=0.135

χ^2: **Chi square test** **FE:** Fisher Exact test
p: p value for comparing between the two studied groups
*: Statistically significant at $p \leq 0.05$

Table 5. Relation between ANC and detection of intestinal protozoa at the nadir of neutropenia in group I patients (n = 40)

Intestinal protozoa	N	ANC			U	p
		Min. – Max.	Mean ± SD.	Median		
Wet mount						
Negative	**25**	0.01 – 0.50	0.20 ± 0.16	0.20	177.50	0.783
Positive (*B. hominis*)	**15**	0.01 – 0.50	0.18 ± 0.12	0.20		
Ziehl Neelsen						
Negative	**38**	0.01 – 0.50	0.20 ± 0.15	0.20	33.50	0.785
Positive (*Cryptosporidium*)	**2**	0.10 – 0.20	0.15 ± 0.07	0.15		
Modified Trichrome						
Negative	**30**	0.01 – 0.50	0.20 ± 0.14	0.20	127.0	0.488
Positive (Microsporidia)	**10**	0.01 – 0.50	0.18 ± 0.17	0.10		
RDT						
Negative	32	0.01 – 0.50	0.20 ± 0.15	0.20	111.0	0.555
Positive	8	0.01 – 0.35	0.16 ± 0.10	0.15		

U: Mann Whitney test
p: p value for comparing between the two categories

where 58.8% of positive cases complained of diarrhea and 50% had abdominal pain, and presence of diarrhea was significantly associated with *B. hominis* positivity in stools (p=0.017) (Table 6).

DISCUSSION

Enteroparasitic infections comprise a serious public health problem in developing countries where sanitary conditions are inadequate. Numerous types of protozoal intestinal parasites affect man, eliciting a wide range of symptoms that are generally associated with the GI tract and reliant on demographic, socio-economic, physiological and immunological factors. Patients with immunocompromised condition and those receiving immunosuppressive therapy have a greater risk of encountering parasitic infections, generally with a high degree of severity (Botero *et al*., 2003).

Traditional diagnostic methods for parasitic infections use fecal samples and must include concentration procedures along with specific staining techniques for proper microscopic detection and identification of the parasite. These methods are laborious, take a long time and require specialized and trained personnel. In addition, microscopic examination of three samples obtained on different days is required to achieve sensitivity up to 85%. Other techniques such as immunofluorescence microscopy (IFM) improve

Table 6. Relation between symptoms and detection of intestinal protozoa at the nadir of neutropenia in group I patients (n = 40)

Intestinal protozoa	Symptoms															
	Fever				Abdominal Pain				Constipation				Diarrhea			
	Negative (n=22)		Positive (n = 18)		Negative (n=22)		Positive (n=18)		Negative (n=30)		Positive (n = 10)		Negative (n = 23)		Positive (n = 17)	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Wet mount																
Negative	11	50.0	14	77.8	16	72.7	9	50	17	56.7	8	80.0	18	78.3	7	41.2
Positive (*B. hominis*)	11	50.0	4	22.2	6	27.2	9	50	13	43.3	2	20.0	5	21.7	10	58.8
χ^2 (p)	3.259 (0.071)				2.181 (0.139)				1.742 (^{FE}p=0.269)				5.736* (0.017*)			
Ziehl Neelsen																
Negative	21	95.5	17	94.4	21	95.5	17	94.4	28	93.3	10	100	23	100	15	88.2
Positive (*Cryptosporidium*)	1	4.5	1	5.6	1	4.5	1	5.6	2	6.7	0	0.0	0	0.0	2	11.8
χ^2 (p)	0.021 (^{FE}p=0.884)				0.021 (^{FE}p=0.884)				0.702 (^{FE}p=1.000)				2.848 (^{FE}p=0.174)			
Modified Trichrome																
Negative	15	68.2	15	83.3	15	68.2	15	83.3	23	76.7	7	70.0	19	82.6	11	64.7
Positive (Microsporidia)	7	31.8	3	16.7	7	31.8	3	16.7	7	23.3	3	30.0	4	17.4	6	35.3
χ^2 (p)	1.212 (^{FE}p=0.464)				1.212 (^{FE}p=0.464)				0.178 (^{FE}p=0.689)				1.671 (^{FE}p=0.274)			
RDT																
Negative	19	86.4	13	72.2	19	86.4	13	72.2	23	76.7	9	90.0	21	91.3	11	64.7
Positive	3	13.6	5	27.8	3	13.6	5	27.8	7	23.3	1	10.0	2	8.7	6	35.3
χ^2 (p)	1.237 (^{FE}p=0.430)				1.237 (^{FE}p=0.430)				0.833 (0.653)				4.322 (^{FE}p=0.053)			

χ^2: **Chi square test**
FE**: Fisher Exact**
p: p value for comparing between negative and positive
*: Statistically significant at $p \leq 0.05$

Figure 1. *Blastocystis hominis* (arrow) by direct saline smear (40x).

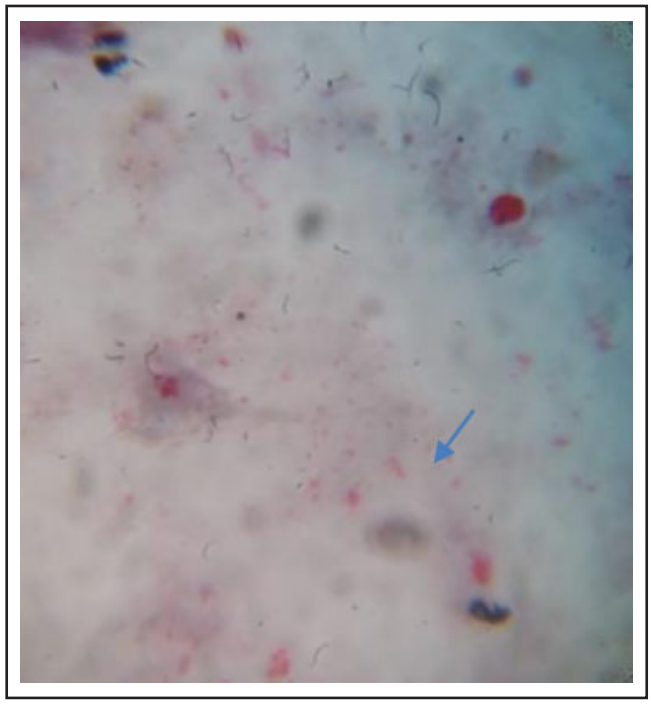

Figure 2. Microsporidia (arrow) by modified trichrome stain (100x).

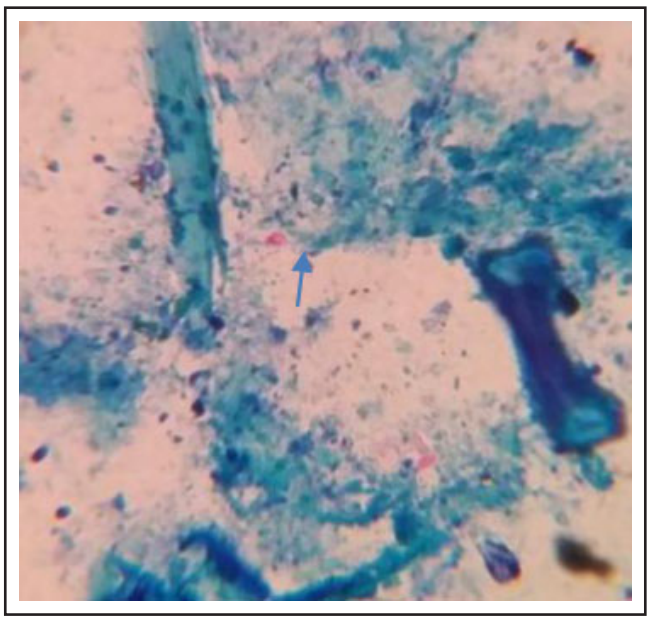

Figure 3. *Cryptosporidium* spp. (arrow) by modified Ziehl-Neelsen stain (100x).

sensitivity (about 97.4% for *Cryptosporidium*), but they are expensive and laborious techniques, and are not routinely available in all laboratories (Goni *et al*., 2012).

The present study was conducted to detect the frequency of intestinal protozoan infections in Egyptian neutropenic patients with acute leukemia and to correlate this with the clinical manifestations of the patients.

Among the 40 neutropenic cases post chemotherapy, 15 (37%) were positive for *B.hominis* by wet mount, 10 (25%) were positive for microsporidian spp.. using modified trichrome stain and 2 cases (5%) were positive by Ziehl-Neelsen stain for *Cryptosporidium*. *B. hominis* was higher in post chemotherapy neutropenic patients compared to controls however this didn't reach level of significance probably due to small sample size. *B. hominis* predominance matched with results of a study conducted by Wassef *et al*. (2016) in Cairo, Egypt which showed that *B. hominis* was the most prevalent protozoan in neoplastic patients (hematological and solid organs malignancy receiving chemotherapy or radiation) with 57 cases out of the 200 cancer patients enrolled in their study tested positive for it (28.5%).

Moreover, in the present study, microsporidian spp. was detected in 25% of our patients which nearly matched with the results of Lono *et al*. (2008) in Malaysia who conducted their study on 311 cancer patients receiving chemotherapy and showed that 21.9% of the patients were positive for micropsporidian spp.

In the present study; among the control group 20% of subjects were positive for *B. hominis* by wet mount, 20% positive for microsporidian spp.. by modified trichrome and none was positive for *Cryptosporidium* by Ziehl-Neelsen. On comparing cases to controls, results were not statistically significant. However, there was a statistically significant difference between cases and controls regarding intestinal protozoa detected by rapid diagnostic test (RIDA®QUICK *Entamoeba/ Giardia/ Cryptosporidium* Combi Test). 20% of acute leukemia cases were positive compared to the entirely negative control group (p= 0.009). The 8 positive cases included 4 cases with *G. intestinalis* (10%) and 2 cases for each of *Entamoeba* and *Cryptosporidium* (5%).

Similarly, Jeske *et al*. (2017) from South Brazil reported that the most common intestinal protozoa among immune-deficient cancer patients undergoing chemotherapy was *G. intestinalis* (26.6%) followed by *Cryptosporidium* spp. (13.3%).

Al-Qobati *et al*. (2018) from Yemen reported that an overall 59 cases (57.8%) of immunocompromised patients were positive for enteric protozoa where *C. parvum* ranked the first (27.5%), and *E. histolytica/E. dispar* was the least (2.9%); and the prevalence rate for *G. intestinalis* was 13.7%.

A Turkish study done by Uysal *et al*. (2017) reported that intestinal parasites were diagnosed in nine (9.9%) patients with leukemia. *Cryptosporidium* was the most frequently identified parasite, recovered from six specimens (6.6%), while *B. hominis* in 3.3% and *Entamoeba* in 1.1%. *Cryptosporidium* spp. and *E. histolytica* were detected together in one patient.

Immunocompromised hosts are at higher risk for acquiring intestinal protozoan infections particularly in the setting of impaired or deficient T-cell function. The immune response against parasites is divided into two broad categories: innate immunity, which alone seldom eliminates the parasite; and adaptive immunity, which is better suited to thwarting the infection. Intestinal protozoa usually trigger a strong adaptive immune response mediated by T cells. However, the immune response may not always be effective. These parasites have developed mechanisms to evade the immune response and survive within the host (Marcos *et al*., 2013).

As for *Cryptosporidium*, studies demonstrated that both humoral and cellular immune mechanisms are essential for guarding against it, though humoral immunity is incompletely protective. IFN-γ mediates a vital protective innate response against *C. parvum* in animal models. Unlike the immunocompetent host, immunocompromised patients with cryptosporidiosis fail to demonstrate a significant serologic response to the organism (Evering & Weiss, 2006).

Studies also showed that innate immunity including physical barriers as the host intestinal mucous layer and the colonic epithelium structure plays the central role in guarding against *E. histolytica*. Disrupted principally by chemotherapy used in treatment of acute leukemia, such a barrier may fail to combat the infection (Evering & Weiss, 2006).

In the present study, 19 cases were tested pre and post chemotherapy for *B. hominis* by wet mount, *Cryptosporidium* by Ziehl-Neelsen stain and microsporidian spp. by modified trichrome. Only microsporidian spp. diagnosed by modified trichrome was statistically significant (p=0.03) on comparing pre- to post-chemotherapy stool samples. This corresponds with that published by Chandramathi *et al*. (2012) in Malaysia. They reported that intestinal parasites emerged as opportunistic infections in breast and colorectal cancer patients (n=46 and n=15, respectively) undergoing chemo-therapy treatment. Stool analyses of all cancer patients were negative for all intestinal parasitic infections before chemo-therapy treatment. The infections happened within the intermediate chemotherapy cycles. Cancer patients were tested positive for either *B. hominis* or microsporidian spp. or both post chemotherapy (Chandramathi *et al*., 2012).

Chemotherapy can result in immunosuppression, which may trigger latent intestinal parasitic infections in stools to emerge. It is highly likely that through the initial stage of chemotherapy, the small number of cysts of *B. hominis* lodged in the villi and the low amount of microsporidian spores caused them to remain undetected in fecal samples. However, the occurrence of infections from repeated cycles of chemotherapy implies that this could have arisen due to its opportunistic nature. It is reasonable that chemotherapy

drugs, which are known to be cytotoxic, could down-regulate the patient's immune system and hence causing augmentation of the parasitic infections (Chandramathi *et al*., 2012).

When comparing between our two studied subgroups (AML and ALL) post chemotherapy regarding the intestinal protozoa detected, *B. hominis* by wet mount were positive in 60% of ALL patients compared to 24% positivity in AML patients and this was of statistical significance (P=0.023). The remaining protozoa detected in both AML and ALL patients by different stains and by the rapid diagnostic test did not show a statistically significant difference (p>0.05).

Similarly, an earlier study conducted by Nomir *et al*. (2000) recruited 25 acute leukemia patients admitted to Alexandria Main University Hospital; reported that the incidence of intestinal parasitic infection was higher in ALL (50%) compared to AML patients (26.6%).

In the present study, of all patients with *B. hominis* infection, 58% had diarrhea and 50% had abdominal pain, and the presence of diarrhea was significantly associated with positive *B. hominis* in stools (p=0.017). The patients stated that diarrhea was not bloody in any of their diarrheal since invasion of intestinal mucosa does not always lead to ulceration. In the study conducted by Laodim *et al*. (2012) most *B. hominis* – infected patients (94%) had underlying diseases; malignancy and chronic diseases were equally top ranked in their study (35.3%) which indicated that *B. hominis* is an opportunistic protozoan.

In the present study; there was no other statistically significant relation between the different GI symptoms and any of the other studied protozoa. This contrasts with Botero *et al*. (2003) in Colombia who reported that there was a statistically significant relation between the different GI symptoms and presence of intestinal protozoa.

CONCLUSION

Intestinal protozoa in acute leukemia patients with neutropenia post-chemotherapy are common. The presence of diarrhea among acute leukemia patients with neutropenia was significantly associated with *Blastocystis* positivity. Furthermore, RIDA®QUICK Rapid diagnostic test (RDT) might be helpful for diagnosing intestinal protozoa in acute leukemia cases with neutropenia. Attention is highly required as intestinal protozoa infections can emerge after chemotherapy such as microspridian spp.

Conflict of interest and source of funding:
None.

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