



Tehran University of Medical
Sciences Publication
<http://tums.ac.ir>

Iranian J Parasitol

Open access Journal at
<http://ijpa.tums.ac.ir>



Iranian Society of Parasitology
<http://isp.tums.ac.ir>

Short Communication

Cryptosporidium Infection in Patients with Gastroenteritis in Sari, Iran

Shirzad GHOLAMI¹, Majid KHANMOHAMMADI², Ehsan AHMADPOUR¹, Abdol Sattar PAGHEH¹, Sara KHADEM NAKHJIRI³, Hamidreza RAMAZANPOUR⁴,
* Abbas SHAHBAZI⁵

1. Molecular and Cell Biology Research Center, Mazandaran University of Medical Sciences, Iran
2. Department of Laboratory Sciences, Marand Branch, Islamic Azad University, Iran
3. Gorgan Faculty of Medicine, Golestan University of Medical Sciences, Iran
4. Faculty of Basic Sciences, University of Mazandaran, Iran
5. Tabriz Research Center of Infections and Tropical Diseases, Tabriz University of Medical sciences, Iran

Received 23 Nov 2013
Accepted 12 Mar 2014

Keywords:

Cryptosporidium spp.,
Gastroenteritis Patients,
Nested PCR

***Correspondence**

Email:
shahbazy42@yahoo.com

Abstract

Background: Cryptosporidiosis is a common coccidian parasite infection in patients with diarrhea that has worldwide distribution especially in developed countries. Therefore, the aim of this study was to determine the occurrence of *Cryptosporidium* infection in patients with gastroenteritis admitted to hospitals of Mazandaran University of Medical Sciences by parasitological and molecular methods in Sari, Iran.

Methods: Stool samples were collected from 348 patients with gastroenteritis admitted to the hospitals of Medical University in the Sari and Ghaemshahr cities in Mazandaran Province, Northern Iran in 2010-2011. Oocysts of *Cryptosporidium* identified using Formalin-Ether concentration method and stained by Acid-fast staining (AFS) and Auramine phenol fluorescence (APF). Genomic DNA extracted from microscopically positive samples and nested PCR -RFLP by using SSU rRNA that identifies of the species of cryptosporidium.

Results: In 348 patients with gastroenteritis, the most clinical symptoms were diarrhea, nausea, vomiting, dehydration, fever and weight loss. 2.3% (8 cases) of diarrheal samples tested by both microscopy and molecular methods were positive for the presence of cryptosporidium. Nested PCR products yielded unique bands of 846 bp, correspond to cryptosporidium. Species diagnosis carried out by digesting the secondary PCR product with *SspI* restriction enzyme, which noted 3 clearly bands of 449, 254, and 108 bp correspond to *Cryptosporidium* spp.

Conclusion: The results of present study on *Cryptosporidium* spp. in this area can make a background data for control programs and further molecular analyses. Thus, further work needs to determine the origin of *Cryptosporidium* species in this area.

Introduction

In recent decades, opportunistic protozoa of the genus *Cyclospora*, *cryptosporidium* and *Toxoplasma*, and enteric pathogen protozoa such as *Giardia intestinalis* and *Entamoeba histolytica*, create the most concerns throughout the world as food-borne diseases and development of diseases in humans and animals (1, 2). Protozoan parasites of the genus *Cryptosporidium* are small coccidia that can infect gastrointestinal and respiratory epithelial cells of vertebrates (3). This protozoan is an intracellular extracytoplasmic monoxenic parasite and is considered as one of the most important pathogenic water and food transmitted zoonotic parasite (2,4,5,6). *Cryptosporidium*, from the late twentieth century, has been known worldwide as an important causative agent of endemic and epidemic diarrhea and affects mostly children (generally under 6 years old) and immunocompromised patients in developed countries (7-10). *Cryptosporidium parvum* and *C. hominis* are the most common species of the parasite that can infect human and transmit through fecal - oral or contaminated drinking water routes (9, 10).

Moreover, in last decade, *Cryptosporidium* has been introduced as a new pathogenic agent in people with normal immune systems in addition to who are immunocompromised; this case illustrates the importance of further extensive studies on any aspects of the parasite and the disease in different regions especially in patients with gastroenteritis, children and people with immune deficiency (11). Prevalence of cryptosporidiosis in patients with diarrhea is more prevalent than the other people and *C. parvum* is known as the third or fourth cause of long-term diarrhea in children that is associated with weight loss (12, 14). In Iran, the prevalence of the parasite in several studies in recent years in patients with gastroenteritis, AIDS and students was from 0.1% to 7.7% (16, 17, 26). The reported prevalence of the parasite in patients with gastroenteritis in

Mazandaran was 0.1 to 4.1% (8, 12). However, in the years 2007-2008 Nahravanian et al. could not find the parasites in stool samples of patients with gastroenteritis in Mazandaran Province (12).

Current common methods for detection of *Cryptosporidium* are including concentration techniques and modified acid-fast staining (3). Recently, the use of molecular biology techniques to determine the species and genotypes of *Cryptosporidium* and as an alternative to conventional methods for detection of the parasite in clinical specimens have been increased (5, 17, 18). The SSU rRNA gene has a high sensitivity for the detection of *Cryptosporidium* and today this gene has been widely used (19, 20). So far, few studies have been conducted on the prevalence of *Cryptosporidium* in the Mazandaran Province.

Considering to the increasing importance of intestinal protozoa in recent years, detection of them by scientific parasitological methods in-patient with diarrhea, children, and immunosuppressed patient is a priority. Therefore, the aim of this study was to determine the occurrence of *Cryptosporidium* infection in patients with gastroenteritis admitted to hospitals of Mazandaran University of Medical Sciences by using parasitological and molecular methods (PCR-RFLP) in Sari, Iran.

Material and Methods

This study was a cluster randomized descriptive - cross-sectional study. Stool sampling was conducted for 348 patients with gastroenteritis admitted to the hospitals of Mazandaran University of Medical Sciences (in the cities of Sari and Ghaemshahr) in Mazandaran Province in 2010-2011. The samples were stored in fixative (10% formalin) and transported to Parasitological Research Laboratory, and assessed for the presence of oocyst of the parasite using concentration method (Forma-

lin- Ether) and stained by acid-fast staining (AFS) and auramine phenol fluorescence (APF) for detection of *Cryptosporidium* oocysts. By light microscopy, oocysts of *Cryptosporidium* are seen as round pink - red objects on a pale green background by the method of Kinyoun acid fast staining (8,10,12,16,19).

DNA extraction

All 348 samples were repeatedly (five times) washed in a solution of phosphate buffered saline (pH =7.2) and centrifuged at 14000 x g for 10 min in 4 °C to remove possible PCR inhibitors. DNA extracted from purified oocysts by 5 cycles of freezing liquid nitrogen for, followed by thawing at 98 °C for 1 min to disrupt the oocyst wall (21, 30). DNA extracted by DNA mimi Kit (Bioneer, Daejeon, Korea) according to the manufactures protocol.

PCR and Restriction Fragment Length Polymorphism (RFLP)

The method of nested PCR and Restriction Fragment Length Polymorphism (RFLP) by using a small-subunit rRNA gene (15, 23, 24) was used for identification of the species of *Cryptosporidium* spp. In initial PCR a product of 1325 bp of the gene was amplified using a set of primers including forward: 5'-TTCTA-GAGCTAATACATGCG-3' and reverse: 5'-CCCATTTCCTTCGAAACAGGA-3'. The thermal cycling condition in primary PCR was including an initial hot start at 94 °C for 4 min following 35 cycles each consisting of 45 sec at 94 °C, 1 min at 52 °C and 45 sec at 72 °C were and a final extension step at 72 °C for 7 min.

The primers used the nested PCR were forward: 5'- GGAAGGGT TGTATTTA TTAGA TAA AG-3'and reverse: 5'-AGGAG-TAAGGAACAACCTCCA-3'. This primer set amplifies a range of 826-864 bp fragments depending on species of the parasite (16, 28, 30). The cycling condition for the nested PCR was identical to the primary PCR with exception of the annealing temperature that was

55 °C. The PCR products visualized with electrophoresis on 1.5% agarose gels stained with Ethidium bromide by UV transillumination (15, 30). Based on PCR product, to differentiate of *Cryptosporidium parvum* from the other species, restriction enzyme of *SspI* (Fermentase, Lithuania) was used for restriction digestion for differentiation of *Cryptosporidium* spp. under condition recommended previously. Visualization of the digested products was performed through 2% agarose gel electrophoresis and Ethidium bromide (0.5 µg mL⁻¹) staining using UV transillumination (15, 16, 23, 25).

Results

In 348 patients with gastroenteritis, distribution of the patient in age groups was 36.8% more than 40 years old, 32.7% were 21-40 years old and 32.8 were in range of 10-20 years old. 53.2% of cases were male. Totally, 2.3% (8 cases) of diarrheal samples were positive for the presence of *Cryptosporidium* by both microscopy and molecular methods. In the 348 patients with gastroenteritis (with diarrhea), the most clinical symptoms were nausea (19.8%), vomiting (14.1%), dehydration (19%), fever (19%) and weight loss (14.1%).

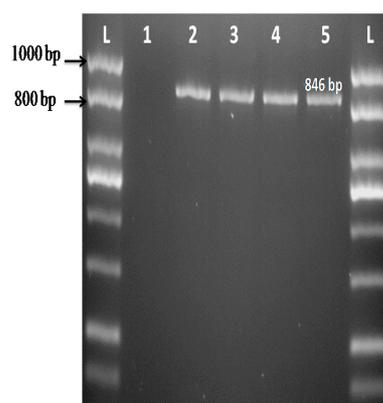


Fig.1: Nested PCR amplified SSU rRNA fragments of *Cryptosporidium*, Line 1: Negative control, line 2-5: Positive samples, DNA bands with size 845 bp. L: DNA ladder (1000 bp)

The region SSU rRNA based nested PCR-RFLP were used to characterize and corroborate of *Cryptosporidium* parasite. The stool samples of 348 patients with gastroenteritis were examined by light microscopy and nested PCR-RFLP methods. Nested PCR products yielded unique bands of 846 bp, correspond to *Cryptosporidium* (Fig. 1). Species diagnosis carried out by digesting the secondary PCR product with *SspI* restriction enzyme. We observed three clearly; bands of 449, 254, and 108 bp correspond to *Cryptosporidium* spp. (*C. parvum* or *C. hominis* genotypes) (Fig. 2).

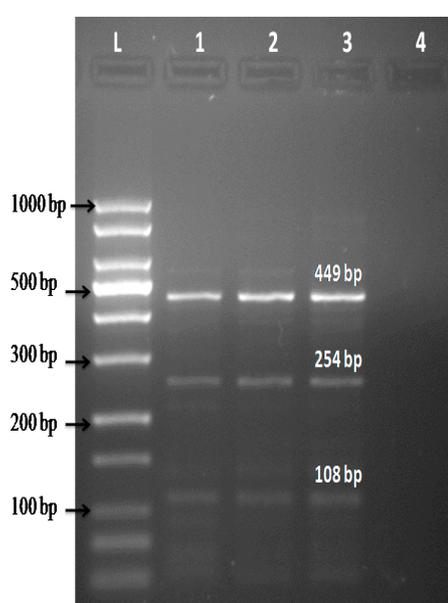


Fig.2: Digestion of secondary PCR product with *SspI* restriction enzyme. Line 1-3: Digestions product of known *Cryptosporidium* Spp (449, 254 and 108 bp). Line 4: Negative control L: DNA ladder (1000 bp)

Discussion

The purpose of the current study was to determine and confirm the occurrence of *Cryptosporidium* infection in patients with gastroenteritis by using molecular methods. The first major finding was that 2.3% (8 cases) of diarrheal samples tested by both microscopy and molecular methods were positive for the pres-

ence of *Cryptosporidium*. Today, enteric opportunistic coccidian, including *Cryptosporidium*, are considered as important infective factors in HIV positive patients, and more recently, in transplant recipients treated with corticosteroids and even in healthy people with normal immune system (26). There are different reports on prevalence of *Cryptosporidium* species among people in the world. Predominate species of the parasite in Kenya, Thailand, Peru, South India, Malawi and South Africa in children or HIV positive adults was *C. hominis* (27). This finding is compatible with the previous parasitological and molecular studies in Iran and UK, Kuwait, Portugal, France, North America, and the Netherland (28-30).

In Iran, there are many evidences showing *Cryptosporidium* in human (31-33). Most of these reports are concentrated on children with diarrhea or mental retardants and people with immune suppression or HIV +. Prevalence of this parasite in various parts of Iran based on microscopic examination of fecal samples was 4.1% in west, 7% in southeastern, 2.2% in south, and 7.7% in north-west (21). In a study conducted in Mazandaran Province in Iran on 142 samples of feces (64 HIV + and 78 HIV-) by methods of concentration (using formalin - ether) and modified Kinyoun acid fast staining, in 4.9% of HIV+ samples and 5.2% of HIV- samples *Cryptosporidium* was detected. (34). In another study on 362 stool samples of children with mental disabilities no cases of *Cryptosporidium* were observed (34). Other study on 614 stool samples of children under 3 years old with or without diarrhea in rural and urban area showed *Cryptosporidium* in 10.4% of the cases (36). The prevalence of the infection in rural children are about twice as urban children, and in children with diarrhea is about three times as in children without diarrhea (36). None of the healthy children HIV- that was investigated in two separate studies in Dakar and Jakarta had been infected with *Cryptosporidium* (37). Only 1.5% of stool samples of 206 patients with HIV + assessed by

Kinyoun acid fast staining was positive for *Cryptosporidium* in Iran (26). In Riyadh, Saudi Arabia, stool samples of 136 patients with suppressed immune system were assessed with modified trichrome and Ziehl – Neelsen, *Cryptosporidium* was detected in more than 8.1% of cases (38).

In this study, similar results were obtained with both the microscopic and molecular methods. All 8 positive cases diagnosed by microscopic methods also were detected by PCR technique. This similarity indicates that if the microscopic method, including staining with Ziehl – Neelsen, be done correctly and accurately can be considered as a valuable diagnostic method for detection of intestinal coccidian. Additionally, molecular characterization of *Cryptosporidium* in fecal samples would be beneficial in providing better insight on the possible transmission dynamics of parasite. Due to the wide range of traditional animal husbandry, special climate, and high humidity, Mazandaran Province is at high risk for zoonotic diseases including cryptosporidiosis.

Conclusion

Detection of *Cryptosporidium* Spp. in this study can reveal the importance of transmitting the infection to human (children, immunocompromised patients, farmers, and veterinarians) with the parasite through direct contact and contamination of food and water with oocysts of the parasite in north of Iran. According to the life cycle of the parasite isolated in present study, direct or indirect contact with human and animals could be the main modes of transmission of the parasite to human. Present results can help public health care system for preventing and managing of cryptosporidiosis in human. In this study, we confronted with limit of the lack of epidemiological data for analyzing various determinant of distribution of the disease in provincial level. Further work needs to be done to establish molecular, parasitological, and epidemiological

investigations on the origin of *Cryptosporidium* Spp. in this area.

Acknowledgements

The results obtained in this paper are graduate MSc student thesis, which was supported by Sari School of Medicine, Cellular and Molecular Research Center, Imam Hospital, Razi Hospital, Booali Hospital and Tuba Center of Mazandaran University of Medical Sciences. This study was financially supported by the Research Affairs of Mazandarn University of Medical Sciences, Sari, Iran. The authors declare that there is no conflict of interests.

References

1. David Dawson T. Foodborne protozoan parasites. *Int J Food Microbiol.* 2005; 103: 207-227.
2. Griffiths JK. Human cryptosporidiosis: epidemiology, transmission, clinical disease, treatment, and diagnosis. *Adv Parasito.* 1998; 40: 37-85.
3. Fayer R, Morgan U, Upton SJ. Epidemiology of *Cryptosporidium*. transmission, detection and identification. *Int J Parasitol.* 2000; 30(12-13):1305-22.
4. Mosier DA, Oberst RD. Cryptosporidiosis. A global challenge. *Ann N Y Acad Sci.* 2000; 916: 102-111.
5. Caccio SM. Molecular epidemiology of human cryptosporidiosis. *Parassitologia.* 2005; 47 (2): 185-192.
6. Xiao L, Ryan UM. Cryptosporidiosis: an update in molecular epidemiology. *Curr Opin Infect Dis.* 2004; 17(5):483-490.
7. Current WL, Garcia LS. Cryptosporidiosis. *Clin Microbiol Rev.* 1991; 4(3): 325-358.
8. Gholami Sh, Hamzah Ali A, Khalilian A, Fakhar M, Daryani A, Sharif M, Gohardehi Sh, Ahmadpou A. The Frequency of Cryptosporidiosis Among Gastroenteritic Patients Referred to Mazandaran University of Medical Science Hospitals, During 2010-2011. *J Mazand Univ Med Sci.* 2012; (22): 263-272(Supple 1) (Persian).

9. Fayer R. *Cryptosporidium*; A water-born zoonotic parasite. *Vet Parasitol.* 2004; 126 (1- 2): 37-56.
10. Hazrati Tappeh KH, Gharavi MJ, Makhdoumi K, Rahbar M, Taghizadeh A. Prevalence of *Cryptosporidium* spp. Infection in Renal Transplant and Hemodialysis Patients. *Iranian J Publ Health.* 2006; 35(3):54-57.
11. Egyed Z, Sreter T, Varga I. Characterization of *Cryptosporidium* spp-recent developments and future needs. *Vet Parasitol.* 2003; 111:103-114.
12. Nahrevanian H, Azarinoosh SA, Esfandiari B, Amirkhani A, Ziapoor SP, Shadifar M. The frequency of cryptosporidiosis among gastroenteritic patients in western cities of Mazandaran Province (2007-2009). *Qazvin University of Medical Sciences.* 2011; 1(58): 78-86 (Persian).
13. MCManus DP, Bowels J. Molecular genetic approaches to parasite identification: their value in diagnostic parasitology and systematic. *Int J Parasitol.* 1996; 26: 687-704.
14. Azami M, Moghaddam DD, Salehi R, Salehi M. The identification of *Cryptosporidium* species (Protozoan) in Isfahan, Iran by PCR-RFLP analysis of the 18 s rRNA gene. *Molecul Biol.* 2007; 41(5): 934-939.
15. Fallah S, Mahdavi-poor B, Jamali R, Nahavidi KH, Asgharzadeh M. Molecular characterization of *Cryptosporidium* isolates from cattle in a slaughterhouse in Tabriz, northwestern Iran. *J Biol Sci.* 2008; 8(3): 639-643.
16. Keshavarz A, Thari A, Hughi A, Kazami B, Abadi A, Hoseini N, Nazmalhoseini Mojarad E, Kashi L. Genetic characterization of *Cryptosporidium* SPP. Among children with Diarrhea in Tehran and Qazvin province; Iran. *Iranian J Parasito.* 2008; 3(3): 30-36.
17. Hamed Y, Safa O, Haidari M. *Cryptosporidium* infection in diarrhetic children in southeastern Iran. *Peditar Infect Dis J.* 2005; 24(4): 86-88.
18. Thompson RC, Olson ME, Zhu G, Enomoto S, Abrahamsen MS, Hijjawi NS. *Cryptosporidium* and cryptosporidiosis. *Adv Parasitol.* 2005; 59: 77-158.
19. McLauchlin J, Pedraza-Diaz S, Amar-Hoetzeneder C, Nichols GL. Genetic characterization of *Cryptosporidium* strains from 218 patients with diarrhea diagnosed as having sporadic cryptosporidiosis. *J Clin Microbiol.* 1999; 37(10): 3153-8.
20. Afshari Safavi E, Reza Mohammadi GH, Naghibi A, Rad M. Prevalence of *Cryptosporidium* spp. infection in some dairy Herds of Mashhad (Iran) and its association with diarrhea in newborn calves. *Comp Clin Pathol.* 2011; 20: 103-107.
21. Kostrzynska M, Sankey M, Haack E, Power C, Aldom GE, Chagla AH, Unger S, Palmateer G, Lee H, Trevors JT, De Grandis SA. Three sample preparation protocols for polymerase chain reaction based detection of *Cryptosporidium parvum* in environment samples. *J Microbiol Methods.* 1999; 35(1): 65-71.
22. Van Soolingen D, de Haas PE, Hermans PW, Van Embden JD. DNA fingerprinting of *Mycobacterium tuberculosis*. *Methods Enzymol.* 1994; 235: 196-205.
23. Xiao L, Bern C, Limor J, Sulaiman I, Roberts J, Checkley W, Cabrera L, Gilman RH, Lal AA. Identification of 5 types of *Cryptosporidium* parasites in children in Lima, Peru. *J Infect Dis.* 2001; 183(3): 492-7.
24. Xiao L, Sulaiman IM, Ryan UM, Zhou L, Atwill ER, Tischler ML, et al. Host adaptation and host-parasite co-evolution in *Cryptosporidium*: implications for taxonomy and public health. *Int J Parasitol.* 2002; 32(14): 1773-85.
25. Fredrich, MA, Brent R, Kingstone RE, Moore DD, Seidman JG, Smith JA, Struhl K. *Short Protocols in Molecular Biology.* 5th ed. John Wiley and Sons; 2002. p.1504
26. Zali MR, Mehr AJ, Rezaian M, Meamar AR, Vaziri S, Mohraz M. Prevalence of intestinal parasitic pathogens among HIV-Positive Individuals in Iran. *JPh J Infect Dis.* 2004; 57(6):268-270.
27. Taghipour N, Nazemalhosseini- Mojarad E, Haghghi A, Rostami- Nejad M, Romani S, Keshavarz A, Alebouyeh M, Zali M. Molecular Epidemiology of Cryptosporidiosis in Iranian Children, Tehran, Iran. *Iran J Parasitol.* 2011; 6(4):41-45.
28. Guyot K, Follet-Dumoulin A, Lelievre E, Sarfati C, Rabodonirina M, Nevez G, Cailliez JC, Camus D, Dei-Cas E. Molecular characterization of *Cryptosporidium* isolates obtained from humans in France. *J Clin Microbiol.* 2001; 39(10): 3472-3480.
29. Wielinga PR, de Vries A, van der Goot TH, Mank T, Mars MH, Kortbeek LM, van der Giessen JW. Molecular epidemiology of *Cryptosporidium* in humans and cattle in The Netherlands. *Int J Parasitol.* 2008; 38(7): 809– 817.

30. Shahbazi A, Gholami Sh, Mirsamadi N, Nokhahi I, Ghazanchaii A, Kumar D, Wannigama L, Izadi S. Detection of *Cyclospora*, *Microsporidia* and *Cryptosporidium* by direct microscopy and PCR in stools specimens in Northwest, Iran. *Res. Opin. Anim. Vet. Sci.* 2012; 2(5): 352-359.
31. Nouri M, Mahdavi Rad S. Effect of nomadic shepherds and their sheep on the incidence of cryptosporidiosis in an adjacent town. *J Infect.* 1993; 26(1):105-6.
32. Fasihi Harandi M, Fotouhi Ardakani R. Cryptosporidium infection of farm animals: first identification of *Cryptosporidium andersoni* and *Cryptosporidium parvum* in Iran. 11th International Congress of Parasitology: Glasgow, Scotland; 2006.p. 6-11.
33. Meamar AR, Guyot K, Certad G, Dei-Cas E, Mohraz M, Mohebal M, Mohammad K, Mehboob AA, Rezaie S and Rezaian M. Molecular characterization of *Cryptosporidium* isolates from humans and animals in Iran. *Appl Environ Microbiol.* 2007; 73(3): 1033-1035.
34. Daryani A, Sharif M, Meigouni M, Mahmoudi FB, Rafiei A, Gholami Sh, Khalilian A, Gohardehi Sh, Mirabi AM. Prevalence of intestinal parasites and profile of CD4+ counts in HIV+/AIDS people in north of Iran, 2007-2008. *Pak J Biol Sci.* 2009; 12(18):1277-81.
35. Sharif M, Daryani A, Asgarian F, Nasrolahei M. Intestinal parasitic infections among intellectual disability children in rehabilitation centers of northern Iran. *Res Dev Disabil.* 2010; 31(4):924-8.
36. Moghaddam AA. Symptomatic and Asymptomatic Cryptosporidiosis in Young Children in Iran. *Pak J Biol Sci.* 2007; 10(7):1108-1112.
37. Idris NS, Dwipoerwantoro PG, Kurniawan A, Said M. Intestinal parasitic infection of immunocompromised children with diarrhea: clinical profile and therapeutic response. *J Infect Dev Ctries.* 2010;4(5):309-17.
38. Al-Megrin WAI. Intestinal Parasites among Immunocompromised Patients in Riyadh, Saudi Arabia. *Pak J Biol Sci.* 2010; 13(8):390-394.