Journal de Mycologie Médicale 29 (2019) 75–79

Available online at ScienceDirect www.sciencedirect.com

Elsevier Masson France EM|consulte www.em-consulte.com

Case report

An unusual case of gastrointestinal basidiobolomycosis mimicking colon cancer; literature and review

R. Mohammadi [a], M. Ansari Chaharsoghi [c], F. Khorvash [d], B. Kaleidari [e], M.H. Sanei [f], F. Ahangarkani [b], Z. Abtahian [g], J.F. Meis [h,i], H. Badali [j,*]

[a] Infectious Diseases and Tropical Medicine Research Center, Department of Medical Parasitology and Mycology, School of Medicine Isfahan University of Medical Sciences, Isfahan, Iran
[b] Student Research Committee, Invasive Fungi Research Center, Mazandaran University of Medical Sciences, Sari, Iran
[c] Department of Infectious Diseases, Isfahan University of Medical Sciences, Isfahan, Iran
[d] Nosocomial Infection Research Center, Isfahan University of Medical Sciences, Isfahan, Iran
[e] Department of Surgery, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran
[f] Department of Pathology, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran
[g] Infectious Diseases and Tropical Medicine Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[h] Department of Medical Microbiology and Infectious Diseases, Canisius-Wilhelmina Hospital, Nijmegen, The Netherlands
[i] Centre of Expertise in Mycology Radboudumc/CWZ, Nijmegen, The Netherlands
[j] Department of Medical Mycology/Invasive Fungi Research Center, School of Medicine, Mazandaran University of Medical Sciences, Sari, Iran

ARTICLE INFO

Article history:
Received 15 September 2018
Received in revised form 14 November 2018
Accepted 30 November 2018
Available online 13 December 2018

Keywords:
Gastrointestinal basidiobolomycosis
Liposomal amphotericin B
Iran

ABSTRACT

Gastrointestinal basidiobolomycosis (GIB), a rare fungal infection associated with high mortality, has been reported worldwide mainly from tropical and subtropical regions of Asia, USA, and Latin America. The clinical manifestations are highly diverse and non-specific depending on the underlying disease, but fever, abdominal pain, weight loss, diarrhea, constipation and chills have been observed. There are no prominent risk factors for GIB but climatic conditions and life style are related to this infection in arid and semi-arid regions. Therefore timely diagnosis and early treatment is a challenge. Herein, we present an unusual case of gastrointestinal basidiobolomycosis in a 54-year-old male, initially misdiagnosed as colon cancer. After follow-up, no evidence of relapse and the patient was successfully cured by liposomal amphotericin B. In addition, the differential diagnosis and histopathological findings are discussed with a review of the literature.

1. Introduction

Basidiobolus, a member of the order basidiobolales in the family of basidiobolaceae, is encountered in human disease with infections ranging from mild sub-cutaneous lesions involving the buttocks, trunk, and limbs to systemic infections with gastrointestinal involvement [1]. *Basidiobolus ranarum* is found in dead plant material, rotten wood, soil, faeces of reptiles, insectivorous fish, and amphibians, mainly limited to tropical regions (Asia, Africa, and South America) [2–4]. The infection was first reported by Joe et al. [5] in Indonesia followed by cases from different parts of the world [6–8]. Although basidiobolomycosis mainly presents as subcutaneous lesions, gastrointestinal basidiobolomycosis (GIB) has been reported due to ingestion of soil, animal feces, and food [9–11]. The clinical manifestations are diverse and nonspecific depending on the underlying disease, but fever, abdominal pain, weight loss, diarrhea, constipation and chills are hallmarks [10,11]. Most of the GIB cases have been misdiagnosed as inflammatory bowel disease, intestinal tuberculosis, sarcoidosis, amebiasis, malignancy or Crohn's disease [11]. GIB is well known in the Middle East, i.e., Saudi Arabia, Kuwait, Iraq and Iran [11–14]. GIB is an emerging fungal infection with around more than 100 cases reported worldwide, may lead to diagnostic confusion, and patient morbidity and mortality. Herein, we present an Iranian case of gastrointestinal basidiobolomycosis in a 54-year-old male that was initially misdiagnosed as an abdominal malignancy.

2. Case report

A 54-year-old male was admitted to a regional hospital in Kazerun, Fars Province, Iran, complaining of a painless abdominal

* Corresponding author.
E-mail address: badalii@yahoo.com (H. Badali).

https://doi.org/10.1016/j.mycmed.2018.11.004
1156-5233/

mass in the right lower quadrant (RLQ). The patient had no fever, chills, pain, or gastrointestinal symptoms. He was not taking medication and he did not have any history of trauma. He was addicted to opium and cigarette abuse and experienced weight loss (4–5 kg) in a two-month-period. Initially, the abdominal mass was surgically resected elsewhere and after 10 days, the mass reappeared. After one week, he was transferred to the tertiary care Al-Zahra hospital in Isfahan, Iran. Peripheral blood counts and red blood cell indices indicated mild anemia, anisocytosis, leukocytosis ($16 \times 10^3/mm^3$; neutrophils: 60% and eosinophils: 15%), and thrombocytosis ($475 \times 10^3/mm^3$). Erythrocyte sedimentation rate (ESR) in the first 1 hr was 50 mm. An abdominal CT scan with contrast showed a soft tissue lesion of $58 \times 59 \times 21$ mm in the RLQ extending into the anterior wall of the caecum and abdominal wall muscles. The differential diagnosis included fungal infection or a malignant process (Fig. 1A-B). The retroperitoneal mass, two iliac lymph nodes, and a piece of small intestine were resected (Fig. 1C). The histopathologic findings showed granulation tissue with mixed inflammatory cells including giant cells (Fig. 2A), deep vein thrombosis (DVT) (Fig. 2B) and broad, non-septated, hyphae-like structures surrounded by an eosinophilic sheath, the so-called Splendore–Hoeppli phenomenon (Fig. 2A-B). The tissue samples were inoculated onto Sabouraud's dextrose agar (SDA; Difco), and SDA supplemented with chloramphenicol (50 μg/ml) and incubated at both 25 °C and 30 °C in the dark, but culture was negative. Ribbon-like aseptated hyphae were seen in direct microscopy (Fig. 1D). Immunohistochemical investigations were negative for CK, CD3, and CD20 markers suggesting no evidence of a malignant process. Postoperatively, the tentative diagnosis of *Basidiobolus* species was made and the patient was treated with liposomal amphotericin B (AmBisome) (5 mg/kg/day) for 55 days, and finally the patient was discharged with a regimen of posaconazole oral solution (10 ml/12 h) for two months. He was discharged and after a follow up of 3 months, the patient was cured without evidence of relapse. Publication of this case was approved by the ethics committee of Isfahan University of Medical Science and written informed consent was obtained from the patient.

3. Discussion

Previously *Basidiobolus* was classified as *B. ranarum, B. haptosporus*, and *B. meristosporus*, however recent taxonomic classifications based on isoenzyme banding, antigenic analysis, and analysis of rDNA reveal that all human pathogens belong to *B. ranarum* [15–18]. *B. ranarum* is a saprophyte in dead plant material, vegetations and soil, and is also isolated from several species of reptiles and amphibians [2,18]. The review process involved study of existing English literature of all reported cases with gastrointestinal basidiobolomycosis using Medline database through PubMed, Embase through Scopus, ISI Web of Science, Science Direct and Google Scholar between 1997 and 2018. Although GIB is a rare infection, more than 100 cases of GIB due *Basidiobolus* species have been reported in the English language literature, i.e., Asia [3,15,19], USA [20], and Latin America [21]. So far, the majority of cases have been reported from the Middle East. Interestingly, Saudi Arabia ($n = 62$) and Iran ($n = 24$) had the majority of cases (Fig. 3) followed by USA ($n = 21$) and Iraq ($n = 6$) [11,14,19,22–64]. Although, the risk factors of GIB are poorly understood, climatic conditions and life style are related to this infection in arid and semi-arid regions. Most of the cases in the USA were reported from Arizona, a state with a hot and dry climate similar to the Middle Eastern climate. Therefore, understanding of factors that contribute to disease in various local climatic conditions may aid in identifying sources of infection and epidemiology [20,61].

In contrast to the present case, infections often occur in children with most cases of the disease reported in male children. The latter may be due to habits like lying on the ground, playing with

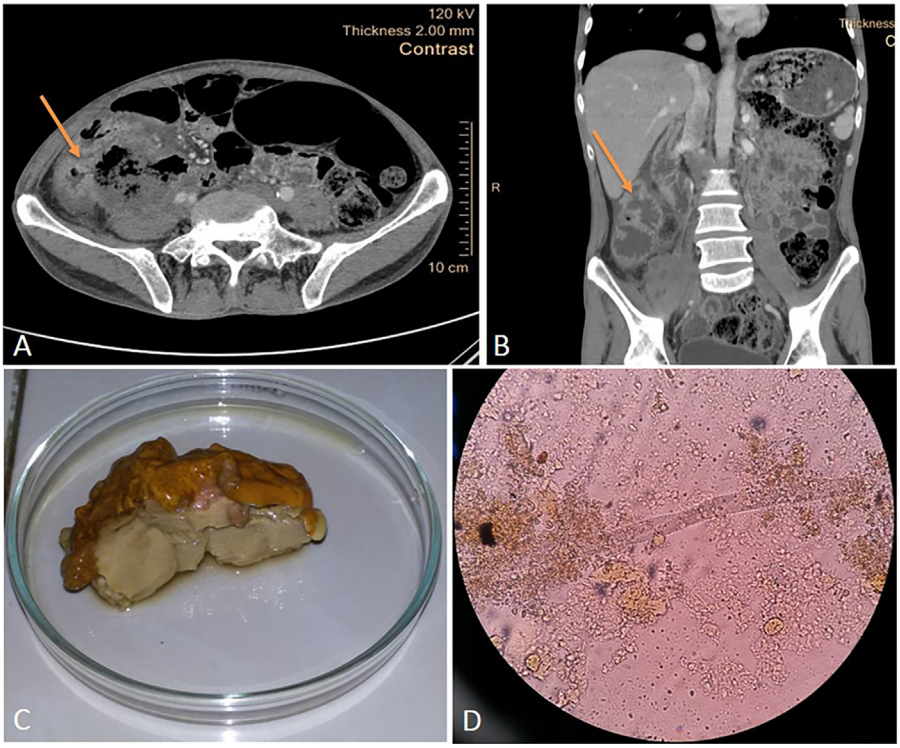

Fig. 1. A-B. Abdominopelvic C.T scan with contrast showed (arrow) a soft tissue lesion of $58 \times 59 \times 21$ mm in the right lower quadrant (RLQ) with extension into the anterior wall of the cecum and Rt abdominal wall muscle. C. Segments of the intestine showing diffuse thickening of the wall. D. Direct microscopic examination showing aseptated hyphae.

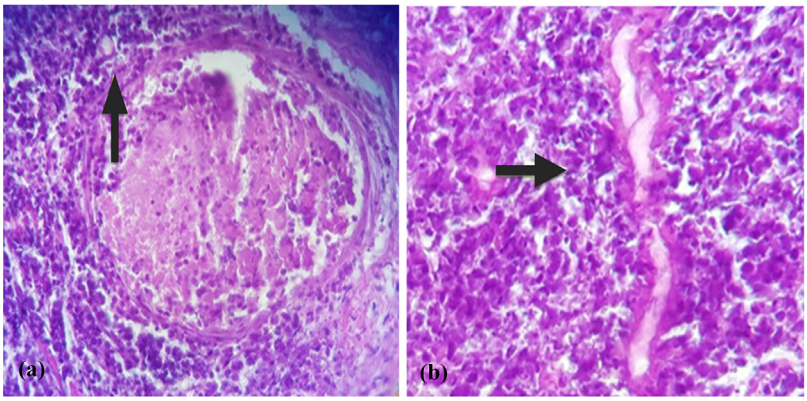

Fig. 2. A-B. The pathologic findings revealed granulation tissue with mixed inflammatory cells including giant cells, deep venous thrombosis and broad, non-septated, hyphae-like structures surrounded by an eosinophilic sheath, the so-called Splendore–Hoeppli phenomenon (Periodic acid–Schiff × 400).

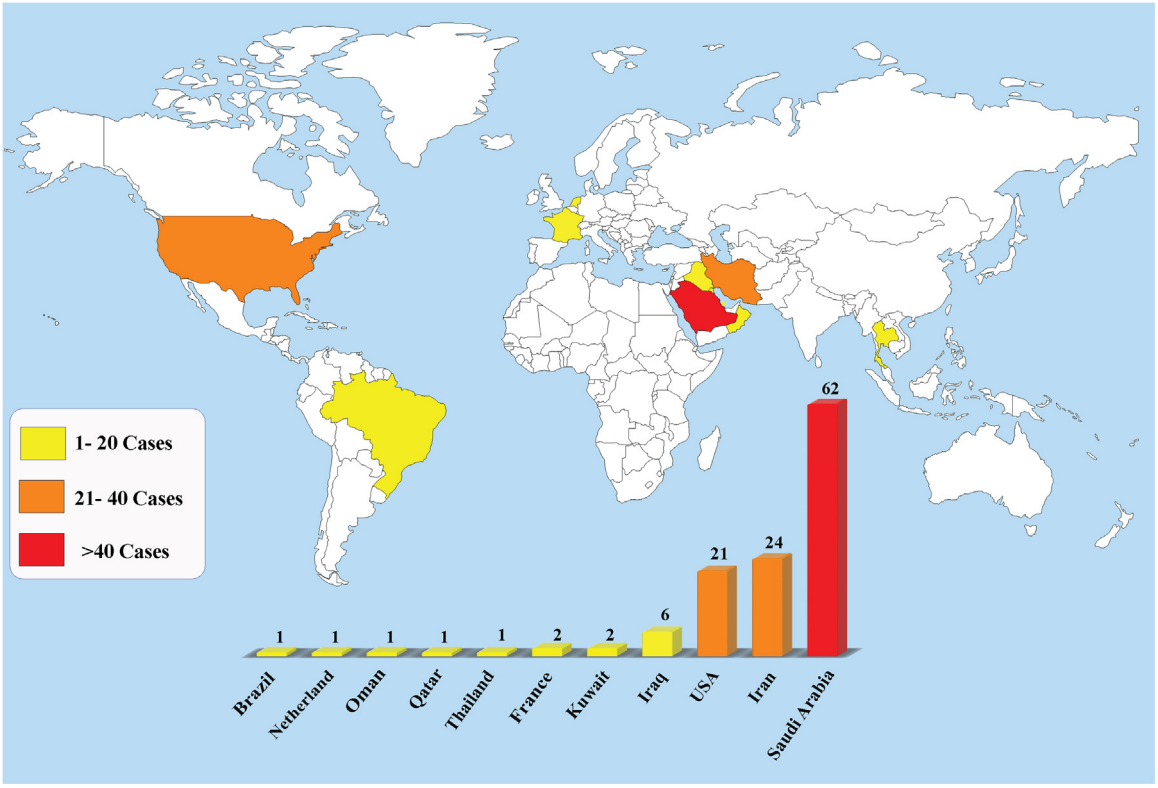

Fig. 3. Distribution and number of reported cases of gastrointestinal basidiobolomycosis due to *Basidiobolus* species in the world.

decaying plants, and the use of leaves as toilet papers [62]. The occupation of the current case was food provider for livestock and he handled large amounts of dried grass daily. In addition there appears to be a relation between GIB, smoking and ranitidine consumption [20]. Remarkably, ranitidine may contribute to GIB by lowering stomach acidity and allowing the fungus to survive [20,63]. Smoking unfavorably influences mucosal WBC function [14]. Our patient was addicted to opium use and cigarette smoking. Several studies reported that cases of GIB were initially diagnosed as inflammatory disease, suggesting that GIB should be kept in the differential diagnosis of inflammatory bowel diseases of the GI tract [3,17,22,23]. Although it is supposed that traumatic implantation with contaminated vegetable matter plays an important role in initiating the infection, fungal spores can also be transmitted by insect bites in sub-cutaneous basidiobolomycosis [17].

Microbiologic cultivation of the fungus is the gold standard for diagnosis; however most reported cases are diagnosed based on histopathology of the removed tissues showing the Splendore–Hoeppli phenomenon. This phenomenon refers to radiating or annular amorphous eosinophilic deposits of host-derived materials and possibly of fungal antigens. The Splendore-Hoeppli phenomenon has also been reported in association with cases of botryomycosis, actinomycosis, aspergillosis, and sporotrichosis [3]. Abdominal masses associated with colon or liver and focal bowel wall thickening are most commonly reported abdominal imaging findings in GIB worldwide. Most reports confuse GIB with inflammatory bowel disease or malignancy. [65].

Although, molecular approaches, i.e., sequencing of ITS rDNA and 18S small-subunit rDNA are powerful tools to identify entomophthoralean fungi in infected tissues of putative cases of conidiobolomycosis or basidiobolomycosis, confirmation relies currently on histological examination and cultural methods (considered as the "gold-standard"). El-Shabrawi et al. used taxon-specific primer pairs Ba1-Ba2, specific for the genus *Basidiobolus*. In addition, Rose et al. amplified and sequenced the ITS-4 region of the ribosomal RNA gene of *B. ranarum* in infected tissues of their patients. Therefore, molecular approaches along with histopathology features of infected tissue may be useful to diagnose patients in endemic areas [4,17,23,66].

Geramizadeh et al. [19] reported 14 cases of GIB in Iran over a period of 10 years and all were diagnosed by histopathology (Splendore-Hoeppli phenomenon) similar to our case and most of the previous reports in the world. Neutrophilic infiltration is a rare phenomenon but eosinophilic inflammation assists in the differentiation between basidiobolomycosis and mucormycosis, the latter being generally characterized by vascular invasion with thrombosis and neutrophilic infiltration.

The optimal choice of antifungal agent for this uncommon fungal infection is not clear, but resection of the affected bowel, followed by prolonged systemic antifungal therapy, i.e., amphotericin B, itraconazole and voriconazole were successfully in many reports [22,23,41].

4. Summary

There are no prominent risk factors for GIB although climatic conditions and life style are related to this infection in arid and semi arid regions. Interestingly, most of the previous Iranian case reports of GIB came from the South, which has a warm and humid climate. This suggests that weather conditions may influence infection rates. GIB has also been commonly reported in the Middle Eastespecially in Saudi Arabia, which has similar climate conditions as found in Southern Iran. Understanding the factors that contribute to disease in various local climatic conditions may aid in identifying sources of infection and epidemiology. We highlight the importance of consciousness and early recognition of a rare fungal infection to prevent unnecessary surgical intervention, chemotherapy, and probably less morbidity.

Disclosure of interest

The authors declare that they have no competing interest.

Acknowledgements

The work of Hamid Badali was financially supported by Mazandaran University of Medical Sciences, School of Medicine, Sari, Iran. The authors thank the staff of Alzahra Hospital, Isfahan, Iran, for their cooperation, and are indebted to Javad Javidnia for technical assistance.

References

[1] Humber RA. Entomophthoromycota: a new phylum and reclassification for entomophthoroid fungi. Mycotaxon 2012;120:477–92.
[2] Shaikh N, Hussain K, Petraitiene R, Schuetz A, Walsh T. Entomophthoramycosis: a neglected tropical mycosis. Med Mycol Case Rep 2016;22:688–94.
[3] Nemenqani D, Yaqoob N, Khoja H, Al Saif O, Amra NK, Amr SS. Gastrointestinal basidiobolomycosis: an unusual fungal infection mimicking colon cancer. Arch Pathol Lab Med 2009;133:1938–42.
[4] Claussen M, Schmidt S. First time isolation and quantification of Basidiobolus spp. from reptile faeces in KwaZulu-Natal (South Africa) using selective media. Mycoses 2018. http://dx.doi.org/10.1111/myc.12868.
[5] Joe LK, Eng N-IT, Pohan A, Van der Meulen H, Emmons CW. Basidiobolus ranarum as a cause of subcutaneous mycosis in Indonesia. AMA Arch Derm 1956;74:378–83.
[6] Kelly S, Gill N, Hutt M. Subcutaneous phycomycosis in Sierra Leone. Trans R Soc Trop Med Hyg 1980;74:396–7.
[7] Bittencourt AL, Londero AT, Araujo MdGS, Mendonca N, Bastos JLA. Occurrence of subcutaneous zygomycosis caused by Basidiobolus haptosporus in Brazil. Mycopathologia 1979;68:101–4.
[8] Burkitt DP, Wilson A, Jelliffe D. Subcutaneous phycomycosis: a review of 31 cases seen in Uganda. BMJ 1964;1:1669.
[9] Thotan SP, Kumar V, Gupta A, Mallya A, Rao S. Subcutaneous phycomycosis — fungal infection mimicking a soft tissue tumor: a case report and review of literature. J Trop Pediatr 2010;56:65–6.
[10] Kumaravel S, Bharath K, Rajesh NG, Singh R, Kar R. Delay and misdiagnosis of basidiobolomycosis in tropical South India: case series and review of the literature. Paediatr Int Child Health 2016;36:52–7.
[11] Almoosa Z, Alsuhaibani M, AlDandan S, Alshahrani D. Pediatric gastrointestinal basidiobolomycosis mimicking malignancy. Med Mycol Case Rep 2017;18:31–3.
[12] Elzein F, Mursi M, Albarrag AM, Alfiaar A, Alzahrani A. Disseminated angioinvasive basidiobolomycosis with a favourable outcome. Med Mycol Case Rep 2018;22:30–4.
[13] Khan ZU, Khoursheed M, Makar R, Al-Waheeb S, Al-Bader I, Al-Muzaini A, et al. Basidiobolus ranarum as an etiologic agent of gastrointestinal zygomycosis. J Clin Microbiol 2001;39:2360–3.
[14] Geramizadeh B, Heidari M, Shekarkhar G. Gastrointestinal basidiobolomycosis, a rare and under-diagnosed fungal infection in immunocompetent hosts: a review article. Iran J Med Sci 2015;40:90–7.
[15] Anand M, Deshmukh SD, Pande DP, Naik S, Ghadage DP. Subcutaneous zygomycosis due to Basidiobolus ranarum: a case report from Maharastra, India. J Trop Med 2010;2010:950390.
[16] Singh R, Xess I, Ramavat A, Arora R. Basidiobolomycosis: a rare case report. Indian J Med Microbiol 2008;26:265.
[17] El-Shabrawi MH, Kamal NM, Jouini R, Al-Harbi A, Voigt K, Al-Malki T. Gastrointestinal basidiobolomycosis: an emerging fungal infection causing bowel perforation in a child. J Med Microbiol 2011;60:1395–402.
[18] El-Shabrawi MH, Arnaout H, Madkour L, Kamal NM, Entomophthoromycosis:. a challenging emerging disease. Mycoses 2014;57:132–7.
[19] Geramizadeh B, Foroughi R, Keshtkar-Jahromi M, Malek-Hosseini S-A, Alborzi A. Gastrointestinal basidiobolomycosis, an emerging infection in the immunocompetent host: a report of 14 patients. J Med Microbiol 2012;61:1770–2174.
[20] Lyon GM, Smilack JD, Komatsu KK, Pasha TM, Leighton JA, Guarner J, et al. Gastrointestinal basidiobolomycosis in Arizona: clinical and epidemiological characteristics and review of the literature. Clin Infect Dis 2001;32:1448–55.
[21] Bittencourt AL, Londero AT, Araujo MDGS, Mendonça N, Bastos JLA. Occurrence of subcutaneous zygomycosis caused by Basidiobolus haptosporus in Brazil. Mycopathologia 1979;68:101–4.
[22] Zavasky D-M, Samowitz W, Loftus T, Segal H, Carroll K. Gastrointestinal zygomycotic infection caused by Basidiobolus ranarum: case report and review. Clin Infect Dis 1999;28:1244–8.
[23] Rose SR, Lindsley MD, Hurst SF, Paddock CD, Damodaran T, Bennett J. Gastrointestinal basidiobolomycosis treated with posaconazole. Med Mycol Case Rep 2013;2:11–4.
[24] Saeed MA, Al Khuwaitir TS, Attia TH. Gastrointestinal basidiobolomycosis with hepatic dissemination: a case report. JMM Case Rep 2014;1:e003269.
[25] Al-Naemi AQ, Khan LA, Al-Naemi I, Amin K, Athlawy YA, Awad A, et al. A case report of gastrointestinal basidiobolomycosis treated with voriconazole: a rare emerging entity. Medicine 2015;94:e1430.
[26] Al-Shahrani M, Al-Qahtani AM. Disseminated gastrointestinal basidiobolomycosis: case report. International Journal of Green Pharmacy 2017;11:919–22.
[27] Abbas G, AL-Wabari A, Tawfeeq M, Alhori O, Alqahtani H. Intestinal basidiobolomycosis "to operate or NOT to operate". Curr Pediatr Res 2017;21:582–5.
[28] Albaradi BA, Babiker AM, Al-Qahtani HS. Successful treatment of gastrointestinal basidiobolomycosis with voriconazole without surgical intervention. J Trop Pediatr 2014;60:476–9.
[29] Al Asmi MM, Faqeehi HY, Alshahrani DA, Al-Hussaini AA. A case of pediatric gastrointestinal basidiobolomycosis mimicking Crohn's disease. A review of pediatric literature. Saudi Med J 2013;34:1068–72.
[30] Alshehri AH, Alshehri A, Bawahab MA, Al-Humayed S, Nabrawi K, Alamri FS, et al. Basidiobolomycosis: an emerging fungal infection of the gastrointestinal tract in adults. Am J Infect Dis 2013;9:1–6.
[31] Al-Qahtani SM, Alsuheel AM, Shati AA, Mirza NI, Al-Qahtani AA, Al-Hanshani AA, et al. Gastrointestinal basidiobolomycosis in children. Curr Pediatr Res 2013;17:1–6.
[32] Saadah OI, Farouq MF, Daajani NA, Kamal JS, Ghanem AT. Gastrointestinal basidiobolomycosis in a child; an unusual fungal infection mimicking fistulising Crohn's disease. J Crohns Colitis 2012;6:368–72.
[33] Al Jarie A, Al Azraki T, Al Mohsen I, Al Jumaah S, Almutawa A, Fahim YM, et al. Basidiobolomycosis: case series. J Mycol Med 2011;21:37–45.
[34] Al Jarie A, Al-Mohsen I, Al Jumaah S, Al Hazmi M, Al Zamil F, Al Zahrani M, et al. Pediatric gastrointestinal basidiobolomycosis. Pediatr Infect Dis J 2003;22:1007–14.
[35] Shreef K, Saleem M, Saeedd MA, Eissa M. Gastrointestinal basidiobolomycosis: an emerging, and a confusing, disease in children (a multicenter experience). Eur J Pediatr Surg 2018;28:194–9.

[36] Alahmadi R, Sayadi H, Badreddine S, Linjawi A. Gastrointestinal basidiobolomycosis, the experience of a tertiary care hospital in the western region of Saudi Arabia and a report of four new cases. Life Sci J 2014;11:344–52.
[37] AlSaleem K, Al-Mehaidib A, Banemai M, bin-Hussain I, Faqih M, Al Mehmadi A. Gastrointestinal basidiobolomycosis: mimicking Crohns disease case report and review of the literature. Ann Saudi Med 2013;33:500–4.
[38] Al-Shanafey S, AlRobean F, Bin Hussain I. Surgical management of gastrointestinal basidiobolomycosis in pediatric patients. J Pediatr Surg 2012;47:949–51.
[39] Hussein MR, Musalam AO, Assiry MH, Eid RA, El Motawa AM, Gamel AM. Histological and ultrastructural features of gastrointestinal basidiobolomycosis. Mycol Res 2007;111:926–30.
[40] Al-Juaid A, Al-Rezqi A, Almansouri W, Maghrabi H, Satti M. Pediatric gastrointestinal basidiobolomycosis: case report and review of literature. SJMMS 2017;5:167–71.
[41] Zekavat OR, Abdolkarimi B, Pouladfar G, Fathpour G, Mokhtari M, Shakibazad N. Colonic basidiobolomycosis with liver involvement masquerading as gastrointestinal lymphoma: a case report and literature review. Rev Soc Bras Med Trop 2017;50:712–4.
[42] Ejtehadi F, Anushiravani A, Bananzadeh A, Geramizadeh B. Gastrointestinal basidiobolomycosis accompanied by liver involvement: a case report. Iran Red Crescent Med J 2014;16:e14109.
[43] Zabolinejad N, Naseri A, Davoudi Y, Joudi M, Aelami MH. Colonic basidiobolomycosis in a child: report of a culture-proven case. IJID 2014;22:41–3.
[44] Arjmand R, Karimi A, Dashti AS, Kadivar M. A child with intestinal basidiobolomycosis. Iran J Med Sci 2012;37:134.
[45] Fahimzad A, Karimi A, Tabatabaei SR, Zadeh MG. Gastrointestinal basidiobolomycosis as a rare etiology of bowel obstruction. Turk J Med Sci 2006;36:239–41.
[46] Eraghi MG, Toutkaboni MP, Farzanegan B, Marjani M, Hashemian SM, Tabarsi P. Antifungal resistant gastrointestinal basidiobolomycosis without eosinophilia: a case report. Arch Clin Infect Dis 2017;12:e66110. http://dx.doi.org/10.5812/archcid.66110.
[47] Sanaei Dashti A, Nasimfar A, Hosseini Khorami H, Pouladfar G, Kadivar MR, Geramizadeh B, et al. Gastro-intestinal basidiobolomycosis in a 2-year-old boy: dramatic response to potassium iodide. Paediatr Int Child Health 2018;38:150–3.
[48] Sayadinia M, Atash Ab Parvar A, Nateghi B. Dramatic response of gastric outlet obstruction with ileoceccal involvement of basidiobolomycosis to amphotericin B: a case report. JRMDS 2018;6:25–8.
[49] Zahir ST, Sharahjin NS, Kargar S, Case Report:. Basidiobolomycosis a mysterious fungal infection mimic small intestinal and colonic tumour with renal insufficiency and ominous outcome. BMJ Case Rep 2013;2013. http://dx.doi.org/10.1136/bcr-2013-200244. pii: bcr2013200244.
[50] Al-Maani AS, Paul G, Jardani A, Nayar M, Al-Lawati F, Al-Baluishi S, et al. Gastrointestinal basidiobolomycosis: first case report from Oman and literature review. SQUMJ 2014;14:e241.
[51] Chiewchanvit S, Khamwan C, Pruksachatkunakorn C, Thamprasert K, Vanittanakom N, Mahanupab P, et al. Entomophthoromycosis in Maharaj Nakorn Chiang Mai Hospital. J Med Assoc Thai 2002;85:1089–94.
[52] van den Berk GE, Noorduyn LA, van Ketel RJ, van Leeuwen J, Bemelman WA, Prins JM. A fatal pseudo-tumour: disseminated basidiobolomycosis. BMC Infec Dis 2006;6:140.
[53] Mandhan P, Hassan KO, Samaan SM, Ali MJ. Visceral basidiobolomycosis: an overlooked infection in immunocompetent children. Afr J Paediatr Surg 2015;12:193.
[54] Hassan HA, Majid RA, Rashid NG, Nuradeen BE, Abdulkarim QH, Hawramy TA, et al. Eosinophilic granulomatous gastrointestinal and hepatic abscesses attributable to basidiobolomycosis and fasciolias: a simultaneous emergence in Iraqi Kurdistan. BMC Infect Dis 2013;13:91.
[55] Cazorla A, Grenouillet F, Piton G, Faure É, Delabrousse É, Mathieu P. A letal case of gastro-intestinal basidiobolomycosis. Ann Pathol 2014;34:228–32.
[56] Pasha TM, Leighton JA, Smilack JD, Heppell J, Colby TV, Kaufman L. Basidiobolomycosis: an unusual fungal infection mimicking inflammatory bowel disease. Gastroenterology 1997;112:250–4.
[57] Pandit V, Rhee P, Aziz H, Jehangir Q, Friese RS, Joseph B. Perforated appendicitis with gastrointestinal Basidiobolomycosis: a rare finding. Surg infect 2014;15:339–42.
[58] Yousef OM, Smilack JD, Kerr DM, Ramsey R, Rosati L, Colby TV. Gastrointestinal basidiobolomycosis: morphologic findings in a cluster of six cases. Am J Clin Pathol 1999;112:610–6.
[59] Nguyen BD. CT features of basidiobolomycosis with gastrointestinal and urinary involvement. AJR Am J Roentgenol 2000;174:878–9.
[60] Vikram HR, Smilack JD, Leighton JA, Crowell MD, De Petris G. Emergence of gastrointestinal basidiobolomycosis in the United States, with a review of worldwide cases. Clin infect dis 2012;54:1685–91.
[61] Centers for Disease Control and Prevention (CDC). Gastrointestinal basidiobolomycosis-Arizona, 1994–1999. MMWR Morb Mortal Wkly Rep 1999;48:710–3.
[62] Gugnani H. A review of zygomycosis due to Basidiobolus ranarum. Eur J Epidemiol 1999;15:923–9.
[63] Neal KR, Briji SO, Slack RC, Hawkey CJ, Logan RF. Recent treatment with H2 antagonists and antibiotics and gastric surgery as risk factors for Salmonella infection. BMJ 1994;308:176.
[64] Sitterlé E, Rodriguez C, Mounier R, Calderaro J, Foulet F, Develoux M, et al. Contribution of ultra deep sequencing in the clinical diagnosis of a new fungal pathogen species: basidiobolus meristosporus. Front Microbiol 2017;8:334.
[65] Flicek KT, Vikram HR, De Petris GD, Johnson CD. Abdominal imaging findings in gastrointestinal basidiobolomycosis. Abdom Imaging 2015;40:246–50.
[66] Vilela R, Mendoza L. Human Pathogenic Entomophthorales. Arch Clin Infect Dis 2017;12:e66110. http://dx.doi.org/10.5812/archcid.66110.