

Gastrointestinal Basidiobolomycosis, the experience of a tertiary care hospital in the western region of Saudi Arabia and a report of four new cases

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Abstract: Background: Basidiobolomycosis is a rare disease that is caused by the fungus *Basidiobolus ranarum* (*B. ranarum*). Gastrointestinal Basidiobolomycosis (GIB) is very rare and, not uncommonly, overlooked or misdiagnosed as other lesions with inevitable adverse consequences to the patient. The aim of this study is to review the clinicopathological pattern of GIB in a tertiary medical centre in the western region of Saudi Arabia and compare our findings with previously reported cases in an attempt to increase awareness of this entity. **Methods:** We retrospectively analyzed the pathological and clinical data of patients diagnosed with GIB in King Faisal specialist hospital and research center, Jeddah (KFSHRCJ) during a period from January 2001 to June 2012. **Results:** Four cases were identified. The age range was 20-63 years. There were 2 males and 2 females patients. Three patients presented with abdominal pain and one presented with bleeding per rectum. All the patients were found to have abdominal masses on radiological investigation and had significant peripheral blood eosinophilia. All the lesions showed similar histological features that included acute and chronic granulomatous inflammation with a large number of eosinophils associated with the presence of the characteristic fungal hyphae. Three of the patients were treated with antifungal therapy in addition to surgery and showed excellent response. **Conclusion:** The presence of intra-abdominal mass lesions accompanied by peripheral blood eosinophilia in an immune-competent patient should raise the suspicion of this infection clinically. The presence of granulomata, necrosis, and increased number of eosinophils in tissue sections should strongly raise the suspicion of this type of infection pathologically and every attempt should be made to identify the fungal hyphae microscopically. It is important for clinicians and pathologists to be aware with this entity to avoid misdiagnosis of this treatable disease.

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1. Introduction:

Basidiobolomycosis is a rare disease that is caused by the fungus *Basidiobolus ranarum* which is an environmental saprophyte that is found worldwide. It belongs to the order Entomophthorales of the class Zygomycetes (1). *B. ranarum* is mainly responsible for a form of tropical and subtropical subcutaneous zygomycosis. Although visceral involvement is very rare, more and more reports describing gastrointestinal Basidiobolomycosis (GIB) have emerged, particularly within the last decade. Many of the reported cases were in Saudi Arabia (only the United States has more reported cases). Therefore, this pathogen appears to be of particular significance in Saudi Arabia and similar subtropical regions in other parts of the world. Despite that, this type of infection may still go unrecognized or misdiagnosed with inevitable adverse consequences to the patient. Therefore, clinicians and pathologists alike should be very familiar with the clinical manifestations and pathological features so that the infection can be

recognized without delay and appropriate treatment initiated. We reviewed our records over a period from January 2001 till June 2012 at King Faisal Specialist Hospital and Research Center in Jeddah (KFSHRCJ), which is a tertiary care center, for cases of GIB. Four cases were identified over the above stated period and, in this article, we are reporting the findings of those cases with emphasis on the clinical presentation and histopathological features that are associated with this type of infection. None of these cases has been reported before.

2. Methods:

We retrospectively searched the records of the anatomic pathology and microbiology sections of the laboratory for cases of GIB diagnosed at KFSHRCJ during a period from January 2001 till June 2012 in order to analyze the pathological and clinical data of those patients. The study was in accordance with the Bioethical institutional review board

committee of King Faisal Specialist Hospital and Research Center and according to the ethical guidelines of the 1975 Declaration of Helsinki. Four cases were identified and the histopathological materials were retrieved from the archives of the Pathology Department and reexamined. Hematoxylin and eosin (H&E) stained slides together with periodic acid Schiff (PAS) and Gomori methenamine silver (GMS) stained slides were reviewed and clinical data collected.

3. Results:

Case 1:

A 43 years old male patient presented to another hospital in 2001 with three months history of on and off epigastric pain and weight loss. He had a history of peptic ulcer disease but was, otherwise, free of any other medical problems. Appendectomy was done for the suspicion of acute appendicitis and subsequently he developed a right lower quadrant mass. CT scan was done and showed a cecal mass. He underwent right hemicolectomy and the histopathology result of the mass was reported as acute and chronic inflammatory reaction, fungal in nature, involving the cecum and ascending colon. He was started on amphotericin B but didn't tolerate it and was transferred to (KFSHRCJ) for further management. On examination in our hospital, he was cachectic and pale but had stable vital signs. His abdomen was soft with mild tenderness in the right iliac fossa but no masses or organomegaly were detected. His laboratory investigations showed high CRP at 239 mg/L (ref. range 0-5 mg/L) and ESR was 139 mm/hr (ref. range 0-15 mm/hr) with leukocytosis at $15 \times 10^9/L$ (ref. range $3.9-11 \times 10^9/L$) with eosinophilia (eosinophils 27%). CT scan showed several hypoechoic masses in the liver ranging from 1.5- 6 cm. in maximum diameter. Liver biopsy was done and showed occasional granulomata and microabscesses with predominance of eosinophils, so one of the differential diagnoses was hypereosinophilic syndrome. However, culture results of the liver biopsy came back as positive for *Basidiobolus ranarum*. With this culture result, the pathology material of the hemicolectomy that was performed initially in the other hospital was reviewed. The microscopic sections showed, within the colonic wall and mesenteric fat, extensive granulomatous inflammation containing multinucleated giant cells in addition to eosinophil-rich microabscesses surrounding areas of necrosis (Figure 1). Many fungal hyphae were also seen within the granulomata and within the microabscesses. These hyphae were large, broad and irregular with sparse septa and thin walls. Some were surrounded by granular eosinophilic material (Splendore-Hoeppli phenomenon) while others were engulfed by

multinucleated giant cells. These fungal hyphae were also highlighted by (GMS) and (PAS) stains (Figure 2). All these features are very characteristic of *Basidiobolus* infection. Deeper sections of the liver biopsy were also re-examined and few fungal hyphae of similar morphology were seen after careful search (Figures 3). The patient was treated with Itraconazole (200mg BID) for 7 months. On follow up visits, his CBC showed resolution of the eosinophilia and CT scan of the abdomen showed resolution of the abdominal masses and liver lesions as well.

Case 2:

A 20 years old female patient presented to another local hospital in 2005 with an abdominal mass and abdominal pain. Surgery was performed in that hospital where she underwent appendectomy and mesenteric lymph node biopsy. The pathological diagnosis at the referring hospital was that of Langerhans cell histiocytosis. The pathology material, however, was sent later to our hospital for a second opinion. Upon reviewing the pathology material in our hospital, there were numerous granulomata with necrosis and extensive fibrosis in the wall of the appendix and all the submitted tissue. There was also mixed chronic and acute inflammation and numerous eosinophils with eosinophilic microabscesses. The granulomata contained many multinucleated giant cells. Fungal hyphae were seen within some of the multinucleated giant cells (Figure 4) and within necrotic material and eosinophilic microabscesses (Figure 5). These hyphae were broad, irregular with thin wall that had few septa and they were also highlighted by the (GMS) and (PAS) stains. Langerhans-type histiocytes were not seen. Therefore, our diagnosis at that time was necrotizing granulomatous inflammation with increased number of eosinophils and with the presence of fungal hyphae, possibly mucor or other type. Several weeks later, we learned that the patient passed away and that microbiology cultures at the referring hospital were positive for *B. ranarum*.

Case 3:

A 63 years old male patient, known to have diabetes mellitus and diverticular disease, underwent sigmoid resection in 2008 in another hospital. Seven months after this surgery, he started to have lower abdominal pain associated with loss of appetite in addition to change in bowel habits. He presented to (KFSHRCJ) surgery clinic with this abdominal pain for further evaluation and management. On examination he was dehydrated and emaciated but had stable vital signs. His abdomen was distended with mild tenderness on examination and positive bowel sounds. His laboratory investigations showed WBC at $12.4 \times 10^9/L$ with eosinophilia (eosinophils were 14% of WBC and absolute eosinophils count was 1.5

$\times 10^9/L$ (ref. range $0.03-1 \times 10^9$). CT scan showed significant dilatation of the large bowel loops, mainly transverse and descending colon with marked thickening of ascending colon as well as mid ileal loops. A soft tissue density mass was also noted in the presacral region abutting the rectum and associated with multiple enlarged para-aortic and mesenteric lymph nodes. Barium enema showed significant narrowing in the region of the sigmoid colon and at the site of the previous surgery. The transverse colon was significantly dilated with a large amount of air. The ascending colon showed marked narrowing with irregular thickening of its wall; mainly in the middle part that extended for approximately 11 cm. Colonoscopy was attempted twice. The first one couldn't be completed as the patient preparation was not adequate but no masses were visualized in the rectum and no stricture was seen at the anastomotic site. The left colon was found dilated up to splenic flexure. The second colonoscopy was completed up to the terminal ileum and it demonstrated normal appearing mucosa but with extrinsic compression of the right colon with doughnut-shaped mucosal area. Biopsy was taken from this area. There was also extrinsic diffuse compression at the level of rectosigmoid junction causing narrowing of the lumen. The biopsy showed chronic and acute inflammation and markedly increased number of eosinophils with a very rare multinucleated giant cell suggestive of an infectious process (parasitic, fungal or bacterial). Exploratory laparotomy was done later which revealed extensive adhesions in the abdomen and multiple masses in the walls of the cecum, transverse colon, descending colon and small bowel and in the surrounding tissue. A mesenteric lymph node was biopsied and sent for intraoperative consultation. A frozen section and cytological smear were performed and showed inflammation and microabscesses with increased number of eosinophils and many multinucleated giant cells with structures suspicious for fungal hyphae (Figure 6). Based on this, tissue was sent for mycology culture and the abdomen was closed without further resection. Postoperatively, the patient was seen by the infectious disease team and further laboratory tests showed eosinophilia of 23 % and elevated ESR at 44mm/hr. Histopathologic examination of the formalin-fixed tissue of the lymph node showed granulomatous inflammation with many multinucleated giant cells with microabscesses containing a large number of eosinophils with necrosis. The presence of several fungal hyphae was also confirmed. These were irregular and broad with thin wall and rare septa. Some were surrounded by eosinophilic granular material on hematoxylin and eosin stained sections (Splendore-Hoeppli phenomenon) (Figure 7) and some were noted within

multinucleated giant cells. These were highlighted by GMS and PAS stains. On the basis of these histological findings, a presumptive diagnosis of infection with *Basidiobolus* Spp. was made because of the very characteristic morphological features of the fungal hyphae and of the type and nature of the associated inflammatory infiltrate. Mycology cultures of the tissue that was sent at the time of intraoperative consultation, however, failed to grow any organisms. The patient was started on voriconazole 200mg bid. A repeat CT scan after 2 months showed interval improvement of the previously noted large bowel dilatation and wall thickening with resolution of the presacral soft tissue mass as well as of the small bowel thickening. CBC also showed resolution of the eosinophilia to 6.3%. Regular follow up of the patient continued every 3-4 months with CT scan and CBC and there was progressive improvement (Figures 8 and 9). The patient completed one year on voriconazole.

Case 4:

A 20 years old female patient presented to another hospital in February 2011 with a history of bleeding per rectum and perianal swelling for 3 months duration. Examination under anesthesia (EUA) revealed the presence of an external hemorrhoid at 2 o'clock position with multiple external tears at the anal verge and a big tear in the anal mucosa posteriorly above the anal verge surrounded by fibrosis and a mass causing stenosis in the anorectal area. An incisional biopsy was done and was reported to show heavy acute inflammatory infiltration but no malignancy. Colonoscopy was also performed in that hospital and showed stenotic areas at 10 cm. and at 30 cm. from the anal verge associated with ulcerated, fungating and necrotic lesions. There was also a tract connecting to a cavitory area parallel to the anal canal. Biopsies were taken from those lesions and were reported to show severe inflammatory changes with ulceration, cryptitis and increased number of eosinophils and, therefore, the pathological diagnosis was severe active colitis/proctitis. She was then referred to our hospital in March 2011 with the same complaints that included severe anal pain and bleeding per rectum in addition to on and off fever and constipation. Initial examination of the perianal area showed a fungating anal verge mass that was tender to touch with some purulent discharge. Laboratory results showed elevated WBC at $14 \times 10^9/L$ with eosinophilia (eosinophils 20%). The WBC went up to $31 \times 10^9/L$ during her initial hospitalization. She underwent EUA and sigmoidoscopy and this showed a large transmural defect of the anal canal at 5 o'clock that ended up with a blind end in the pelvis with puss collection that was surrounded by indurated mass involving the rectovaginal septum. However, 7 cm. from that area, the rectal mucosa appeared normal but inflammation

was noted again in the sigmoid colon. Colostomy was created at that time and a biopsy from the pelvic cavity and rectovaginal septum was obtained. It showed rectal mucosa with extensive ulceration and granulation tissue. In addition, there was fibromuscular tissue that contained heavy chronic and acute inflammatory infiltration with increased number of eosinophils and few granulomata. There were also fragments of necrotic tissue and acute inflammatory exudate that was rich in eosinophils. Ziehl Neelsen stain for acid-fast bacilli and (GMS) and (PAS) stains for fungal organisms were reported to be negative and the findings were, altogether, reported to be suggestive of Crohn's disease and clinical correlation was recommended. Further investigations in the form of abdominal and pelvic CT scan showed multiple perianal and perirectal abscesses of variable size causing significant narrowing of the distal rectum with the largest abscess on the left side measuring 5.7 cm. and extending caudally along the levator ani muscle (Figure 10). A week later, the patient was taken again to the OR for another EUA and for irrigation. At that time, examination revealed a firm mass outside the rectal wall on the left and anterior sides with evidence of complete tear of the anal sphincter. A week later, another CT scan showed interval progression in the size of the perianal and perirectal abscesses with the largest one measuring 8cm. that surrounded the rectum, vagina and urethra. At this time, CT-guided drainage of the abscesses was attempted but failed and a soft tissue mass encasing the rectum and extending into the ischiorectal fossa bilaterally was noted with involvement of the rectovaginal septum (Figure 11). Several days later, she was taken to the OR again and a transvaginal tru-cut biopsy of the mass was taken in an attempt to get into deeper tissue to rule out an underlying neoplastic process. The biopsy showed fibroadipose tissue with extensive chronic and acute inflammation and few eosinophilic microabscesses with necrosis and occasional granulomata. Fungal hyphae were seen within the eosinophilic microabscesses and granulomata and their presence was confirmed by the (GMS) and (PAS) stains. The hyphae were irregular and broad with thin wall and rare septa and some were surrounded by eosinophilic granular material on hematoxylin and eosin stained sections (Splendore-Hoeppli phenomenon). Based on these findings, the presumptive diagnosis of infection with *Basidiobolus* was made with the recommendation to take tissue, if possible, for fungal culture. The previous biopsy was reviewed again and very rare fungal organisms were detected after careful search. Tissue for fungal culture was obtained based on the recommendation but the culture results, however, were negative. She was seen by the infectious disease team and started on terbinafine 250mg PO QD and

voriconazole 20 mg PO Q12H. Over the follow up period, there was a gradual decrease in WBC and eosinophilic count with a return to normal levels during that time. The purulent pelvic discharge also gradually decreased. A follow up CT scan, 4 months after starting the treatment, showed significant interval regression of the masses and the abnormal collections. The last follow up CT scan in December 2011 showed total regression of the perirectal collections with slight regression in the size of the masses. She has completed a one year antifungal treatment with the plan to continue treatment for another year as recommended by the infectious disease team.

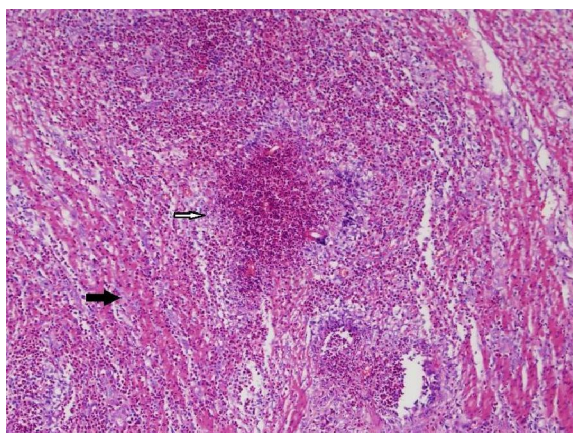


Figure 1: Dense inflammatory infiltration dissecting the muscle wall (black arrow) of the colon with a large number of eosinophils and an eosinophilic microabscess (white arrow) containing some fungal hyphae (Hematoxylin & Eosin, original magnification x100)

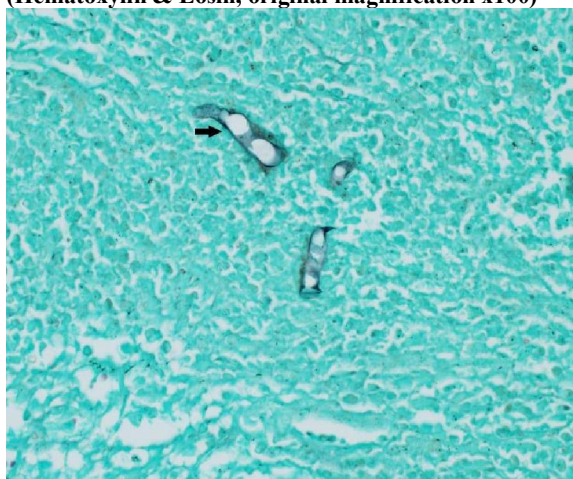


Figure 2: Broad and irregular fungal hyphae with thin wall and rare septa (arrow) typical of *B. ranarum* (Gomori methenamine silver, original magnification x400)

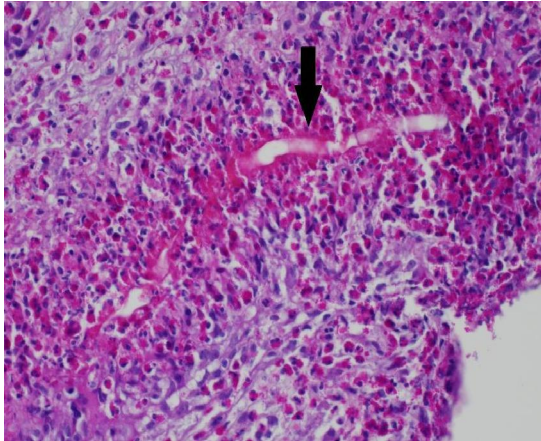


Figure 3: Biopsy of the liver showing rare irregular fungal hyphae with thin wall and rare septa (arrow) surrounded by necrotic eosinophilic material and a large number of eosinophils (Periodic Acid Schiff stain, original magnification x400)

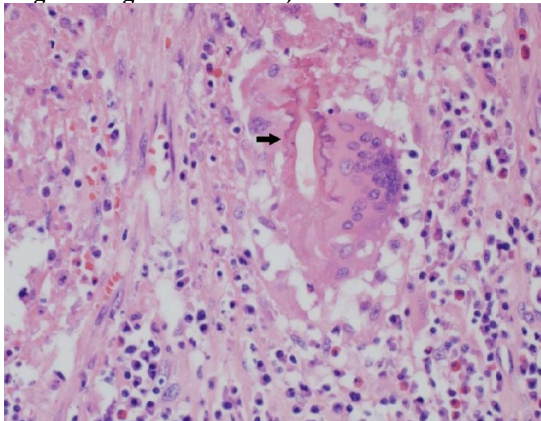


Figure 4: Fungal hyphae (arrow) surrounded by necrotic eosinophilic material are also seen within multinucleated histiocytes (Hematoxylin & Eosin, original magnification x400)

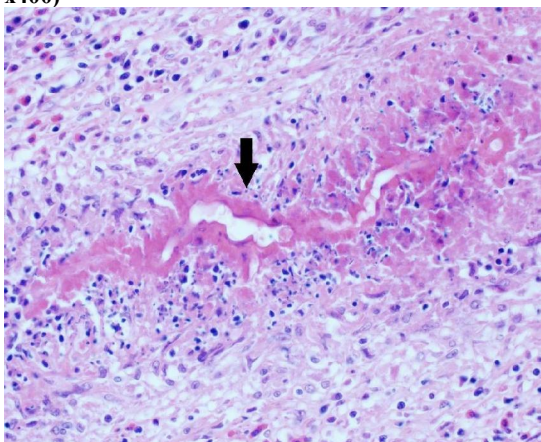


Figure 5: Very irregular, broad fungal hyphae with thin wall and very rare and faint septa surrounded by necrotic eosinophilic granular material (Splendore-Hoeppli phenomenon) (Hematoxylin & Eosin, original magnification x400)

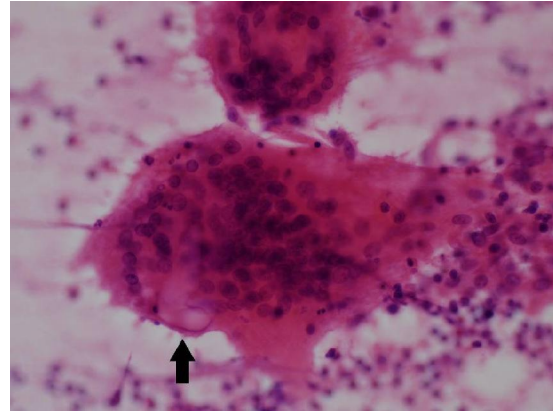


Figure 6: Many multinucleated histiocytes were seen in the cytology smear. One is seen here containing irregular fungal hyphae (arrow) (Hematoxylin & Eosin, original magnification x400)

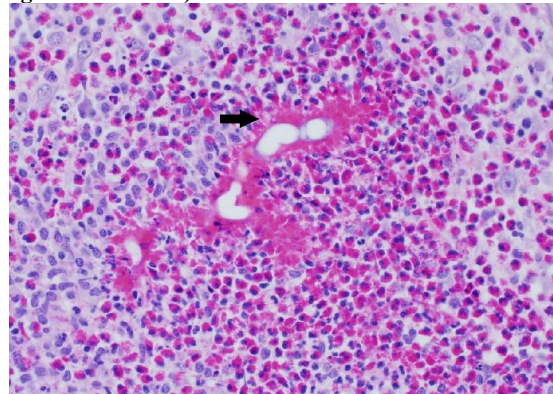


Figure 7: Section of the lymph node showing the typical hyphae with the Splendore-Hoeppli phenomenon (arrow) (Periodic Acid Schiff stain, original magnification x400)

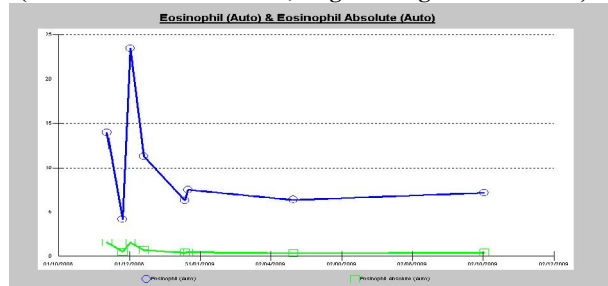


Figure 8: Progressive drop in eosinophilic count during a one year follow up with antifungal treatment

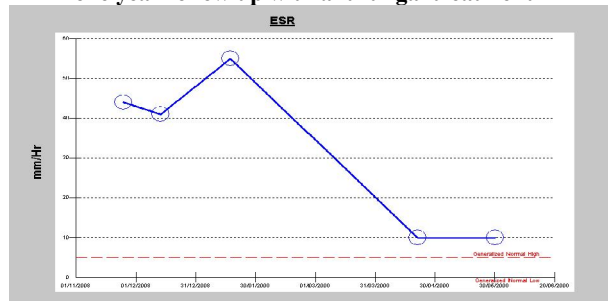


Figure 9: Progressive drop in ESR during a one year follow up with antifungal treatment



Figure 10 : Multiple variable sized perianal/perirectal abscesses (black arrows) causing significant narrowing of the distal rectum (white arrow)



Figure 11 : Inflammatory soft tissue mass (arrow) encasing the rectum

4. Discussion

Basidiobolomycosis is a rare disease that is caused by the fungus *Basidiobolus ranarum* which is an environmental saprophyte, member of the class Zygomycetes, order Entomophthorales, that is found worldwide (1). Zygomycetes constitute a group of filamentous fungi that embrace many species potentially pathogenic to humans. This group is placed in two orders: Mucorales and Entomophthorales. Members of the family Mucoraceae (in the order Mucorales) such as *Absidia*, *Apophysomyces*, *Mucor*, *Rhizomucor*, and *Rhizopus* species are more significant in clinical medicine and are well established causes of acute and progressive opportunistic mycoses affecting hosts immune-compromised by diabetes, lymphoid or other malignancies, severe burns or other causes (2;3). The

order Entomophthorales consists of two main genera: *Conidiobolus* and *Basidiobolus* (2;3) and is less likely to cause human disease.

B. ranarum was first isolated in 1955 from decaying plants in the United States and subsequently has been found in soil and vegetation throughout the world (2). It may also be present as a commensal in the intestinal tracts of frogs, toads, turtles, chameleons, horses, and dogs (2). The first report of a case of human infection caused by *B. ranarum* was one of a subcutaneous mycosis that was reported in 1956 in Indonesia (2).

B. ranarum have been mainly responsible for the tropical and subtropical form of subcutaneous zygomycosis involving limbs, trunk and buttocks in otherwise healthy individuals (2;4). Invasive disease caused by this pathogen, however, is very rare (2;3). Gastrointestinal basidiobolomycosis (GIB) is considered very rare and only a limited number of cases have been reported so far. The majority of these reports were published in the last decade (4-7). Therefore, it seems that this type of infection is becoming more and more recognized by pathologists and clinicians alike and perhaps it is more prevalent than was previously thought. Its recognition by pathologists is extremely important because untreated infection can be fatal. In many of the reported cases, the gastrointestinal infection by *B. ranarum* was clinically confused with cancer, inflammatory bowel disease (IBD) or diverticulitis. The risk factors, mode of acquisition and clinical characteristics remain poorly understood. However, it is presumably acquired through ingestion of soil, animal feces or food contaminated by either, as well as rectal inoculation or through the skin after insect bites, scratches or minor cuts (6;7). Definitive diagnosis requires culture and isolation of the organism. Serodiagnosis with immunodiffusion can be employed as an adjunctive diagnostic method. This test appears to be very specific for *B. ranarum* with no cross-reactivity with other species of the order Entomophthorales. However, its sensitivity is not yet determined but it may be of benefit in monitoring infected patients response to treatment (3).

B. ranarum can be identified by the characteristically beaked zygospores on microscopic examination of the culture material. It can be isolated from surgical specimens and it should be inoculated soon after biopsy or resection because it does not survive at 4°C. Sabouraud agar is an adequate medium and visible growth is usually detected 2 to 3 days after incubation at 25-30°C. Colonies appear white or pale grey and have radial folds (3). In tissue sections, the fungal elements appear as broad, pleomorphic and sparsely septate hyphae that have thin wall and stain faintly with fungal stains (GMS) or (PAS) (1;8-12).

Because a fungal infection is not always suspected at the time of biopsy or surgery, tissue may not be sent for culture and, therefore, in a number of patients the diagnosis must be made on histology alone. The morphology of the fungal elements and the Splendore-Hoeppli phenomenon (radiating, intensely eosinophilic granular material surrounding fungal structures), necrosis and heavy eosinophilic infiltration, although not entirely specific, are very characteristic histological features (4;12).

To our knowledge, the total number of reported cases to date is 48 worldwide: 19 from the United States, 13 from Saudi Arabia, 4 from Brazil, 4 from Iran, 2 from Kuwait, 2 from Nigeria and 1 each from the Netherlands, India, Bangladesh and Italy. The age of the patients ranged from 2-81 years with predominance of males. The majority of these reports have emerged in the last decade (4;6;7;12-15).

Most patients presented with complaints of insidious onset of abdominal pain, fever, constipation, anorexia, weight loss, and, rarely, nausea and vomiting or lower gastrointestinal bleeding or mucus in stool. Peripheral blood leukocytosis with marked eosinophilia as well as elevated erythrocyte sedimentation rate and C-reactive protein were found in the vast majority of cases.

Imaging studies including abdominal computerized tomography (CT) scanning, ultrasonography and barium enema examination were abnormal, usually revealing: thickened bowel wall or stomach wall, large bowel stricture, gastrointestinal tract masses which occasionally involved adjacent organs, a liver mass or masses or even diverticula. These intra-abdominal inflammatory masses which were found on imaging studies or during surgical exploration most commonly involved the colon with occasional involvement of stomach and duodenum. In few cases, there was extension of the infection into the liver, biliary system, and pancreas and, in one case, into the ureter. None of the patients were immunocompromised and most affected patients did not have any apparent risk for a fungal infection and were in apparent good health prior to the infection. However, of the reported cases, 34% had an underlying chronic illness that included mainly diabetes mellitus and gastric disorders (7).

Diagnosis was usually delayed by several months, and some of the cases were misdiagnosed and treated as cancer, inflammatory bowel disease (IBD), diverticulitis or amoebic liver abscess. Histological examination of affected tissue yielded the very characteristic findings of *B. ranarum* infection that included giant-cell granulomata with a large number of eosinophils with eosinophilic microabscesses and thin-walled, large, irregular, sparsely septate fungal elements surrounded by eosinophilic material (the so-

called Splendore-Hoeppli phenomenon). Histology in conjunction with serological immunodiffusion testing was used in diagnosis in one case only while, the remainder of the cases, were diagnosed either by histology alone or in combination with culture.

The vast majority of patients had surgery that was combined with antifungal treatment (either amphotericin B or itraconazole). Only one patient was treated with antifungal alone (amphotericin B and ketoconazole) and his outcome was unknown. One patient had no treatment and he died. Another patient was diagnosed on autopsy. Overall, only 4 patients died, while the rest survived. The four cases that we are reporting herein do not differ significantly from all the previously reported cases and they share many features with them. The onset of illness was insidious in all and the predominant symptoms were abdominal pain, anorexia, and weight loss. None of the patients were immune-compromised or had any apparent predisposing factors although one was diabetic (case 1) as in few of the previously reported cases. This, however, is probably a coincidence and it does not seem reasonable at this time to assume that diabetes is a predisposing factor. All our patients had significant eosinophilia and all had abnormal radiological findings with intra-abdominal or pelvic masses that were clinically thought to be primarily neoplastic in nature. One patient (case 1) also had liver nodules in addition to the abdominal masses which raised the clinical suspicion of malignancy even further. All cases had the characteristic histopathological features which were described above. In three cases, however, the fungal organisms were initially not seen. In (case 1), the initial liver biopsy revealed the presence of granulomata and microabscesses with predominance of eosinophils, so one of the differential diagnoses included a hypereosinophilic syndrome. However, culture results of the liver biopsy came back as positive for *B. ranarum* which prompted us to re-examine the liver biopsy and evaluate deeper levels. This revealed the presence of rare fungal hyphae with the typical morphological features of *B. ranarum*.

In (case 4), the first biopsy from the recto-vaginal septum showed granulation tissue with several granulomata and severe chronic and acute inflammation with markedly increased number of eosinophils and even eosinophilic microabscesses. Therefore, Crohn's disease was suggested. However, a subsequent needle biopsy of somewhat deeper tissue revealed a similar histological picture in addition to the presence of few fungal hyphae that had the typical morphological features of *B. ranarum*. Therefore, a presumptive diagnosis of *B. ranarum* fungal infection was made and, before fungal treatment was started; more tissue was obtained and sent for fungal culture in an attempt to make a definite positive identification of

the fungal species. However, the culture results came back negative. In (case 2), on the other hand, which was referred to our pathology department for a second opinion from another hospital, the pathological diagnosis from the referring hospital was that of eosinophilic granuloma (Langerhans histiocytosis). This was probably due to the fact that there was a large number of eosinophils and many histiocytes. The presence of fungal hyphae was entirely missed by the referring pathologist. Upon reviewing the same pathology material in our hospital, we were able to detect the presence of the fungal hyphae and the presence of heavy chronic and acute inflammation with necrosis and many granulomata and eosinophilic microabscesses which are very characteristic of *B. ranarum* infection. The culture result in this case came out, later, as positive for *B. ranarum* which confirmed the diagnosis. Unfortunately, however, the initial misdiagnosis and delay in recognizing the process as a fungal infection with the consequent delay in appropriate treatment may have contributed to the demise of the patient. This emphasizes the point that failure to recognize or suspect this type of infection early in the course of disease will inevitably cause delay in the appropriate treatment that may result in increased morbidity or even mortality.

Additionally in two of our cases (case 3 and case 4), the mycology cultures failed to grow any fungal organisms despite the fact that the typical fungal organisms were clearly seen in tissue sections. A likely explanation for this failure of the fungus to grow in culture is that the tissue that was submitted for culture was probably not representative and did not contain the organisms. Another possible explanation is that the inoculation of the culture media was not prompt and that the organisms had deteriorated before inoculation. This is possible because it is known, as mentioned earlier, that *B. ranarum* organisms do not survive at 4° C. and should be inoculated soon after the tissue is obtained. Therefore, although every attempt should be made to submit material for fungal culture in order to isolate the organism, culture by itself does not appear to be essential for diagnosis if the fungal organisms with the typical morphology and typical background inflammatory picture are identified in tissue sections. This brings out the point that tissue diagnosis is crucial and it is very important to search diligently for the typical fungal organisms in the appropriate background (granulomata with eosinophils-rich microabscesses and eosinophilic necrotic debris). If the organisms are not seen despite the appropriate background, the pathologist should attempt examining additional levels and special fungal stains (GMS and PAS) or even submit more tissue for microscopic evaluation (in case of large incisional or excisional specimens). If everything fails, the clinician

may be advised to obtain other biopsies from different areas of the mass or lesion.

On the basis of the data gathered from previous reports, it appears that appropriate treatment of gastrointestinal basidiobolomycosis may include surgical intervention and excision or debulking of the mass lesions in conjunction with administration of systemic antifungal agents. As for our cases, in addition to surgical treatment in cases 1&2, the patient in (case 1) was treated with itraconazole while the patient in (case 3) was treated with voriconazole which is a broad-spectrum, second-generation triazole antifungal that shows *in vitro* activity against several *Candida* species, *Aspergillus* species, and other molds that are resistant to fluconazole or itraconazole (16-20). It also has better absorption and the oral formulation has demonstrated almost complete bioavailability (21-24;24). It is extensively distributed into tissues and also penetrates well into cerebrospinal fluid and into vitreous and aqueous humors (16;25-29). To our knowledge, we were the first to use voriconazole as treatment for GIB hoping to have a good result considering its broad-spectrum activity and bioavailability. The patient in (case 4) was treated with a combination of terbinafine and voriconazole. All three patients responded very well and showed continuous improvement till the time of last follow up.

In conclusion the presence of intra-abdominal mass lesion(s) accompanied by peripheral blood eosinophilia and elevated erythrocytes sedimentation rate (ESR) and/or C-reactive protein (CRP) in an immune-competent patient should raise the suspicion of this infection clinically. The presence of granulomata, necrosis, and increased number of eosinophils on tissue sections should strongly raise the suspicion of this type of infection pathologically and every attempt should be made to identify the fungal hyphae microscopically. Identifying the characteristic fungal hyphae with the appropriate background in tissue sections is reliable and adequate for diagnosis of this specific infection. Fungal cultures which are considered the standard for diagnosis may not always be available or they may fail to grow the organisms because the inoculum is obtained from a non-representative area or due to improper handling and processing.

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