

CASE REPORT

GANODERMA LUCIDUM: A CAUSE OF PSEUDOPARASITOSIS

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Abstract. We report a pseudoparasitosis case due to *Ganoderma lucidum*, (lingzhi or reishi mushroom); we believe this to be a first reported case in Thailand. A 49-year-old male patient with non-Hodgkins lymphoma presented with chronic watery diarrhea. He had a history of consumption of powdered lingzhi extract as a dietary supplement and herbal medicine. Stool examination demonstrated many spores of *G. lucidum*, which must be differentiated from intestinal helminth ova and coccidia. After discontinuation of mushroom spores ingestion, the diarrheal symptoms improved and fecal examination subsequently showed no *Ganoderma* spores. Many artifacts in the stool may be confused with parasites. Differentiation of parasites from artifacts depends on characterization of the size, shape, structure, and reactivity with common stains.

INTRODUCTION

Diarrhea is a major health problem in tropical regions. Microorganisms are frequently the causative pathogens responsible for morbidity and mortality. In developing countries parasites should be particularly considered as a cause of chronic diarrhea (WHO, 2003). Stool examination using direct wet smear is simple and practical for the detection of ova and parasites. However, a number of artifacts can be found in fecal samples depending on diet and medication (Markell *et al*, 1999). The identification of pseudoparasites, which resemble helminth eggs, larvae and protozoa, may be a puzzling task for laboratory personnel. The present case of chronic watery diar-

rhea associated with lingzhi or reishi mushroom ingestion is, to the best of our knowledge, the first documented case of pseudoparasitosis related to *Ganoderma lucidum* reported in Thailand.

CASE REPORT

A 49-year-old male patient was admitted to Siriraj Hospital due to non-Hodgkins lymphoma stage IV involving the bone marrow, central nervous system, and eyes. He was previously treated with chemotherapy and radiation therapy. He also had pulmonary tuberculosis and was being treated with antituberculous drugs. He had a history of intermittent diarrhea for 6 months and had been passing stools 4-5 times a day. The stool was watery, sometimes with mucus, but not bloody. The powdered lingzhi extract, containing *Ganoderma lucidum* spores, was given by his wife as a dietary supplement and additional herbal medicine. After reishi mushroom ingestion for 2-3 days his stools became loose and

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subsequently watery. The severity of diarrhea was related to the amount of *G. lucidum* spore intake.

On admission, he was afebrile with a temperature of 36.4°C, blood pressure of 120/80 mmHg, pulse rate of 70/minute, and respiratory rate of 20/minute. Physical examination revealed his respiratory and cardiovascular systems were unremarkable. His abdomen was non-tender and his liver and spleen were not enlarged. His visual acuities were no light perception in one eye and 1/60 in the other. The intraocular pressures were 12 and 14 mmHg. Ocular examination showed 2⁺-3⁺ cell reaction in the anterior chambers of both eyes. The fundi demonstrated retinal atrophy, infiltration, and hemorrhage.

Laboratory data showed a white cell count of 2,190/mm³, with 73.4% neutrophils, 21% lymphocytes, 3.7% monocytes, 1.4% eosinophils, and 0.5% basophils. The hematocrit was 39.2%, with a MCV of 96.3 fl, MCH of 32.2 pg, MCHC of 33.4 g/dl, reticulocyte counts of 0.87%, and a platelet count of 96 x 10³ µl. Urinalysis, renal function tests, cholesterol, and serum electrolytes were within normal limits. Liver function tests showed normal values for AST, ALT, and alkaline phosphatase. Low albumin (3.2 g/dl) and globulin levels (1.4 g/dl) were found with a high GGT level (206 g/dl). A magnetic resonance image of the brain showed lymphomatous intraparenchymal masses of the left frontal and bilateral frontoparietal lobes.

Multiple stool examinations using simple smear and concentration methods showed no ova and parasites. Modified acid-fast and modified trichrome stains revealed no *Cryptosporidium* or microsporidia, respectively. No fecal leukocytes or erythrocytes were detected. Stool culture and acid-fast stain were negative for mycobacteria. No *Salmonella*, *Shigella*, *Vibrio*, *Aeromonas*, *Plesiomonas*, *Shigelloides*, *Bacillus cereus*, or *Staphylococcus aureus* were detected on routine stool culture. Stool wet smear demonstrated

many spores of *Ganoderma lucidum* (Fig 1). They were oval-shaped, yellow brown-colored basidiospores 5.8-7.3 µm in length and 4.2-5.0 µm in width (average 6.7 by 4.7 µm). The outer wall was rugous, the inner wall was yellow brown. The distinctive characteristics of basidiospores are interwall connections and a prominent germ pore with a truncated upper end (Fig 2). The spores were not stained with modified acid-fast or modified trichrome stains, but rugous surfaces and interwall connections were easily seen. A wet preparation of lingzhi extract was examined. *Ganoderma*

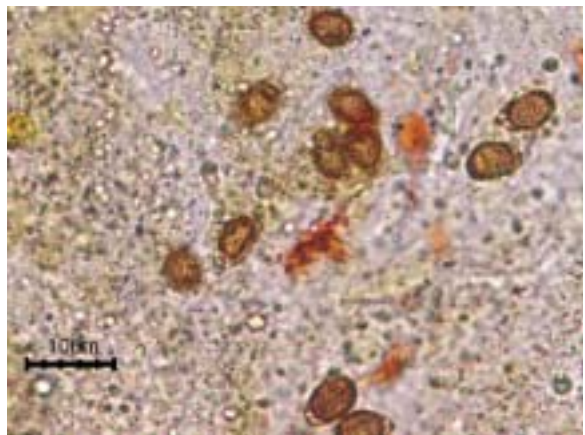


Fig 1—Microscopic examination of stool demonstrated many basidiospores of *Ganoderma lucidum*.

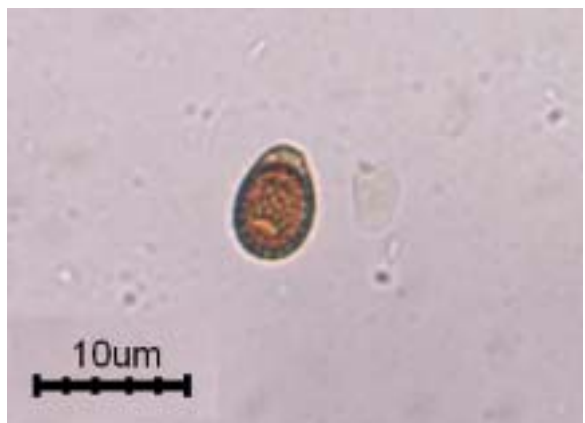


Fig 2—*Ganoderma lucidum* spore showing a rugous outer wall and interwall connection.

basidiospores were identified, as found in the fecal specimens. After cessation of mushroom ingestion for a few days, stool examination found no *Ganoderma* spores.

DISCUSSION

Pseudoparasites are commonly found in stool samples. They are a problem for inexperienced laboratory staff. *Ganoderma* spores can be confused with some parasitic ova or coccidian oocysts. They may resemble eggs of small liver flukes or minute intestinal flukes, but much smaller in size. The spore is yellow to reddish brown with a rugous surface and interwall junctions. The fluke egg, however, is light yellowish-brown and the eggshell is smooth. The *Opisthorchis viverrini* ovum measures about 27x15 μm (Beaver *et al*, 1984). The morphology of minute intestinal fluke eggs is normally indistinguishable from that of *O. viverrini* eggs using light microscopy. They are almost the same size as *Opisthorchis* ova. For example, the eggs of *Haplorchis taichui* are about 29x15 μm and those of *Phanerocephalus bonnei* measure about 23x12 μm (Sukontason *et al*, 1999).

Intestinal coccidia, including *Cryptosporidium parvum*, *Cyclospora cayetanensis*, and *Isospora belli*, are common opportunistic protozoa causing chronic diarrhea in immunocompromised patients. The coccidian oocysts are colorless and transparent with smooth oocyst walls and are stained with a modified acid-fast stain. *Ganoderma* spores are yellow to reddish brown in color and are not stained with modified acid-fast stain. The size of *C. parvum* oocysts (4-6 μm) (Garcia, 2001) is nearly the same as that of *Ganoderma* spores, but they are spherical in shape and usually not identified on wet smear. *C. cayetanensis* oocysts measure 8-10 μm in diameter and appear as spherical cysts with multiple refractile greenish granules. (Wanachiwanawin *et al*, 1995). *I. belli* oocysts are elongated, ovoid with a neck-like appear-

ance at one end. They measure 20-33 by 10-19 μm (Beaver *et al*, 1984), which are much larger than basidiospores of *Ganoderma*.

Eimeria spp are important coccidia infecting domestic animals. The oocysts are usually ovoid, subspherical or spherical in shape. A typical oocyst has a tiny opening or a micropyle at one end which may be covered with a polar cap. The oocyst wall is usually clear and transparent. There are a great number of species belonging to this genus. The sizes of *Eimeria* oocysts vary according to the species and are often much larger than those of the mushroom spores. The bovine oocyst *Eimeria subspherica* measures 9-11 x 8-12 μm , but is larger than the *Ganoderma* spore (Soulsby, 1973).

Ganoderma lucidum is a wood-decaying fungus belonging to the order Polyporales. It has been recognized as a valuable medicinal mushroom in Asian countries since antiquity. It is called lingzhi by the Chinese, or reishi by the Japanese. The name lingzhi means "spirit plant"; another Chinese name is "ten-thousand-year mushroom" (Hobbs and Miovic, 1996; Wachtel-Galor *et al*, 2004; Lin, 2005). The fungus can produce both monokaryotic and dikaryotic fruiting bodies containing haploid basidiospores. The fruiting bodies of *G. lucidum* are reddish-orange to black, usually delicate, slender, and have a definite stalk which usually attaches to the cap from the side, or is stalkless. The spores from a mature basidiocarp are reddish brown in color, oval shape with a very thick wall (Tritatana and Chairasert, 1991). The lingzhi mushroom has been used for treatment of hepatopathy, chronic hepatitis, nephritis, hypertension, arthritis, neurasthenia, insomnia, asthma, and gastric ulcers. It has been widely used for health promotion and longevity (Hobbs and Miovic, 1996; Wachtel-Galor *et al*, 2004; Lin, 2005; Gale, 2006). Previous studies report *G. lucidum* enhances the immune system and has potent anti-tumor activity (Cao and Lin,

2004; Lin and Zhang, 2004; Lin, 2005; Stanley *et al*, 2005). It is a popular medicinal herb used for cancer patients. Reishi products are commercially available as dietary supplement. Adverse effects including skin rash, dry mouth, stomach disturbance, and diarrhea can occur. Diarrheal symptoms occur due to large doses of lingzhi mushroom and can be alleviated by discontinuing it or taking the supplement with meals (Gale, 2006).

The presented case experienced diarrheal symptoms associated with *Ganoderma* intake. Infectious complications are common problems in immunocompromised hosts. Multiple stool examinations did not reveal infectious pathogens. *G. lucidum* spores were the only organism found. The diarrheal symptoms improved after discontinuation of the mushroom spore consumption, and fecal re-examination revealed no *Ganoderma* spores.

Pseudoparasites are commonly present in stools and are responsible for misidentification of parasites. They should be differentiated from intestinal protozoa and helminth eggs and larvae on the basis of size, shape, defining characteristics, and their variable reactivity with common stains. A history of food and drug intake should be made in order to minimize identification errors.

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