Secondary Peritonitis Caused by *Streptomyces viridis*

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*Streptomyces* organisms are soil inhabitants rarely causing nonmycetomic infections. We describe a case of secondary peritonitis caused by *Streptomyces viridis* in a chronic alcoholic patient who presented with fever, abdominal distension, and pain in the abdomen. The most likely source of infection was by inoculation through multiple paracenteses, done for treatment of ascites, before the patient came to our health care center. This is the second case report of *Streptomyces* peritonitis and the first case caused by *Streptomyces viridis*, which is usually found in the soil in our geographic region.

CASE REPORT

A 53-year-old male presented to the medical emergency room with complaints of fever, abdominal distension, and pain in the abdomen for 7 days. He was a chronic alcoholic, taking around 214 g of alcohol daily for the past 10 years. There was no history of melaena or hematemesis. There was also no history of any headache, rhinorrhea, sore throat, cough, dysuria, or bowel complaints. The patient gave a history of multiple paracenteses, done outside our hospital, for management of abdominal distension.

On examination, the patient was febrile (38°C) and was in mild distress due to dyspnea and abdominal pain. His sclerae of both sides were icteric. On palpation, his abdomen was firm, distended, and diffusely tender. The rest of the systemic examination was within normal limits.

On admission, the peripheral leukocyte count was 17,000/mm$^3$, with 84% neutrophils and 12% lymphocytes. The platelet count was adequate. The serum creatinine level was 1.5 mg/dl, and the sodium level was 135 mmol/liter. The total bilirubin level was within normal limits.

The aerobic actinomycetes consist of a large, diverse group of obligate aerobic and relatively slow-growing Gram-positive bacilli with a tendency to form chains or filaments. They are found as saprophytes in soil and other natural habitats. These organisms are categorized on the basis of their acid fastness: *Nocardia* and *Rhodococcus* species are weakly acid fast, while *Streptomyces* and *Actinomadura* species are non-acid fast (11).

Mycetoma, the most common manifestation of *Streptomyces* infection, usually involves the subcutaneous tissue of legs and feet and occurs due to the direct inoculation of the microorganism through an injury caused by a thorn (5). Invasive *Streptomyces* infections, defined as infections other than mycetoma or superfi-
cial skin infections, are extremely rare. These infections occur most often in immunocompromised patients such as those with HIV infection and those on immunosuppressive drugs such as corticosteroids and anticancer drugs (11).

The clinical significance of recovering these organisms is often unclear, as there have been many reports of isolation of Streptomyces species without definitive proof of their pathogenic role. Therefore, the role of Streptomyces species in visceral infections has been controversial, particularly in a polymicrobial setting (4). Diagnosis of invasive Streptomyces infection is made by clinical (i.e., immune status of the patient and infection other than superficial skin infection) and microbiological correlation. Isolation of the organism in pure culture and from a sterile site, direct examination of infected tissue (by Gram staining or biopsy), and exclusion of any other pathogen will confirm true cases caused by Streptomyces species. Earlier identification to the species level was based on morphological features and rapid enzyme tests of fluorophores (4). Currently, 16S rRNA gene sequencing is considered the best method for species identification (9).

To identify all cases of invasive infection due to Streptomyces, we performed a PubMed search and also reviewed the references from previous publications on Streptomyces infection. Only those cases which represented true invasive infections were included (using the criteria given above). A total of 23 reports of Streptomyces species causing infection other than mycetoma have been documented to date.

The majority of invasive Streptomyces infections were bacteremia and lung infections (pneumonia, abscess, and pneumonitis) (4, 9). All of the species identified have been different, showing the opportunistic potential of this pathogen. Most of the patients had some underlying immunosuppressive condition, such as HIV infection, cancer, systemic lupus erythematosus (SLE), Crohn’s disease, etc. S. pelletieri, S. griseus, S. lanatus, and S. albus have been isolated from various patients with lung pathology (7, 9, 10, 16).

Streptomyces spp. causing bacteremia were linked to central venous catheter (CVC) use and the immune status of the patient (4, 9). Carey et al. reported an unusual case of catheter-related bacteremia due to Streptomyces in a female patient with breast carcinoma who was receiving injectable hospital preparations (1). Moss et al. described the isolation of S. bikiniiensis from an osteosarcoma patient without any overt clinical symptoms (12). Joseph et al. reported an unusual case of bacteremia due to Streptomyces spp. in a pregnant female secondary to subcutaneous mycetoma of the scalp (8). Kapadia et al. reviewed 3 cases of CVC-related bacteremia in cancer patients; for all three patients, removal of the CVC line led to resolution of signs and symptoms in patients (9).

The present case was unusual, as only one case of Streptomyces peritonitis, caused by S. somaliensis and with no underlying condition reported, has been described previously (6). The patient we describe here represents the first reported case of secondary peritonitis caused by S. viridis in a patient with chronic alcoholic liver disease and gross ascites. The Streptomyces isolate was considered the primary pathogen because it was seen on the direct smear and isolated in pure form on culture media. Also unique to this case is the likely mechanism by which this infection occurred. Most cases of secondary peritonitis are caused by bacteria which arrive in the peritoneal cavity from a gut source, most often due to rupture of abdominal viscera. In contrast, for our patient the likely source of peritoneal infection was direct inoculation into the peritoneal cavity during paracentesis done in the past. S. viridis is found in the soil in various parts of India (15).

Streptomyces species rarely cause atypical visceral infections. Mossad et al. reported an atypical case of Streptomyces endocarditis in a patient with a prosthetic heart valve (13). S. griseus was isolated from a patient with a brain abscess by Clarke et al. (2). Rose et al. also discussed a case of brain abscess caused by Streptomyces infection following penetration trauma (14).

Based on various in vitro results, the best treatment options for visceral Streptomyces infection include macrolides, minocycline, doxycycline, ceftriaxone, amikacin, and imipenem. Cotrimoxazole is not the drug of choice for treating invasive Streptomyces infection, in contrast to the treatment of nocardiosis (4). A variety of antimicrobial regimens were used in the previously reported cases, and in most cases the outcome was good, with resolution of infection. However, the optimal choice of antimicrobial agent and duration of therapy for treating Streptomyces visceral infections remain to be determined (9).

Conclusions. Though Streptomyces species are not commonly recovered from clinical specimens, these organisms can cause invasive infections. The present case illustrates the potential of Streptomyces spp. to cause invasive infection.

REFERENCES