

Bacillus Cereus Osteomyelitis in an Athlete: Case Report and Review of the Literature

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Abstract

Bacillus cereus is an aerobic Gram-positive, spore-forming rod, widely distributed in the environment. Although, most commonly known to cause gastrointestinal infections, *B. cereus* can also cause osteomyelitis and other deep-seated infections. Here we describe the case of an athlete who presented with *B. cereus* osteomyelitis following surgery for closed displaced mid shaft fracture of tibia and fibula sustained during a football match. The patient had internal reduction and fixation of the fracture; Cephazolin was given as prophylaxis. 9 weeks later he developed osteomyelitis, *B. cereus* was isolated from specimens collected during surgery which was treated with Teicoplanin and Ciprofloxacin. After initial improvement X-ray showed progressive posterior bone bridge at the site of the fracture and no obvious evolution of the distal aspect of the tibia in comparison with the previous radiography. The patient was then transferred to a referral hospital where he had another surgery to drain the pus and remove the intramedullary prosthesis. At this stage *Clostridium aerotolerans* and *Propionibacterium acne* were isolated from the tissues, treated successfully with metronidazole. *Bacillus cereus* osteomyelitis should be considered in the differential diagnosis for infection following limb trauma. It is prudent to use for prophylaxis Vancomycin or Teicoplanin in such situation instead of Cephazolin to which *B. cereus* is usually resistant due to the production of beta lactamases.

Introduction/ Background

Bacillus cereus is a Gram-positive, aerobic, pleomorphic spore-forming bacillus; widely distributed in nature. When colonizing the human body, it exists in the vegetative form. The spores of *B. cereus* are resistant to extreme heat, freezing, drying, radiation, disinfectants, pasteurization, and gamma radiation. Their hydrophilic nature allows them to adhere to surfaces including medical equipment e.g. ventilators [1-5]. The spores are the infective stage of the bacterium. The reservoir of *B. cereus* includes decaying organic matter, fresh and marine waters, vegetables, fomites, and the intestinal tract of invertebrates, from which soil and food products may become contaminated leading to the transient colonization of the human intestine [6-8].

B. cereus grows easily on blood agar and chocolate agar. On blood agar colonies are irregular, gray with rough surface and surrounded by zone of beta hemolysis. *B. cereus* is commonly dismissed as a contaminant or non-pathogenic. However, its pathogenic role is increasingly recognized.

The pathogenicity of *B. cereus* is associated with the production of several extracellular enzymes including four hemolysins, three proteases, phospholipase, emetic toxin, and three enterotoxins [9-13]. In addition to food poisoning, *B. cereus* causes a number of local and systemic infections both in the immunocompetent and the immunocompromised host. Among the most commonly infected are neonates, intravenous drug users, patients sustaining traumatic or surgical wounds, and patients with indwelling catheters. The spectrum of non-gastrointestinal diseases includes bacteremia, central nervous system infections, endophthalmitis, keratitis, pneumonia, cutaneous infections and osteomyelitis.

B. cereus is also associated with healthcare-associated infections and outbreaks among immunocompromised hosts resulting from contamination of air filtration, ventilation equipment, bronchoscopes, linen, gloves, hands of staff, intravenous catheters, alcohol-based hand wash stations, specimen collection tubes, balloons used in manual ventilation, tea bags, theater scrubs suits,

and blasters of pain cast [14-25]. We report a case of osteomyelitis due to *B. cereus* following fracture of the tibia and fibula. To our knowledge this is the first case of *B. cereus* osteomyelitis in an athlete.

Case Report

On 13th of February 2016, a 25 –year-old male football player sustained closed displaced mid shaft fracture of tibia and fibula as a result of direct contact injury during a football match. He was referred to Aspetar Hospital and operated on the same day with reduction and intramedullary nailing. Cephazolin was given prophylactically, 1 gram for a total of 3 doses. Surgery was uneventful and the patient was discharged as planned with partial weight bearing. The patient had a past history of stress fracture of the tibia on the same area which was treated conservatively in 2015.

Nine weeks after surgery X-ray showed modification of the distal tibia with suspicion of osteomyelitis; C - reactive protein (CRP) was 24mg/l (reference range ≤ 9 mg/l), the white cell count was normal at $8.2 \times 10^9/L$ (reference range 4.0-10.5)., and the patient

was afebrile. Two days' later medial distal collection developed and CRP rose to 60.0mg/L. Incision and drainage of the collection was done, distal locking screw was removed, lavage done and the patient started on Teicoplanin 600mg 12 hourly. Six samples were sent for microbiology including pus, tissue, the screw and 2 sets of blood cultures. Samples were processed for routine microbiology both aerobic and anaerobic cultures and TB culture using both molecular and conventional techniques. Anaerobic plates incubated for 7 days according to the laboratory protocol.

Gram stain of all specimens showed moderate pus cells and no organism seen. The following day a *Bacillus* spp was isolated from all specimens, identified as *B. cereus* both by our laboratory and the reference laboratory (Figure 1). It was resistant to Penicillin, Cephazolin, Cefuroxime, and Ceftriaxone, susceptible to Vancomycin, Linezolid, Teicoplanin, Gentamicin, Amikacin, Meropenem, Ciprofloxacin and Clindamycin (Figure 2 and Table 1). At this stage treatment was modified to include Ciprofloxacin 400mg 8 hourly and Teicoplanin 600mg once daily. Two weeks later Teicoplanin was stopped due to low platelets count. TB culture was negative as well as the anaerobic cultures.

Table 1: Summary of case reports of osteomyelitis due to *Bacillus cereus*

#		Site of osteomyelitis	Predisposing factor	Therapy/duration	Course
1	61y /M	T6-T7	Intravenous drug abuse	Clindamycin 3 months	Complete recovery
2	43 y/M	Iliac crest	Sickle cell disease, heroin addict, alcoholism	Gentamicin 40 days	Complete recovery
3	13 y/F	Femur	Surgical trauma, multiple sites	Cephazolin, Clindamycin followed by Vancomycin/ 6 months	Complete recovery
4	24y/M	Femur	anti-IFN- γ autoantibodies	Moxifloxacin/3 months	Complete recovery
5	25 (current case)	Tibia and fibula	Trauma	Teicoplanin and ciprofloxacin for 4 weeks followed by metronidazole 40 days	Complete recovery

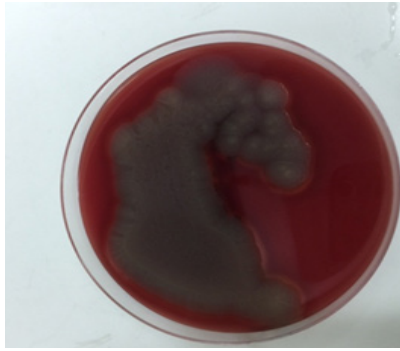
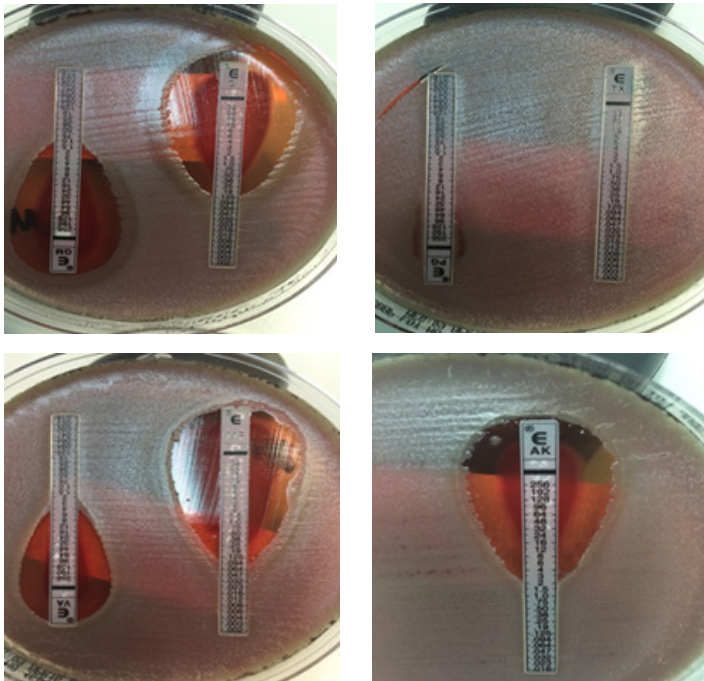


Figure 1: *B. cereus* patient isolate growing on Blood agar



The clinical evolution was good with progressive drop in the inflammatory markers (CRP dropped to 10.5mg/L). A week later the CRP started to rise to 51.7 mg/L. The patient was afebrile walking with partial weight bearing protected with 2 crutches. X-ray showed progressive posterior bone bridge at the site of the fracture. There was no obvious evolution of the distal aspect of the tibia in comparison with the previous radiography. It was then decided to transfer the patient to a specialized hospital in Paris; Ambroise Parie Hospital. There he was operated on with removal of intramedullary osteosynthesis material at several sites by direct approach. The result of culture of samples collected during surgery revealed growth of *Clostridium aerotolerance* (susceptible to Metronidazole, Vancomycin, Erythromycin, and Amoxicillin, resistant to Ceftriaxone, Imipenem, Amikacin, Levofloxacin and Clindamycin) and *Propionibacterium acne* (susceptibility not done). The patient started on Metronidazole and continued for 45 days with excellent recovery.

Discussion and Literature Review

Traditionally *B. cereus* was considered contaminant particularly

in mixed wound infections. In many case reviews of *B. cereus* infections, the organism was found in persons who are immunocompromised or suffered from severe blunt or sharp trauma [26-34]. In an increasing number of case reports *B. cereus* in patients with nongastrointestinal infections, have been associated with purulent pyogenic, and in some cases highly necrotizing disease [30]. The mechanism of virulence of *B. cereus* is due to the production of hemolysins, phospholipase C, enterotoxins and lecithinase [31-37].

Our patient was an athlete who sustained injury in the field while playing resulting in fracture of the tibia and fibula. The portal of entry could be contamination from soil and entry through minor microscopic abrasions or through contaminated surgical instruments, screws and drapes as reported from previous cases [38-40]. However environmental culture, culture of surgical instruments, screws and drapes failed to grow *B. cereus*. This support the assumption contamination with *B. cereus* occurred in the field and entry in the tissues facilitated by the trauma. Since the spores of *B. cereus* are resistant to disinfectants such as chlorhexidine in alcohol which is routinely used for surgical disinfection of the surgical site, the spores which escaped the disinfection process may had been carried into the deeper tissues during the surgical procedure where it multiplied and caused infection.

The isolation of *B. cereus* from multiple samples by our laboratory as well as the referral laboratory leave no doubt that *B. cereus* was the initial cause of the osteomyelitis. Infection with *B. cereus* is a mixed infection. In our case we isolated 2 types of coagulase negative *Staphylococci* and both reported as contaminants but all susceptible to Teicoplanin which was used in the treatment of this case. The specimens collected at the time of second surgery which was performed in France one month later, grew *Clostridium aerotolerance* and *Propionibacterium acne* and no *B. cereus*.

Both our laboratory and the reference laboratory did not grow an anaerobe in spite of the prolonged incubation of the cultures for one week. Since *C. aerotolerance* is not a fastidious anaerobe and can grow easily even in the presence of oxygen, and there was a gap of one month between the first and second infection, we considered the isolation of *C. aerotolerance* and *P. acne* as superinfection.

Another explanation the *C. aerotolerance* may be initially present in very small numbers and started to overgrow when Teicoplanin was stopped due to the low platelet counts. Treatment was continued with Ciprofloxacin to which *C. aerotolerance* is probably resistant since it was resistant to Levofloxacin (Ciprofloxacin susceptibility was not done in France).

Bone infections by *B. cereus* are rare in the English Literature. There are only 4 confirmed cases of *B. cereus* osteomyelitis, our patient is the 5th case and the first case to be reported in an athlete (Table 2). In previous articles *B. cereus* has been described as being susceptible to Penicillin, and later became resistant to all beta lactams due to the production of beta lactamases, but susceptible to Kanamycin, Chloramphenicol, and Tetracycline [25-41]. *B. cereus* from our patient as well as other reported cases of *B. cereus* osteomyelitis were resistant to beta Lactams but

susceptible to Gentamicin, Amikacin, Ciprofloxacin, Linezolid, Teicoplanin, Vancomycin, Meropenem and Clindamycin (Table 2). Since it is a possible cause of infection post trauma we recommend replacing Cephazolin with Vancomycin or Teicoplanin for surgical prophylaxis. Our patient was giving Cephazolin prophylactically.

Table 2: The result of antimicrobial susceptibility test of *B. cereus* isolate

Antibiotic	Minimum Inhibitory Concentration in ug/l	Interpretation
Penicillin	256	R
Ceftriaxone	32	R
Meropenem	0.094	S
Ciprofloxacin	0.125	S
Clindamycin	0.5	S
Gentamicin	1	S
Amikacin	3	S
Teicoplanin	0.5	S
Vancomycin	3	S

Treatment with Teicoplanin was started and the patient responded very well, but due to the drop of platelets count, Teicoplanin was stopped and replaced by Ciprofloxacin. The successful therapy in this patient is the removal of screws, necrotic tissue and drainage of pus together with appropriate antibiotic therapy. In summary we describe an athlete with *B. cereus* osteomyelitis following trauma. The pathogenic role of *B. cereus* was more than incidental on the basis of isolation of the organism from several samples collected during surgery by 2 laboratories and the marked clinical improvement of the patient's condition with appropriate antibiotic therapy. The isolation of *B. cereus* from cases of osteomyelitis should not be dismissed as contaminant when it is combined with supportive laboratory findings and clinical evidence of infection. Mixed infections with anaerobes should not be dismissed. We recommend the use of vancomycin or Teicoplanin for surgical prophylaxis in patients who sustain fracture with the possibility of soil contamination.

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