**Bacillus cereus** panophthalmitis associated with intraocular gas bubble

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**SUMMARY** It has become increasingly apparent that *Bacillus cereus* can cause a severe and devastating form of endophthalmitis following penetrating trauma by a metallic object. *B. cereus* is an uncommon aetiological agent in non-clostridial gas-forming infections. The patient studied in this single case report showed evidence of intraocular gas mimicking gas gangrene infection. The physiology of non-clostridial bacteria producing gas from anaerobic metabolic conditions is reviewed. Further intraocular and systemic complications which may be avoided by accurate and early diagnosis and the use of recommended treatment with antibiotics such as clindamycin.

First reported in 1952, *Bacillus cereus* panophthalmitis following penetrating trauma is a serious and very rare type of ocular infection, resulting in enucleation in most cases. Owing to the difficulties in identification and taxonomic classification of the *Bacillus* species the specifically appropriate treatment is often delayed. The condition may be further confused by its close similarity to clostridial infection clinically and by the initial Gram’s stain interpretation of smears. Since the presence of gas results from anaerobic metabolic conditions, these infections may present as myonecrosis or cellulitis mimicking true gas gangrene. In contrast to gas gangrene there is confusion about the nature, proper classification, and virulent potential of other gas-forming infections. Accurate species identification of the bacillus is important, since the antibiotic of choice for clostridial infections is penicillin while *B. cereus* is resistant to this drug. In view of the extremely destructive and rapidly necrotising nature of *B. cereus* infections prompt diagnosis and effective treatment are mandatory.

We report here a case of trauma-induced *Bacillus cereus* panophthalmitis with clinical and CT scan evidence of intraocular gas production. Recognition and early suspicion may help in microbiological diagnosis and facilitate prompt treatment of one of the most destructive infections to afflict the ocular tissues.

**Case report**

A 28-year-old man presented with a history of penetrating injury of the left eye by a metallic foreign object released while he was hammering on a piece of metal two days earlier. He complained of severe pain, redness, and loss of vision in the affected eye. Examination revealed marked lid oedema, proptosis, complete ophthalmoplegia, and mucopurulent discharge (Fig. 1). The conjunctiva was chemotic and the most destructive infections to afflict the ocular tissues.

**Fig. 1** Patient with *B. cereus* panophthalmitis. Note periorbital swelling.
prolapsed inferiorly. Biomicroscopy showed severe stromal oedema and total loss of epithelium of the cornea. An entry site was seen in the cornea at 2 o'clock, 3 mm from the limbus. The anterior chamber showed a fibrinoid reaction and hypopyon, with dispersed blood at the pupillary margin. The pupil was fixed and dilated. Lens, vitreous, and fundus could not be seen. The eye was hard to palpation, with increased intraocular pressure.

A CT scan of the left orbit was performed by lying the patient on his back with the head lowered for full neck extension. It showed a dense metallic foreign body and a gas bubble in the globe, with soft tissue swelling of the orbit (Fig. 2). The air bubble moved during the examination.

Cultures were taken from the conjunctiva, cornea, anterior chamber, and vitreous. All specimens were transported to the ocular microbiology service for anaerobic and aerobic culture. The patient was initially started on intravenous gentamicin 80 mg every eight hours and cefazolin 500 mg every six hours, as well as topical fortified gentamicin 14 mg/ml every hour and cefazolin 50 mg/ml every hour. Intravitreal injections of cefazolin (2-25 mg) and gentamicin (0-4 mg) were administered. The patient also received intravenous mannitol (20%) followed by acetazolamide 1 g/day in four divided doses, timolol maleate 0-5%, and propine 0-1% twice daily. The patient was admitted to hospital and this treatment was continued while we awaited laboratory results.

Laboratory findings of the vitreous and anterior chamber fluid revealed numerous polymorphonuclear cells with a mixture of Gram-positive and Gram-negative to variable bacilli seen on direct smears. Gram staining of broth cultures from the anterior chamber revealed many large Gram-positive non-spore-forming rods (Fig. 3). Results from subcultures showed pure growth of β-haemolytic Bacillus sp. 48 hours after receipt of specimens. The colony was 4–5 mm, dry, β-haemolytic catalase positive, and glucose, sucrose, maltose, and indole positive. No further isolates were encountered after 14 days' incubation. Results of sensitivity testing showed resistance to penicillin but sensitivity to chloramphenicol and cephalosporin. A specimen was sent to the Center for Disease Control (CDC) in Atlanta, Georgia, for verification, and the organism was identified as Bacillus cereus.

The patient deteriorated after three days of treatment. He became febrile (38°C) and had a leukocytosis, the white blood cells being 15-9×10⁹/ml with 83% polymorphonuclear cells.

Evisceration of the globe was carried out. Histopathological studies of the ocular contents revealed extensive tissue necrosis and evidence of haemorrhage. Microscopic findings confirmed the diagnosis of acute suppurative endophthalmitis and acute keratitis. The patient was placed on intravenous chloramphenicol 1 g every six hours and topical chloramphenicol 0-5% every four hours for seven days postoperatively.

Discussion

VanBeek and associates' reviewed 73 cases of probable non-clostridial crepitant infections with an additional seven recorded by those authors. They proposed a new clinical classification based on the physiology of microbial growth. In-vivo gas production is the end result of anaerobic metabolism by bacteria which are either strict or facultative anaerobes. Any organisms capable of utilising an anaerobic pathway may produce gas if the conditions
in the tissue are appropriate. Trauma and surgical
and vascular injuries generate areas of tissue anoxia
resulting in carbohydrate and protein metabolism
proceeding anaerobically, with accumulation of
lactic acid.  The buffer system in this environment is
depleted, and a subsequent decrease in pH occurs,
leading to lysosomal disruption and release of
autolytic lysosomal enzymes. These in turn release
peptides, amino acids, and other reducing substances
that may act as microbial substrates. The resulting
increase in concentrations of reducing substances
coupled with a low pH and anoxia provides an ideal
environment for anaerobic microbial metabolism.
Gases of varying solubility may be produced by at
least three recognised anaerobic pathways: dentrific-
cation, fermentation, and deamination. 4

The genus Bacillus, belonging to the family
Bacillaceae, is a group of endospore-forming rods of
which some are pathogenic for man. They are easily
differentiated from other genera of the family by
their ability to produce catalase and rod-shaped cells
which are aerobic or facultatively anaerobic. 5
Bacillus species are capable of utilising an anaerobic
pathway to produce both H2 and CO2, with variations
seen in some strains. 6

The patient reported on here showed both clinical
and radiological evidence of intraocular gas produc-
Radiologically a definite intraocular gas bubble
could be identified, with increased intraocular
pressure. There have been two reports of a gas
gangrene infection, presumed to be clostridial
myonecrosis, which were proved by culture to be
Bacillus cereus in wound and muscle tissue. 7, 8
In both cases the patient was initially treated for a
probable Clostridium perfringens infection owing to
the clinical appearance and the finding of Gram-
positive rods in smears. Jonsson and associates 9
reported the first case of simultaneous infection with
B. cereus and Clostridium bifermantans isolated from
pleural fluid. In view of the reported resistance to
penicillin and grave prognosis of B. cereus infec-
tions 4 ophthalmologists finding an intraocular gas
bubble should be alert to the possibility of B. cereus
in cases with severe endophthalmitis.

Many saprophytic species of Bacillus have low
virulence and are difficult to distinguish from B.
anthracs except on the basis of pathogenicity. But
few laboratories have the facilities to differentiate
the many species of Bacillus. There are said to be 400 or
more reported species for which little taxonomic
information is available. 10 Twenty-two are widely
accepted as distinct entities, and 26 others have so far
received less widespread recognition. Isolation of B.
cereus, B. subtilis, and B. laterosporus 15 from ocul-
tissue have been previously reported. B. cereus has
been implicated in food poisoning outbreaks, endo-
carditis, meningitis, and rarely septicaemia. The
dNA base composition indicates that B. cereus is
most closely related to B. anthracis. But unlike B.
anthracs, B. cereus is resistant to penicillin and the
cephalosporins owing to the production of extra-
cellular penicillinase and cephalosporinase. 16

Although it is known that B. cereus is not a usual
inhabitant of the conjunctival sac, it may become part
of the flora, 7 especially in people handling hay or
taking care of stables and horses. Tabbara and Burd 17
have isolated Bacillus spp. from kolh, which is
commonly used by women of Asia, the Middle East,
and North Africa as a cosmetic. The widespread use
of kohl may increase the incidence of Bacillus spp.
in the conjunctival cul de sac and thus may increase the
risk of bacillus endophthalmitis following trauma.

It has recently become known that this species can
result in a virulent endophthalmitis with total
destruction of the ocular contents, especially if the
diagnosis has been delayed. For reasons not known
the cornea has a natural resistance to the growth of
this organism; only two cases of infectious keratitis
due to a Bacillus sp. have been reported. 4 Since the
vitreous body has no lymphatic system, it may be
immunologically compromised and so offer a good
medium for the growth of B. cereus.

Bacillus cereus ocular infections may be endogenous—usually in intravenous drug
abusers 8—or exogenous—for example, following
penetrating trauma by metallic intraocular foreign
bodies. A high index of suspicion should be exercised
in patients presenting with history of penetrating
injury contaminated by soil. Other clues to diagnosis
will include a rapidly progressive panophthalmitis
with fever and leucocytosis, much like that of
Clostridium perfringens, which differs from other
micro-organisms causing endophthalmitis in not
producing systemic signs.

Once diagnosis is suspected, a vitreous tap should
not be delayed. Clindamycin, if given in the therapeu-
tic range in the vitreous, has been found to be
effective in the treatment of these infections. 18
Liesegang 19 has suggested that a method of inactivat-
ing the exotoxins responsible for the severe necrosis
in panophthalmitis should be investigated. Early
recognition and institution of therapy directed
specifically against B. cereus must be initiated early,
for the speed with which irreversible changes occur
leaves a very short time to save the eye.

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