

Bacillus cereus panophthalmitis associated with intraocular gas bubble

AMAL AL-HEMIDAN, KATHLEEN A BYRNE-RHODES,
AND KHALID F TABBARA

From the Research Department, King Khaled Eye Specialist Hospital and the Department of Ophthalmology, King Saud University, Riyadh, Saudi Arabia

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 1952,¹ *Bacillus cereus* panophthalmitis following penetrating trauma is a serious and very rare type of ocular infection, resulting in enucleation in most cases.^{2,3} 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.⁴ 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^{5,6} 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



Fig. 1 Patient with *B. cereus* panophthalmitis. Note periorbital swelling.

Correspondence to Dr Khalid F Tabbara, Research Department, King Khaled Eye Specialist Hospital, PO Box 7191, Riyadh 11462, Saudi Arabia.



Fig. 2 Photograph of CT scan showing gas bubble (a) and metallic foreign body (b). Patient lying on back with neck extended and head lowered.

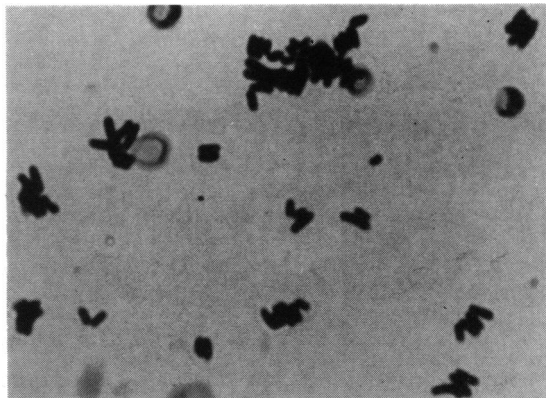


Fig. 3 Photomicrograph of bacteria taken from cooked meat broth culture. Note pleomorphism. Gram stain, $\times 620$.

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 cephazolin 500 mg every six hours, as well as topical fortified gentamicin 14 mg/ml every hour and cephazolin 50 mg/ml every hour. Intravitreal injections of cephazolin (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 leucocytosis, the white blood cells being $15.9 \times 10^9/\text{ml}$ with 83% polymorphonuclear cells.

Evisceration of the globe was carried out. Histo-pathological 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 associates⁴ 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.⁷ 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: denitrification, fermentation, and deamination.⁸

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.⁹ *Bacillus* species are capable of utilising an anaerobic pathway to produce both H₂ and CO₂, with variations seen in some strains.¹⁰

The patient reported on here showed both clinical and radiological evidence of intraocular gas production. 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.^{11,12} 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 associates¹³ reported the first case of simultaneous infection with *B. cereus* and *Clostridium bifermentans* isolated from pleural fluid. In view of the reported resistance to penicillin and grave prognosis of *B. cereus* infections¹⁴ 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. anthracis* 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 ocular 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. anthracis*, *B. cereus* is resistant to penicillin and the cephalosporins owing to the production of extracellular 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,⁶ especially in people handling hay or taking care of stables and horses. Tabbara and Burd¹⁷ have isolated *Bacillus* spp. from kohl, 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.⁶ 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 abusers¹⁸—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 therapeutic range in the vitreous, has been found to be effective in the treatment of these infections.¹⁹ Liesegang²⁰ has suggested that a method of inactivating 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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