A case of bacterial keratitis caused by multi-drug-resistant *Shewanella algae* without marine exposure

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**Abstract**

*Shewanella* are Gram-negative rods and marine pathogens. Here, we report a case of bacterial keratitis caused by *Shewanella algae* without marine exposure. A 66-year-old man with suspected pneumonia was sent to the emergency department from a nursing hospital. He had been in there for 2 years in a vegetative state and could not close his eyes voluntarily. Neither the patient nor his family had experienced any marine exposure. Keratitis was suspected in his right eye. Gram-negative rods grew from swab culture and identified as *S. algae* by matrix-assisted laser desorption/ionization time-of-flight mass spectrometry and 16S rRNA sequencing. The patient was treated with topical tobramycin, moxifloxacin and ofloxacin as well as steroids for 14 days, and the keratitis improved.

**Keywords:** *Shewanella algae*, bacterial keratitis, marine, human pathogen

**INTRODUCTION**

*Shewanella* spp. are facultatively anaerobic, Gram-negative, motile rods first described by Derby and Hammer in 1931 [1, 2]. They are typical marine pathogens found in marine, cold water environments and deep sea sediments [3]. Human infections by *Shewanella* spp. are very rare, although the number of reports has increased recently [4]. Most human infections caused by *Shewanella* spp. have a marine association, such as infection from trauma while fishing. There are more than 20 known *Shewanella* species. The species reported most frequently as human pathogens are *Shewanella putrefaciens* and *S. algae* [4]. Since first identification of *S. algae* in 1992, various human infections caused by *S. algae* have been published worldwide, including bacteremia, skin and soft tissue infection, peritonitis, pericarditis and bone infections [4]. In Korea, reported *S. algae* infections have caused endophthalmitis, tenosynovitis, peritonitis and bacteremia [5–7]; all cases were related to marine environments, including trauma while fishing, slipping on the beach and eating raw fish. Here, we report a case of keratitis caused by multi-drug-resistant *S. algae* that was not related to a marine environment.

**CASE REPORT**

A 66-year-old man was sent to the emergency department from a nursing hospital because of desaturation. He had been hospitalized for more than 2 years in an unconscious state due to a cervical spine injury. He was unable to close his eyes voluntarily. Neither the patient nor his family had a history of marine exposure. At admission, pneumonia was suspected, and conjunctival injection, purulent discharge and central white opacity were detected in his right eye. He was admitted to the respiratory department, and treatment with piperacillin–tazobactam was started for pneumonia. An ophthalmologist examined the patient at the bedside. Examination of his right eye revealed 6.0 × 5.0 mm corneal opacity and hyphema with hypopyon in the anterior chamber. Fundus examination was impossible due to corneal haziness. Corneal swabs were sent for Gram staining, bacterial culture and antimicrobial sensitivity testing,
KOH mount smear and fungal culture. Empirical treatment with tobramycin, moxifloxacin and ofloxacin eye drops was started. The KOH smear and Gram stain were negative. After a 2-day incubation, medium-sized gray and dark pink colonies grew on blood agar plate and chocolate agar plate (Fig. 1). Other types of colony did not grow on the plate. S. algae was identified by matrix-assisted laser desorption/ionization time-of-flight mass spectrometry using the Vitek system (bioMérieux, Marcy-L’Étoile, France). 16S rRNA sequencing revealed 99.93% (1410/1411 bp) identity with S. algae JCM 21037(T) (GenBank accession number BAL001000089). Susceptibility testing of the isolate indicated susceptible to amikacin, aztreonam, cefepime, ceftazidime, colistin and gentamicin, resistant to cefotaxime, imipenem, piperacillin and piperacillin/tazobactam, and intermediate to ciprofloxacin, levofloxacin and meropenem. We added steroid eye drops to control the inflammation and continued the antibiotic eye drops. After 14 days, his keratitis had improved.

**DISCUSSION**

Microbial keratitis is inflammation of the cornea caused by bacteria, fungi, or protists. The main causative bacteria are Staphylococcus aureus, Pseudomonas aeruginosa, Streptococcus pneumoniae and Serratia species [8]. Bacterial keratitis caused by Shewanella species is extremely rare. Only one case of S. algae infection has been reported worldwide; this was in the USA in 2019 [9]. In Korea, there has been one case of S. algae endophthalmitis but no reported keratitis cases [7]. We report the second case of S. algae keratitis worldwide and the first in Asia. Colonies of *Shewanella* species on medium are convex, circular, and smooth and produce an unusual brown to tan pigment, in contrast to the white colonies of the major keratitis pathogens *S. aureus* and *P. aeruginosa* [2]. The colonies we observed were also medium-sized circular smooth colonies that were dark pink to brown on both blood agar plate and chocolate agar plate (Fig. 1). This should inform clinicians of the unusual colony morphology, which differs from that of the major keratitis pathogens observed in clinical microbiology laboratory.

This case has two exceptional aspects. First, the isolate was resistant to multiple drugs. There are no criteria for antimicrobial susceptibility testing of *Shewanella* species in international guidelines, such as the Clinical and Laboratory Standards Institute and European Committee on Antimicrobial Susceptibility Testing. Therefore, we used the criteria for *P. aeruginosa*, which is a related strain. The antimicrobial susceptibility tests showed resistance to cefotaxime, piperacillin, piperacillin/tazobactam, and carbapenem and intermediate to quinolone, which shows more resistant tendency than previous reported isolates. In a 2013 review of 239 cases since 1973, 82%, 94%, 94% and 98% of *Shewanella* species were susceptible to imipenem, ciprofloxacin, piperacillin and piperacillin/tazobactam, respectively [10]. In our case, S. algae was multi-drug resistant, rendering it difficult to treat, which can lead to treatment failure. Furthermore, the types of antibiotics that can be used in eye drops are limited, decreasing the treatment options.

Second, the patient had no history of seawater exposure. *Shewanella* infections are often associated with marine exposure [5, 7]. Our patient had been hospitalized in a nursing hospital for more than 2 years, and his family had no relation to the sea. Consequently, we did not suspect *S. algae* infection in this patient sooner. It is necessary to consider whether there are *S. algae* infection routes other than marine exposure. We did not perform other culture such as stool culture, therefore it was not possible to confirm that *S. algae* existed in the patient as colonization. Although *S. algae* mainly inhabit the marine environment, there is a possibility of infection even if the patient did not have marine exposure. *S. algae* is found naturally in wildlife including seawater as well as soil, fish, meat, and dairy product [6]. There have been several cases of eye infections without marine exposure in previously published reports (Table 1). Although no

![Figure 1](image_url)

**Table 1.** Eye infections caused by *Shewanella* species

| Year | Age | Sex | Species       | Clinical manifestation | Underlying condition | Marine exposure | Country | Reference number |
|------|-----|-----|---------------|------------------------|----------------------|-----------------|---------|------------------|
| 2007 | 58  | M   | *Shewanella putrefaciens* | Keratitis | s/p LASIK | None | USA | [11] |
| 2013 | 27  | M   | *Shewanella algae* | Endophthalmitis | None | Trauma during fishing | Korea | [7] |
| 2014 | 25  | M   | *S. putrefaciens* | Endophthalmitis | None | Trauma with a fishhook | India | [9] |
| 2019 | 75  | M   | *S. putrefaciens* | Keratitis | None | None | Korea | [12] |
| 2019 | 75  | M   | *S. algae* | Keratitis | Chronic dry eye syndrome, glaucoma | None | USA | [9] |
other investigation has been conducted to find the source of the infection, it should be thought that various environment including care giving staff and ingestion of seafood also can be the sources of infection.

As in this case, clinical isolates can be extremely rare species with high levels of drug resistance and can involve an atypical patient history. For best clinical practice, clinicians need to keep an eye on the laboratory results after ordering cultures.

This is the second report of bacterial keratitis caused by multi-drug resistant \textit{S. algæ} worldwide and the first in Asia. Clinicians must track microbiology test results to determine appropriate antimicrobial treatment.

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\textbf{CONFLICTS OF INTEREST}

No conflicts of interest.

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\textbf{ETHICAL APPROVAL}

No approval was required for the case report from the local ethical committee.

\textbf{CONSENT}

Consent was obtained in written format from the patient’s family for clinical information to be reported in the journal.

\textbf{GUARANTOR}

J.C. and J.E.S.

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