## Osteomyelitis caused by Enterobacter cancerogenus infection following a traumatic injury: case report and review of the literature

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Osteomyelitis Caused by Enterobacter cancerogenus Infection following a Traumatic Injury: Case Report and Review of the Literature

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We report a case of osteomyelitis caused by Enterobacter cancerogenus resistant to aminopenicillins in a 56-year-old male who had a motorcycle accident and suffered from multiple bone fractures with abundant environmental exposure. E. cancerogenus has rarely been associated with human infections, and its clinical significance remains unclear.

CASE REPORT

A previously healthy 56-year-old lawyer had a severe motorcycle accident, in which he was thrown onto the ground. He suffered from an open fracture of the proximal third of the right leg, a right acromioclavicular (AC) luxation and multiple fractures in other body parts.

He immediately underwent surgery with reduction and external fixation of the open tibial fracture. A single dose of cefamandole (2 g) given intravenously (i.v.) was administered as prophylaxis at the time of anesthesia. Empirical therapy with amoxicillin-clavulanic acid (2.2 g given i.v. every 8 h) and metronidazole (500 mg given i.v. every 8 h) was introduced, starting from the day following the intervention. A week later, another surgery was performed in order to reduce the AC luxation and to insert an external fixator on the right ulna. Metronidazole therapy was stopped after 2 weeks.

Four weeks after admission, while on continued antibiotic treatment with amoxicillin-clavulanic acid, the patient started complaining of increasing leg pain, with concomitant appearance of spontaneous purulent drainage from the wound on the anterior tibial side. The patient remained afebrile with normal white blood cells, an erythrocyte sedimentation rate of 38 mm/h, C-reactive protein level of 8.2 mg/liter (normal values, 0 to 5 mg/liter), and fibrinogen level of 445 mg/dl. An X-ray of the right leg showed that the fracture had not healed.

A swab culture of the purulent wound grew Enterobacter cancerogenus resistant to aminopenicillins (in the presence or absence of β-lactamase inhibitor) and to cefazoline: amoxicillin-clavulanic acid was therefore stopped, and a new antibiotic regimen consisting of levofloxacin (500 mg given i.v. once a day) plus ceftriaxone (2 g given i.v. once a day) was chosen on the basis of the susceptibility tests.

At the end of the fifth week, the patient underwent extensive debridement with resection of infected and necrotic-appearing areas of the tibial bone. An Ilizarov ring fixator was positioned. E. cancerogenus was cultured again from the bone specimens collected during the operation. The resistance pattern was unchanged from that of the previous isolate, and no change in antibiotic treatment was required. In the following days, the rapid recovery of the lesion allowed the uneventful application of a skin graft. An X-ray showed an overt tendency toward healing, with newly formed bone tissue seen at the site of fracture. Inflammatory markers returned to values in the normal range.

The patient was discharged after 7 weeks of i.v. treatment with levofloxacin and ceftriaxone.

The National Nosocomial Infections Surveillance system in the United States recently reported that nosocomial infections caused by Enterobacter spp. are increasing and a matter of concern (8). This trend has been confirmed all over Europe in the last several years, with Enterobacter spp. accounting for 8% of the microorganisms isolated from intensive care units (15).

At this time, there are 13 recognized species in the genus Enterobacter. Enterobacter cloacae and Enterobacter aerogenes are routinely isolated from human clinical specimens, while the other species are mostly isolated from environmental or vegetal sources (5). Enterobacter cancerogenus is one of the five new species identified over the last few years. Originally designated enteric group 19 and first ascribed to the genus Erwinia, it has been transferred to the genus Enterobacter as a senior synonym of Enterobacter taylorae when extensive taxonomic investigations revealed its genetic identity to a microorganism identified by Urosević in 1966 and named Erwinia cancerogena (6). E. cancerogenus is a lactose-fermenting rod. E. cancerogenus has a DNA relatedness of 61% to E. cloacae and differs from it mostly by being ornithine decarboxylase negative and D-arabinose positive.

E. cancerogenus exhibits natural resistance to aminopenicillins (i.e., amoxicillin and amoxicillin-clavulanic acid) and/or to narrow- and expanded-spectrum cephalosporins (i.e., cefaclor, cefazoline, loracarbef, and cefoxitin). The β-lactam phenotype of E. cancerogenus is similar to that expressed by other well-known Enterobacter spp. and indicates the presence of chromosomally encoded AmpC β-lactamases (Amber class C β-lactamases) (3, 12, 14).

In agreement with our finding, Pitout et al. found inducible AmpC β-lactamases in all E. cancerogenus strains examined (n = 6), with isoelectric point (pI) values of >9, suggesting an enzyme similar to those found in the same study in wild-type
No. of
Researchers and
patients
Case description
Outcome
Antibiotic treatment

1987 Westblom and Coggins (16) 1 Osteomyelitis of the femur in a 18-yr-old man with an open fracture
Chronic infection
Cefotaxime (2 weeks); cefotaxime/11001 tobramycin
NA

1989 Reina et al. (10, 11) 2 Urinary tract infection in a 70-yr-old adult with urinary lithiasis
NA
b
Infection of a traumatic cranial wound (car crash) in a 36-yr-old man
NA NA
Tobramycin (4 days); cefotaxime
Died

1997 Martinez et al. (7) 3 Two cases of
1997 Abbott and Janda (2) 5 Infection of the hand after traumatic cut
Cephradine
Healed
Bacteremia, cholangitis, and pneumonia in a 75-yr-old man with adenocarcinoma of the gallbladder
Died
Multiple aminoglycosides; penicillin
NA

2. Most cases have common features: traumatic wounds with environmental source of infection, E. cancerogenus infections seem to occur mostly in the setting of contaminated wounds, even if other exposures have been reported (Table 1). The aim of our brief report is primarily to contribute to the understanding of E. cancerogenus infections, to the knowledge of the epidemiology, clinical manifestations, and therapeutic options. In this case, the history of an open fracture following a crush injury suggests an environmental, rather than nosocomial, source of the organism: indeed, E. cancerogenus is generally recovered from environmental or vegetal sources and is considered mostly phytopathogenic (1). Our strain displayed a multidrug resistance profile and was resistant to multiple antibiotics, including extended-spectrum cephalosporins and aminoglycosides, which are often ineffective against E. cancerogenus isolates. The combination of ACT-1, a plasmid-mediated AmpC beta-lactamase, and carbapenem resistance in E. cancerogenus isolates is associated with severe trauma or crush injuries. This highlights the importance of considering E. cancerogenus infections when treatment with aminopenicillin is unsuccessful or when wound environmental contamination is plausible.

REFERENCES