Osteomyelitis and septic arthritis caused by *Kingella kingae*

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SUMMARY The clinical and bacteriological findings in two cases of osteomyelitis and one case of septic arthritis caused by *Kingella kingae* are presented. This appears to be the first report providing clear evidence for a pathogenic role for this species in bone and joint infections.

In 1968, Henriksen and Bøvre¹ reported the results of their study on strains of bacteria representative of a group designated as *Moraxella*, new species 1 by Miss EO King and as group M-1 by later workers at the Center for Disease Control (CDC), Atlanta, USA.² Although the group showed marked differences from *Moraxella* spp, the authors considered that the similarities shown were sufficient to warrant inclusion in the genus, and described a new species, *Moraxella kingii*, later corrected to *Moraxella kingae*.³ In 1976, Henriksen and Bøvre⁴ presented genetic and phenotypic evidence to justify the transfer of *Moraxella kingae* to a new genus, *Kingella*.

Of the 75 isolates of *Kingella kingae* referred to CDC, 35 were from blood, 14 from throats and 21 from bone- or joint-associated sites.² However, no information on the clinical significance of the isolates is recorded. We report here three isolations of the species, two from cases of osteomyelitis and one from a case of septic arthritis. This appears to be the first report in which a pathogenic role for *Kingella kingae* in bone and joint infections is specifically highlighted.

Case reports

PATIENT 1

A six-month-old baby boy was admitted to hospital on 18 May 1978 with a painless lump over the upper left portion of the sternum. Although the lump had gradually enlarged since it was first noticed one week before admission, the child had been well and afebrile. Examination revealed a hard non-fluctuant mass, measuring approximately two centimetres in diameter, over the manubriosternal junction. The lump appeared to be attached to deeper structures,

not to the skin. An x-ray examination revealed rarefaction of the lower part of the manubrium, with a large, soft tissue swelling anterior to the sternum; there were no areas of rarefaction in the skull, pelvis or long bones. The day after admission, the lump was incised and surgically drained of approximately one millilitre of thick, yellow pus and the area of bone was curetted. Histological examination revealed the wall of an abscess. No organisms were seen in a Gram-stained smear of the pus, but culture of the specimen yielded a profuse, pure growth of *Kingella kingae*. The osteomyelitis was treated with cloxacillin (250 mg six-hourly intravenously, then orally) and penicillin (125 mg six-hourly intravenously, then 200 mg six-hourly intravenously, then 250 mg six-hourly orally) then with penicillin only (150 mg six-hourly orally) when the isolate was found to be sensitive to penicillin. The treatment was continued for six weeks. A scanty growth of a *Peptostreptococcus* sp was obtained from a swab of the wound four days after the operation; otherwise the wound healed well and the infection responded satisfactorily to antibiotic treatment.

PATIENT 2

A two-year-old boy was admitted to hospital on 14 May 1979 with a history of a limp and pain in the left hip over the previous four weeks. An x-ray examination made almost two weeks before admission had shown a lytic lesion in the metaphysis of the left upper femur and the child was referred to the hospital for further investigations. On admission, the child was afebrile and appeared well. An x-ray examination made the day after admission showed a moderate progression of the lytic lesion; this result, together with that of a bone scan, suggested a diagnosis of low-grade osteomyelitis. Three days after admission, curettage of the femoral neck was carried out. The histology of the curetted material

was consistent with a diagnosis of chronic osteomyelitis. A Gram-stained smear of the material showed cellular debris and pus cells, but no organisms; culture yielded a scanty, pure growth of *Kingella kingae*. Antibiotic treatment with flucloxacillin and ampicillin (both 500 mg six-hourly intravenously) was commenced after the operation; both antibiotics were taken orally after three days and the therapy was continued for six weeks. Apart from a brief, low-grade pyrexia post-operatively, the patient's recovery was uneventful and he was discharged from hospital nine days after admission. An examination six weeks later showed a satisfactory response to the antibiotic treatment and he has required no further attention.

PATIENT 3

A 13-year-old boy was admitted to hospital on 14 January 1978 with a history of pain in the left hip over the previous 24 hours. The patient gave an uncertain story of a previous fall but had been otherwise well. On examination, the left hip was irritable with some restriction of the extremes of movement; by the next afternoon, the hip was too painful to move and the patient's temperature had risen to 38.6°C. When purulent fluid was aspirated from the joint in theatre that day, an immediate arthrotomy was performed and more pus was obtained. No organisms were seen in a Gram-stained smear of the pus. A light, pure growth of *Kingella kingae* was obtained from culture. The isolate was sensitive to penicillin so the initial antibiotic treatment of cloxacillin and ampicillin (both 500 mg six-hourly intravenously) was changed to penicillin (one million units six-hourly intravenously). When the patient's condition did not improve over the next few days, the penicillin dosage was doubled to two million units six-hourly intravenously and probenecid was given. The condition of the patient improved and he became afebrile within 24 hours. After eight days, he again became febrile and developed a skin rash. Although there was some evidence of a viral infection in the patient, the possibility of a hypersensitivity reaction to penicillin could not be excluded so tetracycline (250 mg six-hourly orally) was substituted for the penicillin treatment. The patient rapidly improved and was allowed home on crutches three weeks after admission. Tetracycline treatment was continued for two and a half weeks after discharge. When seen four months later, he had completely recovered.

BACTERIOLOGY

Cultures of pus and bone lesion material, collected before the start of antibiotic treatment, were incubated on horse blood agar at 35°C aerobically

and anaerobically (patients 1 and 2) and at 37°C under 5% CO₂ and anaerobically (patient 3). Cultures for detection of *Haemophilus* spp were included in all cases.

The colonial morphology and haemolytic properties of the three isolates were described from 5% (vol/vol) horse blood agar (HBA). Ability to grow anaerobically was tested on HBA and nutrient agar by incubation in an atmosphere of 90% H₂ and 10% CO₂. Biochemical characteristics were determined mainly by the methods and media described by Cowan and Steel.⁵ Deamination of phenylalanine and growth in minimal medium with β -hydroxybutyrate as the sole carbon source were tested by methods described by Bøvre and Henriksen.⁶ Acid production from glucose, lactose, maltose and sucrose was determined in cystine trypticase agar medium (CTA Medium, BBL) containing 1% carbohydrate. Hugh and Leifson's OF medium, Thornley's arginine agar and all peptone-based liquid media were supplemented with 5% horse serum.

Tests for antimicrobial sensitivity were performed by the CDS method described by Bell.⁷

Colonies on HBA after 48 hours' incubation under 5% CO₂ at 35°C were gray, semi-opaque, low convex and smooth in consistency, with an entire edge. They were 1.5 to 2 mm in diameter and surrounded by a narrow zone of β -haemolysis. Slight pitting of the medium occurred around the colonies of strains from patients 2 and 3. Gram-stained smears of all isolates showed plump Gram-negative coccobacilli and bacilli in pairs and chains.

Optimal growth occurred at 35°C in an atmosphere containing 5% CO₂; growth under anaerobic conditions was weaker and under aerobic conditions was delayed and poor. Colonies grew weakly and slowly on HBA at 22°C. The presence of blood or serum promoted growth; no requirement for "X" or "V" factors was demonstrated. No growth occurred on MacConkey agar. The organisms were non-motile when grown at 37°C and 22°C.

The results of biochemical tests performed on the isolates from patients 1 and 2 are shown in the Table. These results, together with the growth characteristics, microscopic morphology and motility results, agreed with those obtained for the holotype strain of *Kingella kingae* (*Moraxella kingii* NCTC 10529).

The isolates from patients 1 and 2 were sensitive to penicillin, ampicillin, cloxacillin, erythromycin, tetracycline, cotrimoxazole, gentamicin and chloramphenicol.

The isolate from patient 3 died before its characterisation could be completed. However, its growth characteristics, microscopic morphology, saccharolytic activity, positive oxidase and negative catalase

*Characteristics of the holotype strain of Kingella kingae (Moraxella kingii NCTC 10529) and of the isolates from patients 1 and 2**Isolates positive for:*

Acid from glucose	Fermentative reaction in
Acid from maltose	Hugh and Leifson's OF
Casein digestion	medium
Cytochrome oxidase	Phosphatase

Isolates negative for:

Acid from lactose	Indole production†
Acid from sucrose	Lysine decarboxylase
Aesculin hydrolysis	Nitrate reduction
Arginine hydrolysis	Opalescence on lecithovite agar
Catalase	Ornithine decarboxylase
Deoxyribonuclease	Phenylalanine deaminase
Digestion of inspissated serum	Starch hydrolysis
Gelatin liquefaction	Tween 80 hydrolysis
Growth on β -hydroxybutyrate	Urease
Growth on Simmons' citrate agar	β -galactosidase
Hydrogen sulphide production in TSI*	

Isolates differed in:

Hydrogen sulphide production (lead acetate paper)‡

*TSI = triple sugar iron agar.

†Using Kovács' reagent.

‡Isolate from patient 1, negative; holotype strain and isolate from patient 2, trace.

and nitrate reactions allowed it to be identified as *Kingella kingae*.

Discussion

Henriksen considers that the natural habitat of *Kingella kingae* is the mucous membranes of the upper respiratory tract where it exists as a "comparatively harmless parasite."⁸ It has been incriminated in two cases of infective endocarditis.^{9 10} It has also been reported from blood cultures, bone- or joint-associated sites, throat cultures, a nose culture and an abscess in an eyelid.^{1 2 8} However, in these cases either clinical information is not given or the pathogenicity of the organism is in doubt. Although 21 of the 75 isolates of *Kingella kingae* held at the Center for Disease Control have as their source bone- or joint-associated sites,² the pathogenic role of this species in bone or joint infections does not appear to have been documented. We could find no reports of osteomyelitis associated with *Kingella* spp or *Moraxella* spp, and only two recorded cases of septic arthritis associated with *Moraxella* spp.^{11 12} A third and more recent report on the identification of a *Moraxella* sp from infectious arthritis in an adult¹³ was based on inadequate criteria and the inappropriate use of the API 20E system in the characterisation of a fastidious Gram-negative diplococcus. The three cases reported here are of interest because, in each case, the isolation of *Kingella kingae* in pure culture indicates the organism's probable pathogenic role in the infection. Apart from

the age of patient 1 and the possibility of previous injury to the hip of patient 3, there appear to have been no conditions in the patients described that would have predisposed them to infection. It is likely that the bacterium was spread from its normal site by a haematogenous route to the bone or joint.

Kingella kingae was originally described as a species of *Moraxella*, and its microscopic appearance, fastidious growth requirements, positive oxidase reaction and sensitivity to penicillin are characteristic of that genus. It may be distinguished from *Moraxella* spp, however, by its negative catalase reaction and its saccharolytic activity. Two other Gram-negative rod-shaped organisms, *Eikenella corrodens* and *Cardiobacterium hominis*, share the fastidious growth requirements of *Kingella kingae* as well as its unusual combination of positive oxidase and negative catalase reactions. Characteristics for distinguishing *Kingella kingae* from these two species as well as from *Moraxella* spp, *Branhamella* spp, and other members of the *Kingella* genus, have been described by Snell and Lapage.¹⁴

Kingella kingae is not commonly encountered in clinical specimens and may be unfamiliar to many laboratory workers. The cases reported indicate the need to consider this organism as a possible pathogen in bone and joint infections.

Addendum

We have recently noted a letter (Redfield DC *et al.* *Arch Dis Child* 1980;**55**:411) reporting the isolation of *Kingella kingae* from the blood of a leukaemic child with skin lesions and arthritis of the left knee.

We are grateful to Mr W Huffam of the Geelong District Hospital, Geelong, and Mr A Woodward and Mr M Menelaus of the Royal Children's Hospital, Melbourne, who kindly provided us with the clinical information that made this paper possible. We also thank Ms J Banks of the Geelong District Hospital and Mr A Hewstone and Miss M Ritchie of the Royal Children's Hospital for their valuable help.

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