Osteomyelitis Caused by *Pantoea agglomerans* in a Closed Fracture in a Child

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**abstract**

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Development of osteomyelitis in a closed fracture is rare. Although it has been reported that trivial trauma may be associated with the subsequent development of acute osteomyelitis, no evidence has been found that fractures are involved in the etiology of osteomyelitis. Only 25 cases (11 in adolescents) of osteomyelitis after closed fracture have been reported in literature.

The authors report a case of osteomyelitis in an 8-year-old girl after a forearm fracture involving the diaphysis of the radius and ulna. Radiographic examinations were performed 5, 14, and 30 days after trauma. At last examination, the forearm appeared swollen and red. Blood culture and radiographs confirmed the clinical suspicion of osteomyelitis. The cultures grew *Pantoea agglomerans*, a saprophytic gram-negative bacterium commonly isolated from plants, flowers, seeds, water, and soil and sensitive to all of the most common antibiotics. After the arm was immobilized, high doses of intravenous antibiotics were administered for 4 weeks, and oral antibiotics were prescribed for an additional 4 weeks. The patient responded well to treatment. Twelve months after the initial injury, the patient regained full elbow and wrist flexion–extension range of motion.

Based on their experience and a review of the literature, the authors suggest that bone infection be considered for patients with closed fractures complicated by excessive or prolonged pain and swelling with evident signs of inflammation where no other obvious infection is apparent. Moreover, in children, bacterial infection may cause osteomyelitis more frequently than in adults, but no evidence exists that a closed fracture increases the incidence of osteomyelitis in children with a systemic infection.

**Figure:** Oblique (A) and anteroposterior (B) radiographs of the forearm showing a minimally displaced fracture of the diaphysis of the radius and ulna.
Development of osteomyelitis in a closed fracture is rare. Although it has been reported that trivial trauma may be associated with the development of acute osteomyelitis, some authors reported that no evidence indicated that fractures were involved in the etiology of osteomyelitis. To the current authors’ knowledge, only 25 cases (11 in adolescents) of osteomyelitis after closed fracture have been reported in literature.

The current authors report a case in which a bone infection developed after a closed fracture of the forearm involving the diaphysis of the radius and the ulna.

**CASE REPORT**

An 8-year-old girl presented to the emergency department at the authors’ hospital after falling from a seesaw and landing on her left forearm. Skin abrasions were found only on the palmar side of her hand, and no foreign bodies were found. Radiographs of the forearm revealed a minimally displaced fracture of the diaphysis of the radius and ulna (Figure 1). Closed reduction was performed without anesthesia.

The fracture was immobilized in an above-the-elbow plaster cast. Five and 14 days after trauma, radiographic examinations showed that the fractured bones were well aligned, and no signs of osteomyelitis were observed (Figure 2). Thirty days after trauma, the patient returned for a radiographic examination and cast removal.

At this time, the forearm appeared swollen and red. Her mother reported for the first time that the girl had had a continuous fever of 37.5°C to 38°C since the day before the trauma and that the pediatrician, suspecting an upper respiratory tract infection, had prescribed oral ampicillin that was administered for 5 days. Moreover, the mother reported that in the past week the child had complained of pain in her forearm, and the pediatrician had prescribed 250 mg of acetaminophen taken 2 times per day. Based on this new information, a blood examination was performed; the white blood cell count was higher than normal, and a proportional increase in neutrophils was found.

Radiographs taken at this time showed diffuse changes in the radius and ulna extending from the fracture site to the proximal metaphyses and involving the entire diaphysis (Figure 3). The distal diaphysis of the radius and ulna were not involved, nor were any carpal bones near the initial wound. Osteomyelitis was suspected; however, blood culture results were negative.
Surgery was the second diagnostic/therapeutic step. Two surgical access sites were used to explore the infection site. Intraoperatively, a small amount of purulent liquid was discovered. On visual examination, the surrounding soft tissue appeared to be infected. Wound swabs, tissue samples, and blood were collected for Gram staining and cultures. Irrigation, debridement, periosteal stripping, and bone drilling were performed. A direct connection was not found between the initial skin lesions and the bones, and no foreign bodies were found.

Pathology specimens showed fibrous tissue focally infiltrated by plasma cells and lymphocytes. Cultures from the ulna and radius (with no risk of contamination...}

<table>
<thead>
<tr>
<th>Study</th>
<th>Patient</th>
<th>Sex/Age, y</th>
<th>Infection Site</th>
<th>Time From Injury</th>
<th>Possible Primary Infection Source</th>
<th>Organism</th>
<th>Factors Affecting Infection Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veranis et al⁵</td>
<td>F/9</td>
<td>Radial neck</td>
<td>2 wk</td>
<td>Respiratory infection</td>
<td>None grown</td>
<td>None</td>
<td></td>
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<tr>
<td>Canale et al⁸</td>
<td>M/11</td>
<td>Distal radius</td>
<td>1 wk</td>
<td>Sore throat</td>
<td>None grown</td>
<td>None</td>
<td></td>
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<tr>
<td>Hardy &amp; Nicol⁷</td>
<td>M/10</td>
<td>Femoral shaft</td>
<td>8 wk</td>
<td>Tonsillitis</td>
<td>S aureus</td>
<td>None</td>
<td></td>
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<tr>
<td></td>
<td>M/5</td>
<td>Femoral shaft</td>
<td>10 wk</td>
<td>Urinary tract infection</td>
<td>Micrococcus</td>
<td>None</td>
<td></td>
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<tr>
<td></td>
<td>F/8</td>
<td>Bilateral distal radii</td>
<td>3 d</td>
<td>Pharyngitis</td>
<td>None grown</td>
<td>None</td>
<td></td>
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<tr>
<td></td>
<td>M/13</td>
<td>Tibia &amp; mandible</td>
<td>21 &amp; 34 d</td>
<td>IV site</td>
<td>Staphylococcus aureus, Strptococcus, Bacteroides fragilis, B melaninogenicus, unidentified Streptococcus</td>
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<td></td>
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<tr>
<td>Watson &amp; Whitesides⁸</td>
<td>F/58</td>
<td>Humeral neck</td>
<td>4 d</td>
<td>IV site</td>
<td>S aureus</td>
<td>Alcoholism</td>
<td></td>
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<tr>
<td></td>
<td>F/61</td>
<td>Humeral neck</td>
<td>8 d</td>
<td>IV site</td>
<td>Betahealmonic streptococcus B</td>
<td>Diabetes</td>
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<tr>
<td></td>
<td>F/96</td>
<td>Femoral neck</td>
<td>12 d</td>
<td>Respiratory &amp; urinary tract infections</td>
<td>None grown</td>
<td>None</td>
<td></td>
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<tr>
<td></td>
<td>F/59</td>
<td>L3 vertebra</td>
<td>22 d</td>
<td>Respiratory &amp; urinary tract infections</td>
<td>Bacteiroides</td>
<td>Diabetes</td>
<td></td>
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<tr>
<td>Aalami-Harandi ¹⁵</td>
<td>M/4</td>
<td>Distal radius</td>
<td>2 wk</td>
<td>U</td>
<td>U</td>
<td>U</td>
<td></td>
</tr>
<tr>
<td>Atsatt ¹⁶</td>
<td>M/60</td>
<td>L2 vertebra</td>
<td>13 d</td>
<td>Gingiva</td>
<td>Streptococcus</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Baharuddin &amp; Sharaf ¹⁷</td>
<td>M/5</td>
<td>Femur</td>
<td>7 wk</td>
<td>U</td>
<td>S aureus</td>
<td>None</td>
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<tr>
<td>Baskaran et al ¹⁸</td>
<td>M/38</td>
<td>Femur</td>
<td>N/A</td>
<td>U</td>
<td>U</td>
<td>None</td>
<td></td>
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<tr>
<td>Cozen ²⁰</td>
<td>F/50</td>
<td>Tibia</td>
<td>5.5 mo</td>
<td>U</td>
<td>Staphylococcus</td>
<td>U</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F/60</td>
<td>Femoral neck</td>
<td>5.5 mo</td>
<td>U</td>
<td>Pseudomonas</td>
<td>U</td>
<td></td>
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<tr>
<td>Cuschieri et al ²¹</td>
<td>M/18</td>
<td>Sternum</td>
<td>U</td>
<td>Mediastinitis</td>
<td>S aureus</td>
<td>Drug abuse</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M/18</td>
<td>Sternum</td>
<td>U</td>
<td>Mediastinitis</td>
<td>S aureus</td>
<td>Drug abuse</td>
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</tr>
<tr>
<td></td>
<td>M/18</td>
<td>Sternum</td>
<td>U</td>
<td>Mediastinitis</td>
<td>S aureus</td>
<td>Drug abuse</td>
<td></td>
</tr>
<tr>
<td>Enat et al ²²</td>
<td>M/57</td>
<td>Sternum</td>
<td>3 wk</td>
<td>Pneumonia</td>
<td>S aureus</td>
<td>Prediton for asthma</td>
<td></td>
</tr>
<tr>
<td>Milgram &amp; Romine ²³</td>
<td>F/52</td>
<td>L3 vertebra</td>
<td>6 wk</td>
<td>Gangrenous foot</td>
<td>S aureus</td>
<td>Diabetes</td>
<td></td>
</tr>
<tr>
<td>Seifon ²⁴</td>
<td>M/6</td>
<td>Femur</td>
<td>4 wk</td>
<td>IV site</td>
<td>Pneumococcus</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviation: IV, intravenous; U, unknown.
because the cultures were taken from 2 different accesses grew Pantoea agglomerans. The antibiogram showed adequate serum cidal levels with the most common antibiotics. The arm was immobilized using a brachial–metacarpal cast, and high doses of intravenous cloxacillin were prescribed for 4 weeks; then, oral antibiotics were prescribed for 4 more weeks. The patient responded well to treatment.

Three months after injury, radiographic examination confirmed improvement but showed ossification of the interosseous membrane (Figure 4). Twelve months after injury, the patient regained full flexion–extension range of elbow and wrist motion, but a partial loss of pronosupination had occurred consequent to ossification of the interosseous membrane.

**Discussion**

Pantoea agglomerans (formerly identified as Erwinia species) is a saprophytic gram-negative motile rod commonly isolated from plants, flowers, seeds, water, and soil. It is relatively easy to grow with standard microbiological media and is thought to be low in virulence and sensitive to most antibiotics used for a gram-negative organism. A literature review revealed that bacterial growth after plant thorn injuries is reported infrequently. The organism’s pathogenicity became apparent in 1970, when 9 infants died from an intravenous solution infected with Pantoea agglomerans. A P agglomerans infection is suspected when a penetrating trauma with a retained foreign body occurs in a patient living in a rural area and the patient reports chronic symptoms of pain, swelling, and loss of motion. In the international literature, the authors found 6 cases of septic arthritis after plant thorn injury, 1 case of osteomyelitis after a tibial open fracture, and 8 cases of osteomyelitis caused by P agglomerans associated with a penetrating trauma without fracture.

In the current case, the child fell while she was playing on a seesaw. She reported skin abrasions only on her hand, and although contamination cannot be excluded, the authors found no foreign bodies in the skin abrasions, and the infection site extended far from the wounds.

The alterations in her temperature since the day before trauma, with antibiotic therapy and no evidence of foreign bodies, may suggest an acute hematogenous osteomyelitis, although they are rare. Hematogenous osteomyelitis secondary to a soft tissue injury has been reported as a rare complication. In 1 study, an association was found between infection and a history of seemingly trivial blunt trauma but not with fracture in one-third of osteomyelitis cases. Farr found no evidence of related trauma in 98 cases of hematogenous osteomyelitis. A literature search revealed few documented cases of a closed fracture that became secondarily infected.

The literature review also revealed a 48% incidence of osteomyelitis in closed fractures occurring in children (mean age, 9 years) and this is in agreement with Nade, who reported that the explanation for the rate of osteomyelitis in closed fractures in children could be found in the peculiar vascular arrangements of growing bone.

The current case and the literature review focused the authors’ attention on some mandatory clinical aspects of osteomyelitis in closed fractures. They are statistically more frequent in children, perhaps due to their immune systems and bone physiology at this age. A delay in diagnosis often occurs because the pain is mild, possibly because the cortex has already been broken by the fracture, so the pressure in the bone is decreased.

The frequency of osteomyelitis is not related to the fracture but rather to the patient’s age. Osteomyelitis complicating closed fractures is a rare event, and trauma is probably not a significant factor in the pathogenesis of acute hematogenous osteomyelitis.

**Conclusion**

In children, osteomyelitis is a rare event that occurs in closed fractures. Pantoea agglomerans is an uncommon cause of infection in children. Diagnoses of bone or joint infections are often delayed due to the indolent nature of the pathogen and the low level of clinical suspicion for this bacterium. Moreover, the radiographic evidence of osteomyelitis is clear only after 4 to 5 weeks. In the current case, the authors performed radiographic examinations 5, 14, and 30 days after trauma and only found radiographic evidence of osteomyelitis at the last examination (Figure 3). Consequently, the diagnosis is often made when a child has evidence of chronic osteomyelitis, altering the treatment duration and prognosis.

In children, a bacteria infection may cause osteomyelitis more frequently than in adults, but the current study found no evidence that a closed fracture increased the incidence of osteomyelitis in a child with a systemic infection.

**References**

8. Watson FM, Whitesides TE Jr. Acute hematogenous osteomyelitis complicating closed


