CLINICAL REPORT

Salmonella enterica subsp. arizonae bone and joints sepsis. A case report and literature review

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Summary Osteoarticular infections caused by Salmonella enterica subsp. arizonae are rarely seen in humans but young children and immunocompromised adults are at particular risk of acquiring this bacteria. Reptiles and their by-products (e.g. meat preparations or medications) are particularly likely to harbor Salmonella. We report on a case of septic arthritis of the hip transmitted by a reptile in a 10-month-old child. We carry out a recall of the complex nomenclature of Salmonella, a review of the literature and provide information on the recommended precautions for reducing the risk of transmission of Salmonella from reptiles to humans.

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Introduction

Salmonella enterica subsp. arizonae is an uncommon human pathogen. Most cases described in the literature occurred in the south-western United States, in immunocompromised infants and adults. These bacteria are usually transmitted to humans after direct or indirect contacts with reptiles or by ingestion of snake-based products (e.g. meat, traditional medicine preparations).

We report on a case of septic arthritis of the hip caused by S. enterica subsp. arizonae in a 10 month-old child contaminated by a pet snake. To the best of our knowledge, there is no similar case report in the French literature. The aim of the current study was to provide a clear interpretation of the complex nomenclature of Salmonella, to look through the literature and provide information on the recommended precautions for reducing the risk of transmission of Salmonella from reptiles to humans.

Clinical case

Antoine W., a 10 month-old boy with no previous medical history, was admitted to the emergency department with a history of painful left lower limb. The patient had developed an episode of high-grade fever (39.5 °C) 24 hours prior...
to admission. Clinical examination suggested involvement of the hip joint and scan revealed a 3.8 mm articular effusion. Laboratory findings showed an inflammatory response (CRP: 68 mg/L, leucocytosis: 16.2 $\times 10^3$/L). Clinical diagnosis of septic arthritis of the left hip was confirmed. Results of plain pelvic and left hip radiographs were normal. An articular puncture under general anesthesia was subsequently performed prior to traction of the limb and a probabilistic antimicrobial therapy of intravenously administered amikaccine (150 mg/kg per day in one taking) and cloxacillin (100 mg/kg per day in three doses) was initiated. Bacteriological analysis of synovial fluid identified the presence of S. enterica subsp. arizonae and the isolate was subjected to antibiotic susceptibility testing. Blood cultures obtained at day 1, 2 and 3 were found to be sterile. A stool culture was performed 48 hours after the beginning of antibiotic therapy and did not reveal the presence of the bacterium.

Since no clinical and biological improvement was observed at 72 hours, a scan was repeated. It provided evidence of a 7 mm articular effusion. Intra-articular puncture/drainage was performed again and adapted antibiotic therapy was initiated according to antibiogram data (cloxacillin replaced by cefotaxime 100 mg/kg per day in three daily dosings). After 5 days of treatment, amikaccine was stopped and cefotaxime administering was pursued. Clinical improvement and apyrexy were noted at 8 days with normalization of CRP level at day 14, a resin long leg pelvic cast was applied and intravenous ceftriaxone administration was continued for 4 weeks, 50 mg per day once-daily dosing regimen to facilitate home-care treatment.

Radiographic examination reported satisfactory outcome at 1 year follow-up with no recurrence of infection and no observable growth disorder.

Anamnesic data revealed that the family had acquired a corn snake 2 years ago which used to live in a vivarium up to then. The snake had escaped from its cage 2 weeks earlier and had been allowed to roam freely throughout the house. A stool culture from the snake yielded Salmonella.

**Discussion**

Salmonella nomenclature is complex and has been subjected to many changes and controversies. Nevertheless, good understanding of Salmonella nomenclature is necessary to carry out a relevant bibliographic research. S. enterica subsp. arizonae is a Gram negative bacillus and a member of the family Enterobacteriaceae, first described by Caldwell and Ryerson [1] in 1939 and named Salmonella dar-essalaam. It was subsequently reclassified Arizonahinshawii, Salmonella arizonae, Salmonella choleraesuis subsp. arizonae and finally S. enterica subsp. arizonae in 2002 [2]. Currently, authors may choose among the two available systems of nomenclature: S. choleraesuis subsp. arizonae (old system) and S. enterica subsp. arizonae (new system) [3].

A review of the literature [4–17] from 1944 up to now reported 22 cases of osteoarticular infections caused by S. enterica subsp. arizonae (Table 1).

This series of 23 patients includes 10 males and 13 females. The average age was 30 years old (ranging from 7 months to 73 years). Two higher-risk groups can be established from this population: children under five with no particular medical history (six cases) and patients with severe underlying chronic pathology (19 cases), 11 of which are treated with long-term corticothreapy. Drepanocytosis is a well-known predisposing factor for osteoarticular infections caused by Salmonella [18].

The source of contamination was identified in 12 out of 23 patients; Salmonella infection was attributed to ingestion of snake-based traditional remedies in seven cases, exposure to a reptile in four cases and ingestion of non-pasteurized milk in one case.

Salmonella is usually contracted by consumption of contaminated eggs, snake meat and snake-based traditional medications [14,15] or hand-transmitted [19] as animal skin, feces and vivarium are particularly likely to be contaminated [20]. A case of transmission by animal bite is also reported [21]. In the present case, it was probably a hand-transmitted infection.

Specifically snakes, lizards, turtles and other cold-blood reptiles can act as reservoirs of Salmonella [17,20,22], 90% of reptiles are carriers of one or more species of Salmonella, potentially pathogenic for human. No serotype is specific to reptiles. Snakes are usually unaffected carriers but S. enterica subsp. arizonae might sometimes reveal pathogenic for animal [23].

The use of snake-based traditional medication preparations in Spanish–American communities in the southern United States accounts for the geographic repartition of osteoarticular infections caused by S. enterica subsp. arizonae. Our case report is the second one in Europe and the first one in France.

Annually, 93,000 reptile-associated cases of Salmonella infection (7%) are reported in the United States. Accurate diagnosis is challenging since clinical symptoms are frequently benign and do not lead to bacteriological investigations. There is an increasing prevalence of reptile-related Salmonella infections in the United States [25] due to the ever-growing number of pet reptile owners. From 1991 to 2001, the estimated number of households with reptiles doubled to reach 1.7 million or approximately 3% of the American households which represents 7.3 million reptiles [24,25].

Salmonella bacteria generally induce benign gastroenteritis but may also be an etiologic agent of severe infections (septicemia, urinary tract infections, osteomyelitis, pericarditis, myocarditis, peritonitis). Diseases of the locomotive organs are uncommon.

Among the 23 patients of the series, the localized infection involves a single site in the body whereas eight cases demonstrate disseminated infections in various organs [2–7]. The knee is the most commonly affected joint (13 times). Associated symptoms, not involving the locomotive organs, are reported in 10 patients. They include gastroenteritis in six cases, urinary tract infections in six cases, septicemia in six cases and one case of septic complications in false aortic aneurysm.

Treatment of osteoarticular infections caused by S. enterica subsp. arizonae is not consensual. Actually, antimicrobial therapy is comprehensive and various lengths of treatment are available (from one week to lifetime treatments). Recovery was achieved in 19 patients (including our case), four patients died within 6 months (two of...
### Table 1 Presentation of the series.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Age</th>
<th>Gender</th>
<th>Associated pathology</th>
<th>IS</th>
<th>Type of osteoarticular infection</th>
<th>Other symptoms</th>
<th>Antibiotic course</th>
<th>Other treatments</th>
<th>Recurrence</th>
<th>Outcome (last follow-up)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fischer [4]</td>
<td>2 years</td>
<td>M</td>
<td>Histiocytose X</td>
<td>NC</td>
<td>Disseminated osteomyelitis</td>
<td>Septicaemia, gastroenteritis</td>
<td>7 months</td>
<td>Radiotherapy</td>
<td>No</td>
<td>Recovery (1 year)</td>
</tr>
<tr>
<td>Krag and Shean [5]</td>
<td>63 years</td>
<td>F</td>
<td>Idiopathic thrombopenic purpura</td>
<td>NC</td>
<td>Knee osteoarthritis</td>
<td></td>
<td>No</td>
<td>Bone curettage</td>
<td>NC</td>
<td>Death</td>
</tr>
<tr>
<td>Guckian et al. [6]</td>
<td>52 years</td>
<td>F</td>
<td>Disseminated lupus erythematous, diabetes, Raynaud syndrome</td>
<td>Yes</td>
<td>Bilateral knee arthritis + pre tibial abscess</td>
<td>Urinary tract infection, gastroenteritis (1) <em>Barre de visée proximale</em></td>
<td>Articular drainage</td>
<td>Yes, 3 months antibiotic therapy</td>
<td>Recovery</td>
<td></td>
</tr>
<tr>
<td>Hruby et al. [7]</td>
<td>2.5 years</td>
<td>F</td>
<td>Drepanocytosis</td>
<td>NC</td>
<td>Disseminated osteomyelitis</td>
<td>Septicaemia</td>
<td>6 weeks</td>
<td>No</td>
<td>Recovery (8 months)</td>
<td></td>
</tr>
<tr>
<td>Smilack and Goldberg [8]</td>
<td>23 years</td>
<td>F</td>
<td>Disseminated lupus erythematous, drepanocytosis</td>
<td>Yes</td>
<td>Knee and shoulder arthritis + tibial abscess</td>
<td></td>
<td>No</td>
<td>NC</td>
<td>Yes</td>
<td>Recovery</td>
</tr>
<tr>
<td>Keren et al. [9]</td>
<td>53 years</td>
<td>M</td>
<td>Ethylism</td>
<td>No</td>
<td>T12L1 vertebral osteitis</td>
<td>Gastroenteritis</td>
<td>3 weeks</td>
<td>Yes, 1 year antibiotic therapy</td>
<td>Recovery (2 years)</td>
<td></td>
</tr>
<tr>
<td>Ogden [10]</td>
<td>1 year</td>
<td>M</td>
<td>Drepanocytosis</td>
<td>No</td>
<td>Osteomyelitis</td>
<td></td>
<td>No</td>
<td>No</td>
<td>Recovery</td>
<td></td>
</tr>
<tr>
<td>Ogden and Light [10]</td>
<td>2 years</td>
<td>M</td>
<td>Drepanocytosis</td>
<td>No</td>
<td>Osteomyelitis</td>
<td></td>
<td>No</td>
<td>No</td>
<td>Recovery</td>
<td></td>
</tr>
<tr>
<td>McIntyre et al. [11]</td>
<td>73 years</td>
<td>M</td>
<td>Diabetes type 2, arterial hypertension</td>
<td>No</td>
<td>Right ankle arthritis</td>
<td>Septic aortic aneurysm, urinary tract infection For life</td>
<td>Articular drainage amputation of the leg</td>
<td>No</td>
<td>Recovery (9 months)</td>
<td></td>
</tr>
<tr>
<td>Quismorio et al. [12]</td>
<td>31 years</td>
<td>F</td>
<td>Disseminated lupus erythematous, pulmonary tuberculosis</td>
<td>Yes</td>
<td>Left knee osteoarthitis</td>
<td></td>
<td>No</td>
<td>No</td>
<td>Death at 4 months for other reason</td>
<td></td>
</tr>
<tr>
<td>Quismorio et al. [12]</td>
<td>41 years</td>
<td>M</td>
<td>Kidney transplant, chronic hepatitis B</td>
<td>Yes</td>
<td>Right knee arthritis</td>
<td>Kidney abscess</td>
<td>4 weeks</td>
<td>Yes, 1 week antibiotic therapy</td>
<td>Death at 6 months for other reason</td>
<td></td>
</tr>
<tr>
<td>Reference</td>
<td>Age</td>
<td>Gender</td>
<td>Associated pathology</td>
<td>IS</td>
<td>Type of osteoarticular infection</td>
<td>Other symptoms</td>
<td>Antibiotic course</td>
<td>Other treatments</td>
<td>Recurrence (treatment)</td>
<td>Outcome (last follow-up)</td>
</tr>
<tr>
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<tr>
<td>Quismorio et al. [12]</td>
<td>48 years old</td>
<td>F</td>
<td>Waldenström macroglobulinemia</td>
<td>No</td>
<td>Left knee osteoarthritis</td>
<td>Urinary tract infection, septicaemia, gastroenteritis</td>
<td>4 weeks</td>
<td>Reiterative punctures</td>
<td>Yes</td>
<td>Death due to recurrence</td>
</tr>
<tr>
<td>Croop et al. [13]</td>
<td>11 years old</td>
<td>M</td>
<td>NC</td>
<td>NC</td>
<td>Osteomyelitis</td>
<td>No</td>
<td>NC</td>
<td>NC</td>
<td>No</td>
<td>Recovery</td>
</tr>
<tr>
<td>Cone et al. [14]</td>
<td>71 years old</td>
<td>F</td>
<td>Rheumatoïd polyarthritis</td>
<td>Yes</td>
<td>Iliac abscess + sacroiliac arthritis</td>
<td>Septicaemia, gastroenteritis</td>
<td>NC</td>
<td>Iterative drainages</td>
<td>No</td>
<td>Recovery (10 months)</td>
</tr>
<tr>
<td>Kraus et al. [15]</td>
<td>27 years old</td>
<td>M</td>
<td>Dermatomyositis</td>
<td>Yes</td>
<td>Hip arthritis on THA</td>
<td>No</td>
<td>NC</td>
<td>Articular drainage</td>
<td>No</td>
<td>Recovery (19 months)</td>
</tr>
<tr>
<td>Kraus et al. [15]</td>
<td>34 years old</td>
<td>F</td>
<td>Disseminated lupus erythematosus</td>
<td>Yes</td>
<td>Knee osteoarthritis</td>
<td>No</td>
<td>NC</td>
<td>Articular drainage</td>
<td>No</td>
<td>Recovery</td>
</tr>
<tr>
<td>Kraus et al. [15]</td>
<td>14 years old</td>
<td>F</td>
<td>Disseminated lupus erythematosus</td>
<td>Yes</td>
<td>Bilateral knee osteoarthritis</td>
<td>Septicaemia</td>
<td>NC</td>
<td>No</td>
<td>Recovery</td>
<td></td>
</tr>
<tr>
<td>Kraus et al. [15]</td>
<td>36 years old</td>
<td>F</td>
<td>Disseminated lupus erythematosus</td>
<td>Yes</td>
<td>Knee and shoulder osteoarthritis</td>
<td>No</td>
<td>6 weeks</td>
<td>Articular drainage</td>
<td>No</td>
<td>Recovery (1 year)</td>
</tr>
<tr>
<td>Kraus et al. [15]</td>
<td>29 years old</td>
<td>F</td>
<td>Disseminated lupus erythematosus</td>
<td>Yes</td>
<td>Shoulder and bilateral knee osteoarthritis</td>
<td>Septicaemia, urine</td>
<td>4 weeks</td>
<td>No</td>
<td>Recovery</td>
<td></td>
</tr>
<tr>
<td>Kraus et al. [15]</td>
<td>61 years old</td>
<td>F</td>
<td>Primary biliary cirrhosis</td>
<td>NC</td>
<td>T10T11 vertebral osteitis</td>
<td>Urinary tract infection</td>
<td>NC</td>
<td>No</td>
<td>Recovery</td>
<td></td>
</tr>
<tr>
<td>Nowinski and Albert [16]</td>
<td>7 months</td>
<td>F</td>
<td>No</td>
<td>No</td>
<td>Proximal humeral osteoarthritis</td>
<td>No</td>
<td>10 weeks</td>
<td>No</td>
<td>Recovery</td>
<td></td>
</tr>
<tr>
<td>Foster and Kerr [17]</td>
<td>14 years old</td>
<td>M</td>
<td>No</td>
<td>No</td>
<td>Ankle arthritis</td>
<td>Gastroenteritis</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td>Recovery (1 year)</td>
</tr>
<tr>
<td>Our case report</td>
<td>10 months</td>
<td>M</td>
<td>No</td>
<td>No</td>
<td>Hip osteoarthritis</td>
<td>No</td>
<td>8 weeks</td>
<td>Articular drainage</td>
<td>No</td>
<td>Recovery (1 year)</td>
</tr>
</tbody>
</table>

NC: non communicated; IS: pathology or immunosuppressive treatment.
which as a result of infection) and one patient underwent limb amputation due to the progression of infection. Five recurrences of infection were observed in patients with short course of antibiotic therapy (1 to 4 weeks). The fluoroquinolones have potent activity against Salmonella and report good penetration into bone. However, these drugs are not recommended for use in children and in other specific cases. The use of a third-generation cephalosporin during a 6-week treatment is conceivable. It thus reduces potential antimicrobial-resistance in Salmonella bacteria.

Full respect for Centers of Disease Control and Prevention (CDC) recommendations for preventing transmission of Salmonella from reptiles to humans is the primary means of prevention (Table 2). There is no healthy carrier of Salmonella infection in humans.

What are the secondary precautionary measures? What do happen with Salmonella-positive animals? Treating animals with antibiotics may result in the evolution of drug-resistant organisms and reveals ineffective in rooting out Salmonella from the animal [24]. Considering the rarity of severe infections, banning pet reptiles is not justified. Therefore, getting rid of animals which are carriers of Salmonella is not approved and anyone should apply the CDC precautionary measures as the only accepted prevention.

**Conclusion**

The clinical diagnosis of Salmonella infection should be suggested on the basis of infection symptoms in patients who had contact with reptiles or having ingested reptile by-products.

In case of suspected S.enterica subsp. arizonae infection, contact with a reptile, ingestion of animal by-products, weakened immune system should be investigated.

A 6-week antibiotherapy made of third-generation cephalosporins or fluoroquinolones is highly advisable in persons at increased risk for Salmonella contamination and recurrent infections.

CDC recommendations for preventing Salmonella transmission should be taken seriously by all pet store personnel and reptile owners. CDC reports and recommendations are available on www.cdc.gov/mmwr/preview/mmwrhtml/mm5249a3.htm.

**References**


**Table 2** Centers of Disease Control and Prevention (CDC) recommendations for preventing transmission of Salmonella from reptiles to humans.

Recommendations for preventing transmission of Salmonella from reptiles to humans:

- Pet-store owners, health-care providers and veterinarians should provide information to owners and potential purchasers of reptiles about the risks of reptile-associated salmonellosis.
- Persons should always wash their hands thoroughly with soap and water after handling reptiles or their cages.
- Persons at increased risk for infection or serious complications from salmonellosis (e.g. children aged under 5 years or immunocompromised persons) should avoid contact with reptiles and any items that have been in contact with reptiles.
- Reptiles should be kept out of households that include children aged under 5 years or immunocompromised persons. A family expecting a child should remove the reptile from the home before the infant arrives.
- Reptiles should not be allowed in child-care centers.
- Reptiles should not be allowed to roam freely throughout a home or living area.
- Pet reptiles should be kept out of kitchens and other food-preparation areas to prevent contamination. Kitchen sinks should not be used to bath reptiles or to wash their dishes, cages or aquariums. If bathtubs are used for these purposes, they should be cleaned thoroughly and disinfected with bleach.

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