Staphylococcus caprae bone and joint infections: a re-emerging infection?

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Abstract

Staphylococcus caprae has been recently classified as a human pathogen, but the incidence of *S. caprae* in human bone and joint infections (BJIs) is under-reported. In this study, we report 25 cases of *S. caprae* BJI, and we review the 31 cases published in the literature. Molecular techniques and matrix-assisted laser desorption ionization time-of-flight mass spectrometry improved the identification of clinically relevant *S. caprae* strains. In this study, 96% of *S. caprae* BJIs were localized to the lower limbs, and 88% of the cases involved orthopaedic device infections. *S. caprae* joint prosthesis infections (JPIs), internal osteosynthesis device infections (I-ODIs) and BJIs without orthopaedic device infections were recorded in 60%, 28% and 12% of cases, respectively. Ten (40%) *S. caprae* BJIs were polymicrobial infections. These infections were associated with past histories of malignancy (p 0.024). Of the 14 bacterial species related to *S. caprae* BJI, 57% were staphylococci. I-ODIs were significantly associated with polymicrobial infections (p 0.0068), unlike JPIs, which were monomicrobial infections (p 0.0344). Treatment with rifampicin and fluoroquinolone was recorded in 40% of cases. Surgical treatment was performed in 76% of cases, e.g. prosthesis removal (36%), osteosynthesis device removal (24%), and surgical debridement (16%). Thirty per cent of cases were not treated. Relapses were observed mainly in the patients treated by surgical debridement only (p 0.033). In summary, *S. caprae* BJI is an underestimated hospital-acquired emerging infection. *S. caprae* BJI is correlated with infections in orthopaedic devices, which must be removed to control the infection.

Keywords: Arthritis, bacteria, human, MALDI-TOF, osteitis, osteoarticular infection, *Staphylococcus caprae*
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Introduction

Staphylococcus caprae is a commensal coagulase-negative staphylococcus that usually colonizes the skin and the mammary glands in goats [1], occasionally causing mastitis [2]. In humans, commensal *S. caprae* exists in noses, nails, and skins [3,4]. Furthermore, *S. caprae* strains cause community-acquired and/or hospital-acquired infections in humans (Table 1), e.g. acute otitis externa [3,5], peritonitis [6], urinary tract infections [7,8], pneumonia [9], endocarditis [8], meningitis [10], and many cases of bacteraemia [4,8,9,11–16]. Some *S. caprae* strains isolated from goats produce toxic shock syndrome toxin 1 [17].

The relationship between *S. caprae* and human bone and joint infections (BJIs) was first reported in 1997 [3,18]. However, only 31 cases of *S. caprae* BJI have been reported [3,11,18–27]. Most *S. caprae* BJIs result from orthopedic device infections, including joint prosthesis infections (JPIs) in 21 cases [3,11,19,20,23–26,28] and internal osteosynthesis device infections (I-ODIs) in two cases [19,21]. Only four cases of *S. caprae* BJI were not associated with I-ODIs, i.e.

TABLE 1. Review of 106 cases of *Staphylococcus caprae* human infection, including 31 cases of *S. caprae* osteoarticular infection

Clinical specimens	Case (*n*)	Reference
Colonizing strains	10	
Nose	7	Shuttleworth *et al.* [3], Ross *et al.* [4]
Nail	1	Shuttleworth *et al.* [3]
Skin	2	Shuttleworth *et al.* [3], Ross *et al.* [4]
Pathogenic strains	106	
Acute otitis externa	32	Shuttleworth *et al.* [3], Roland and Stroman [5]
Peritonitis	3	Shin *et al.* [6]
Urinary tract infection	4	Kanda *et al.* [7], Vandenesch *et al.* [8]
Pneumonia	1	Barelli *et al.* [9]
Endocarditis	1	Vandenesch *et al.* [8]
Bacteraemia	33	Vandenesch *et al.* [8], Spellerberg *et al.* [13], Barelli *et al.* [9], Fujita *et al.* [12], Ross *et al.* [4], Kini *et al.* [16], Kato *et al.* [14], Abdul Rahman *et al.* [15], Darrieutort-Laffite *et al.* [11]
Meningitis	1	Kato *et al.* [14]
Bone and joint infections	31	
Arthritis	1	Elsner *et al.* [18]
Bone infection without osteosynthesis device	3	Shuttleworth *et al.* [3], Darrieutort-Laffite *et al.* [11]
Prosthesis	21	Shuttleworth *et al.* [3], Allignet *et al.* [19], Blanc *et al.* [20], Arciola *et al.* [23], Campoccia *et al.* [28], Achermann *et al.* [24], Roux *et al.* [25], Bajwa *et al.* [26], Darrieutort-Laffite *et al.* [11]
Osteosynthesis device	2	Allignet *et al.* [19], Lang *et al.* [21]
Presence of osteosynthesis device was not mentioned	4	Sivadon *et al.* [22]

three cases of osteitis [3,11] and one case of arthritis [18]. The presence of an osteosynthesis device was not mentioned in four cases of *S. caprae* BJI [22] (Table 1).

The prevalence of *S. caprae* human infections is often underestimated by conventional phenotypic identification. Allignet *et al.* [19] reported that only five of ten *S. caprae* strains in human BJIs are identified by the ID32-staph system (BioMérieux, Marcy l'Etoile, France). Many clinical *S. caprae* strains are incorrectly identified by automated phenotypic identification systems, including MicroScan (Dade Behring, West Sacramento, CA, USA), Vitek 2 (BioMérieux), and Crystal GP (Becton Dickinson, Sparks, MD, USA) [3,29,30]. Molecular techniques have improved the identification of *S. caprae* strains [6,12,19,22,31,32], and are useful when the standard culture tests give negative results [27]. An innovative tool for bacterial identification in the clinical microbiology laboratory is matrix-assisted laser desorption ionization time-of-flight mass spectrometry (MALDI-TOF MS) [33], which has been recently used for the rapid and accurate identification of clinical *S. caprae* strains [30,34].

In this study, we report 25 cases of *S. caprae*-associated osteoarticular infections that were managed in our centres in the last 6 years. We also review 31 cases of osteoarticular infections and 75 other human infections caused by *S. caprae* in the literature.

Materials and Methods

Study population

We retrospectively reviewed 25 *S. caprae* BJIs, including arthritis, osteitis, JPIs and I-ODIs. Sixteen *S. caprae* BJIs were recorded in the medical charts of patients managed in the South-East regional referral centre for BJI in the University Hospital of Marseille from 2006 to December 2012. This centre is composed of four orthopaedic surgery units, two plastic surgery units, and two infectious diseases units. Nine other *S. caprae* BJIs were recorded in the University Hospital of Nimes from January 2007 to December 2012. This centre contains one orthopaedic surgery unit and one infectious diseases unit.

All *S. caprae* BJIs were diagnosed on the basis of past medical history with clinical evidence of infection, using biological and/or radiological compliant data, with at least one positive culture from two or more deep samples obtained with surgical procedures that excluded the contaminated bacteria. JPI and I-ODI were classified as early (within 1 month), delayed (2–6 months), and late (after 6 months), according to the time of onset after surgery [35–37]. We evaluated each medical history, assessing factors such as demographic characteristics, open fracture and postoperative infections, and other risk factors associated with *S. caprae* BJI, including cancer, haematological malignancy, systemic or local corticosteroid treatment, diabetes mellitus, and contact with goats or sheep. We also recorded the location of infection and the presence of orthopaedic prostheses or devices. We individually reviewed the antimicrobial and/or surgical treatment approach used.

We evaluated treatment success as the remission rate at 3, 6 and 12 months after the end of antibiotic treatment. Recurrent infections were defined by pain and swelling of the bone or joint, wound drainage, implant site erythema, induration or oedema, joint pain, joint effusion, fever, purulent discharge from the wound, sinus tract drainage, and persistent positive culture from deep samples obtained with surgical procedures after treatment during follow-up examinations at the clinic. Treatment failure was defined as: (i) recurrence of BJI or relapse of infection with the previous microorganism at any time after the first line of medical and surgical treatment; (ii) recurrence of the same BJI with a different strain or different microorganism at any time after the first intervention; and (iii) death directly caused by sepsis resulting from active BJI without another known infection.