



## A case report of primary sternal osteomyelitis caused by polymicrobial bacteria, including *Actinomyces israelii*

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### ABSTRACT

We herein report a case of primary sternal osteomyelitis caused by polymicrobial bacteria, including *Actinomyces israelii*. A 72-year-old man presented with a fever and precordial pain. Chest computed tomography (CT) revealed peristernal fluid associated with an osteolytic lesion and a peripheral nodule in the right upper lobe. We suspected sternal osteomyelitis, and an incision and drainage were performed. Culture of the drainage fluid and bone tissue yielded *A. israelii*, *Fusobacterium necrophorum*, and *Streptococcus constellatus*. Treatment with benzylpenicillin potassium (PCG) was administered. A subsequent chest CT scan showed that the peripheral nodule decreased in size after antimicrobial therapy. We therefore presumed the peripheral nodule as septic pulmonary embolism (SPE). Antimicrobial agents were administered for a total of 6 months. To our knowledge, this is the first case report of primary sternal osteomyelitis associated with presumed SPE caused by polymicrobial bacteria, including *A. israelii*. It is important to identify the causative pathogen in osteomyelitis, which requires long-term antibiotic treatment.

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### Introduction

Actinomycosis is a chronic and slowly progressive granulomatous disease caused by *Actinomyces* species, which are filamentous Gram-positive anaerobic bacteria that colonize the human oropharynx, gastrointestinal tract, and urogenital tract [1]. Infection caused by this pathogen has been reported in various sites, including the face, bone and joints, skin and soft tissue, respiratory tract, gastrointestinal tract, genitourinary tract, and central nervous system [2]. Primary sternal osteomyelitis is very rare, accounting for approximately 0.3 % of all cases of osteomyelitis [3]. It is generally caused by *Staphylococcus aureus* or *Pseudomonas aeruginosa* [4], and primary sternal osteomyelitis due to *A. israelii* is rare.

We herein report a case of primary sternal osteomyelitis with septic pulmonary embolism caused by polymicrobial bacteria

including *A. israelii* and review the literature on primary sternal osteomyelitis caused by *A. israelii*.

### Case report

The patient was a 72-year-old man who presented with a fever and precordial pain. Seven days prior to presentation, he had visited a local clinic where he was diagnosed with pharyngitis and prescribed oral levofloxacin at 500 mg/day. However, his precordial pain and swelling had not subsequently improved. He was thus referred to the outpatient service of our hospital for further examination and treatment.

He had no history of chest trauma, thoracic surgery, or diabetes mellitus; however, he visited a dentist a few months prior to admission. On examination, his body temperature was 36.5 °C, blood pressure was 122/69 mmHg, and pulse rate was 96 beats/min. Swelling and redness were observed in the peristernal region. He had poor oral hygiene and dental caries. Other physical examinations were unremarkable. Laboratory tests revealed an elevated white blood cell count (12,200/ $\mu$ L) and an elevated C-reactive protein level (2.8 mg/dL).

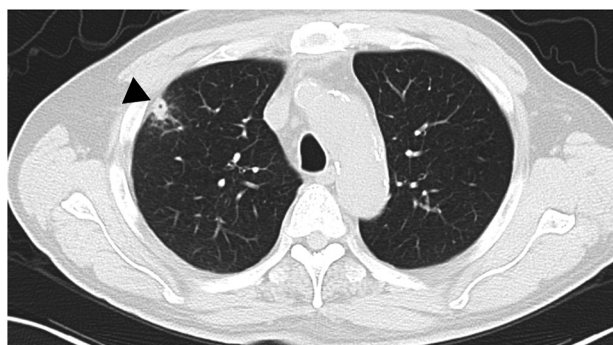
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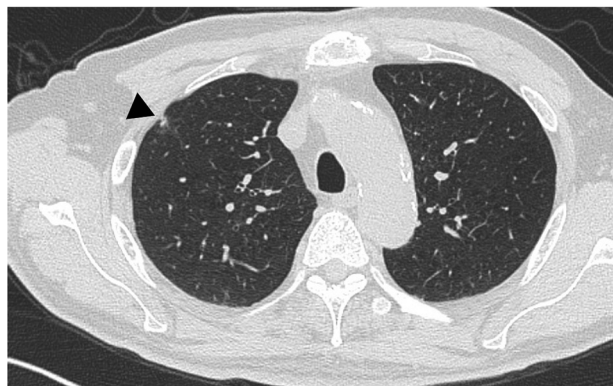
Chest X-ray findings were unremarkable. Chest computed tomography (CT) revealed peristernal fluid associated with an osteolytic lesion (Fig. 1A) and a peripheral nodule in the right upper lobe (13 mm × 11 mm in size) (Fig. 1B).



(A)



(B)



(C)

**Fig. 1.** Chest computed tomography (CT) finding on admission and on day 66.  
 (A) Chest CT image on admission. Peristernal fluid associated with an osteolytic lesion is shown (arrow).  
 (B) A peripheral nodule is observed in the right upper lobe (13 mm × 11 mm in size) (arrowhead).  
 (C) The peripheral nodule in the right upper lobe decreased in size after the initiation of antimicrobial therapy (4 mm × 4 mm in size) (arrowhead).

Incision and drainage were performed, and Gram staining of the drainage fluid and bone biopsy tissue showed the presence of Gram-positive rods only (Fig. 2). Ceftriaxone (2.0 g every 24 h) was initiated after drainage. Two sets of blood cultures were negative at admission. On day 8, *A. israelii*, *Fusobacterium necrophorum*, and *Streptococcus constellatus* were identified from the draining fluid and bone tissue culture using the RapID ANA II system (Innovative Diagnostic Systems, Inc., Atlanta, GA, USA). Further identification was performed because *A. israelii* was identified using the RapID ANA II system with 83.2 % probability. 16S rRNA gene sequencing results analyzed by using BLAST (GenBank) and BIBI databases (<http://pbil.univ-lyon1.fr/bibi/>) identified the strain as *A. israelii*. On day 9, ceftriaxone was switched to benzylpenicillin potassium (PCG) (3.0 million units every 4 h) and the redness and swelling of his neck were getting better after treatment. On day 31, PCG was switched to oral amoxicillin-clavulanic acid, and the patient was subsequently discharged. On day 66, chest CT showed that the peripheral nodule in the right upper lobe had decreased in size to 4 mm × 4 mm (Fig. 1C).

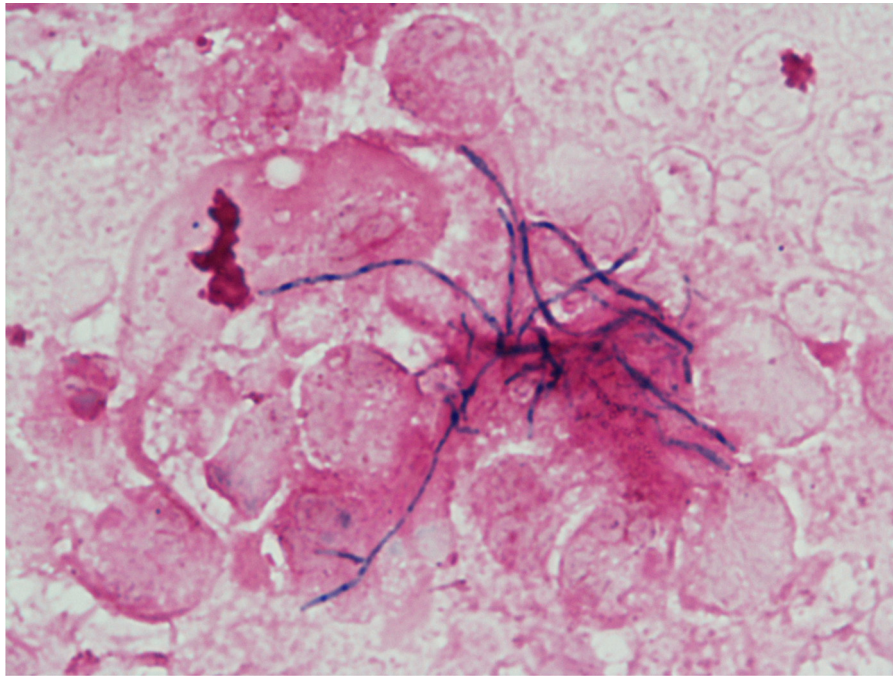
## Discussion

Primary sternal osteomyelitis is very rare, especially that caused by *A. israelii*. The prognosis of primary sternal osteomyelitis caused by *A. israelii* in an immunocompetent adult patient can be favorable with surgical drainage or debridement and appropriate antibacterial therapy [5,6]. *Actinomyces* spp. are susceptible to PCG, cephalosporins and so on. However, fluoroquinolone has poor activity against *Actinomyces* spp. [7]. The treatment duration for actinomycosis is intravenous PCG for 2–6 weeks followed by oral penicillin antibiotics for 6–12 months [1]. Although other organisms are commonly identified concurrently with *Actinomyces* spp. as part of the polymicrobial flora, treatment regimens that target only *Actinomyces* spp. are usually curative [7]. Therefore, in the present case, ceftriaxone was switched to PCG for the treatment of primary sternal osteomyelitis caused by polymicrobial bacteria, including *A. israelii*.

In this case, the peripheral nodule in the right upper lobe shrank after antibacterial drugs were administered, suggesting septic pulmonary embolism (SPE) or pulmonary actinomycosis. Pulmonary actinomycosis results from the aspiration of the species or spread through the bloodstream from an oral infection focus [8]. However, few cases of SPE caused by *Actinomyces* spp. have been reported [9,10]. We considered that the chest CT finding suggested SPE because the peripheral nodule showed feeding vessel signs and was a wedge-shaped peripheral lesion abutting the pleura [11]. Blood cultures were negative in our case, but hematogenous spread is reportedly rare for *Actinomyces* spp [12].

In our case, *A. israelii*, *F. necrophorum*, and *S. constellatus* as normal bacterial flora of the oral cavity were detected in the drainage fluid and bone tissue culture. Therefore, we considered that polymicrobial bacteria of oral flora spread to the sternum, followed by hematogenous spread to the lung.

To our knowledge, this is the first case report of primary sternal osteomyelitis with SPE caused by *A. israelii*. Clinicians should be aware that although osteomyelitis caused by *A. israelii* is rare, this bacterium should be included in the differential diagnosis as a causative pathogen.



**Fig. 2.** Gram-positive rods were found in the bone tissue. (Gram stain, magnification 1000×).

### Author statement

Ryosuke Hamanaka: collected the data, analysed the data and drafted the manuscript.

Takehiro Hashimoto, Eri Mizukami, Yuki Okutsu, Kazuhiro Masutomo, Kosaku Komiya, Shin-ichi Nureki, Katsuhiko Shimoda: collected the data and participated in the concept of the manuscript.

Kazufumi Hiramatsu: participated in the concept of the manuscript and revised the article for intellectual content.

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None to declare.

### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### References

- [1] Brook I. Actinomycosis: diagnosis and management. *South Med J* 2008;101:1019–23, doi:<http://dx.doi.org/10.1097/SMJ.0b013e3181864c1f>.
- [2] Valour F, Sénéchal A, Dupieux C, Karsenty J, Lustig S, Breton P, et al. Actinomycosis: etiology, clinical features, diagnosis, treatment, and management. *Infect Drug Resist* 2014;7:183–97, doi:<http://dx.doi.org/10.2147/IDRS39601>.
- [3] Boll KL, Jurik AG. Sternal osteomyelitis in drug addicts. *J Bone Joint Surg Br* 1990;72:328–9.
- [4] Hasan Z, Hanna Meldrum W. Primary sternal osteomyelitis: a case and review of the literature. *J Cardiothorac Med* 2016;4(1):418–21, doi:<http://dx.doi.org/10.22038/jctm.2016.6527>.
- [5] Lee JH, Jeon SC, Jang HJ, Kim H, Kim YH, Chung WS. Primary sternal osteomyelitis caused by *Actinomyces israelii*. *Korean J Thorac Cardiovasc Surg* 2015;48:86–9, doi:<http://dx.doi.org/10.5090/kjtcs.2015.48.1.86>.
- [6] Pinilla I, Martín-Hervás C, Gil-Garay E. Primary sternal osteomyelitis caused by *Actinomyces israelii*. *South Med J* 2006;99:96–7, doi:<http://dx.doi.org/10.1097/01.smj.0000197512.82441.41>.
- [7] Smego RA, Foglia G. Actinomycosis. *Clin Infect Dis* 1998;26(6):1255–61, doi:<http://dx.doi.org/10.1086/516337>.
- [8] Kobashi Y, Yoshida K, Miyashita N, Niki Y, Oka M. Clinical analysis of pulmonary actinomycosis. *Kansenshogaku Zasshi* 2005;79(2):111–6, doi:<http://dx.doi.org/10.11150/kansenshogakuzasshi1970.79.111> [Published in Japanese].
- [9] Gupta R, Robison LR. Actinomycosis with septic pulmonary emboli developing after dental abscess. *Mayo Clin Proc* 2013;88(11):e137, doi:<http://dx.doi.org/10.1016/j.mayocp.2013.04.032>.
- [10] Endo S, Mishima E, Takeuchi Y, Ohi T, Ishida M, Yanai M, et al. Periodontitis-associated septic pulmonary embolism caused by *Actinomyces* species identified by anaerobic culture of bronchoalveolar lavage fluid: a case report. *BMC Infect Dis* 2015;15:552, doi:<http://dx.doi.org/10.1186/s12879-015-1286-0>.
- [11] Ye R, Zhao L, Wang C, Wu X, Yan H. Clinical characteristics of septic pulmonary embolism in adults: a systematic review. *Respir Med* 2014;108(1):1–8, doi:<http://dx.doi.org/10.1016/j.rmed.2013.10.012>.
- [12] Jeffery-Smith A, Nic-Fhogartaigh C, Millar M. Is the presence of *Actinomyces* spp. in blood culture always significant? *J Clin Microbiol* 2016;54(4):1137–9, doi:<http://dx.doi.org/10.1128/JCM.03074-15>.