The case:

A 41-year-old man has had worsening right pelvic pain for 5 months. He is a never smoker.

Figure 1: Outlet radiograph (A) and CT scan (B) of the pelvis. Radiograph of the chest (C). Abnormalities indicated by arrows.

Your diagnosis?
Diagnosis:
Musculoskeletal Actinomycosis
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A pelvic outlet radiograph shows right iliac wing permeative osteolysis (arrows) (Figure 2A). A pelvic computed tomography (CT) scan shows anterior right iliac osteolysis and soft tissue mass (arrows) (Figure 2B). A chest radiograph shows right lower lobe consolidation (arrow) (Figure 2C). This 41-year-old man had progressive right pelvic pain for 5 months. Metastatic bronchogenic carcinoma was suspected, but a culture of pelvic soft tissue mass biopsy grew Actinomyces israelii. Lung and bone lesions, once malignancy is excluded, suggest an unusual, indolent infection including tuberculosis and fungal disease. Post-primary tuberculosis would rarely be in a lower lobe.

PATHOGENESIS
Actinomycosis, “the great pretender,” has been likened to a sheep in wolf’s clothing and presents in many ways mimicking other diseases, especially malignancy. This disease is a rare, indolent, slowly progressive infection that causes suppurative and granulomatous inflammation. The oral cavity, gastrointestinal tract, and female genitalia are colonized in normal people. The low pathogenicity of this bacterium requires mucosal barrier disruption to cause disease.

The organisms are filamentous, branching, gram-positive, pleomorphic, nonspore-forming, nonacid-fast anaerobic bacteria. Actinomyces act as the pathogen, with 8 species causing disease in humans. The strictly anaerobic Actinomyces israelii is most common. Less commonly, A naeslundii, A viscosus, A odontolyticus, A meyeri, and A gerencseriae cause actinomycosis. Most infections are polymicrobial and associated with other anaerobic and aerobic bacteria including Aggregatibacter actinomycetemcomitans, Eikenella corrodens, Fusobacterium, Capnocytophaga, Streptococcus, Staphylococcus, and Enterobacteriaceae. It is believed these co-pathogens enhance the pathogenic potential of actinomyces by inhibiting host defenses and lowering local oxygen tension.

The acute phase is characterized by a painful cellulitis, but the chronic phase is usual-
of cases. Actinomyces is part of the endogenous flora of the oral cavity, gastrointestinal tract, and female genitalia. The oral cavity is colonized by age 2 in nearly 100% of cases. Actinomycosis has never been cultured from nature, and there are no documented cases of person-to-person transmission. Since the widespread use of antibiotics, the frequency and aggressiveness of infection have decreased substantially. Dutch and German studies estimated the incidence to be 1:100,000 in the 1960s and 1:300,000 in the Cleveland, Ohio, area in the 1970s. In the United States, the annual reported incidence is <100 cases, but may be higher due to the indolent nature of the organism. Infection occurs in all age groups but is rare in children younger than 10 years and adults older than 60 years. Most cases occur in the middle decades. Men are infected more than women (ratio 3:1). This is postulated to be secondary to poor dental hygiene and increased oral trauma in men.

**PRESENTATION OF DISEASE**

Disease of the oral-cervical region is the most common form of actinomycosis, accounting for 55% of cases. The classic presentation is a painless mass at the angle of the jaw. Thoracic involvement accounts for 15% of actinomycosis cases, most often secondary to aspiration of oropharynx organisms. Soft tissue extension into the chest wall with or without a draining sinus is often mistaken for malignancy. Abdominal infections account for approximately 20% of cases and are caused by any disruption of the gastrointestinal mucosa. Presentation can mimic malignancy. Pelvic disease is due to the spread of intra-abdominal infection and has also been associated with intrauterine contraceptive devices.

Before the widespread use of antibiotics, vertebral infection was the most common site of osseous actinomycosis due to the unopposed spread of thoracic and abdominal disease. Today, actinomycosis of bone is mainly due to spread of adjacent tissue infections. The mandible and maxilla lesions most often cause periositis or osteomyelitis. Osseous infections can also occur from blunt and penetrating trauma. In 1 study, the majority of osseous disease of the extremities was the result of trauma, with fewer due to oral-cutaneous contact or minor skin laceration. Hip and knee prosthetic infections have been reported. A majority of patients with extremity bone lesions have cutaneous sinus tracts and abscesses.

Hematogenous dissemination has decreased since the widespread use of antibiotics. *Actinomyces meyeri* has the greatest capacity to produce disseminated disease. Any primary site can serve as the origin of infection. The lungs and liver are most affected, and multiple lung nodules mimic malignancy.

**DIAGNOSIS AND DIFFERENTIAL DIAGNOSIS**

The diagnosis is seldom considered, especially when the presentation mimics malignancy. Three clinical presentations should prompt consideration of actinomycosis: chronic progression across tissue planes with mass-like features, sinus tracts that spontaneously resolve and recur, and relapsing infection following a short course of antibiotic therapy. Identification of an actinomycosis from a sterile site confirms the diagnosis. It is critical to avoid antibiotic therapy prior to obtaining specimens, as even a single antibiotic dose can undermine organism isolation. Fine-needle CT or ultrasound-guided aspiration or biopsy have been used to obtain specimens for diagnosis. When only a small sample is obtained, characteristic sulfur granules may not be present, with only fibrosis and/or inflammation present histologically. This can be remedied by...
obtaining multiple specimens. Bacterial growth from specimens usually appears in 5 to 7 days with primary isolation taking 2 to 4 weeks. However, sulfur granules are definitive enough to start therapy before cultures become positive. Microscopically, gram stain is usually more sensitive than culture for diagnosis, especially if the patient received antibiotics. Species are often invisible on hematoxylin-eosin while identification is aided by special stains such as Gomori methenamine silver, p-aminosalicylic acid, McCallen-Goodpasture, and Brown-Benn.1

**IMAGING**

**Radiographs**

Osseous actinomycosis involvement has been described as periosteal proliferation, osteitis, acute or chronic osteomyelitis, and frank destruction.12,18 Rib periostitis with a dense, wavy appearance is highly suggestive of actinomycosis (Figure 4). Patients with pulmonary disease often have a soft tissue mass with adjacent rib periostitis or frank rib and vertebral destruction. Vertebræ show erosion of the body, transverse processes, and adjacent ribs. A mottled appearance of bones is due to repeated destruction and new bone formation. Vertebral body collapse and intervertebral disk space narrowing are not features of actinomycosis. Involvement of the appendicular skeleton can manifest as a well-defined lucency.12

**Computed Tomography and Magnetic Resonance Imaging**

Computed tomography findings of actinomycosis are similar to radiographic findings showing rib periostitis, rib and vertebral body destruction, and adjacent soft tissue masses.19,20 These findings have also been demonstrated in the axial skeleton. Subchondral cystic changes also occur.13 Computed tomography attenuation of inflammatory masses is variable but characteristically less than muscle or solid organs (Figures 5, 6).19

There a few reports of magnetic resonance imaging used for diagnosis and follow-up.

**Bone Scintigraphy**

Bone scintigraphy has been used to identify actinomycosis infections. Long-bone involvement on Tc-99m MDP bone scan shows increased focal uptake in the bone and adjacent soft tissues.21,22 Bone scintigraphy is also useful in differentiating actinomycosis-induced periostitis from osteomyelitis.23

It is important to know that the imaging appearance of other diseases can be similar to actinomycosis. Tuberculosis, blastomycosis, cryptococcosis, nocardiosis, and malignancy can all involve the chest wall as well as the lung.19

**TREATMENT AND PROGNOSIS**

Antibiotics alone are usually curative, including invasive disease.15 Therapy is individualized based on initial disease burden, site of infection, and clinical and radiologic response to treatment.24,25 Normally, 18 to 24 million units of intravenous penicillin for 2 to 6 weeks, followed by oral penicillin or amoxicillin for 6 to 12 weeks, is given for serious infection or bulky disease. For the penicillin allergic patient, tetracycline has been used. If there is an abscess, drainage is needed in addition to antibiotics. Relapses are a hallmark of disease and are minimized if antibiotic therapy is extended beyond resolution of measurable disease. Magnetic resonance imaging and CT scans can be used to observe for residual infection and monitor for relapse. Cure rates of actinomycosis infections are high, deformity uncommon, and death rare.

**CONCLUSION**

Osseous actinomycosis is a rare and most often chronic, indolent disease that can mimic malignancy. Imaging findings are nonspecific, but presentations suggesting the diagnosis include mass like spread across tissue planes, si-
nus tracts that spontaneously resolve and recur, and relapse after antibiotic therapy. Most patients have poor oral hygiene and dental or periodontal disease, but there can be direct inoculation, especially in the extremities. Sulfur granules can be identified pathologically from biopsies or draining sinus tracts and are definitive enough to start therapy before cultures become positive. Most patients with extremity bone lesions have cutaneous sinus tracts and abscesses.

REFERENCES