

BRODIE'S ABSCESS REVISITED

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Radiology plays an important role in the diagnosis of a Brodie's abscess, as can be difficult for a clinician to identify the disease using clinical information alone. A Brodie's abscess is clinically difficult to diagnose because patients typically have mild local symptoms, few or no constitutional symptoms, and near normal laboratory values. Furthermore, a Brodie's abscess may mimic various benign and malignant conditions, resulting in delayed diagnosis and treatment. The most frequently made incorrect diagnosis is that of a primary bone tumor. The present pictorial review summarizes imaging clues to the diagnosis of a Brodie's abscess, such as the serpentine sign on conventional radiographs and the penumbra sign seen on Magnetic Resonance (MR) images. A Brodie's abscess is difficult to diagnose, however, once diagnosed, it is a curable disease with a 100% cure rate.

Key-word: Bones, abscess.

History

The original description of a localized bone abscess dates from 1832 and is named after Sir Benjamin Collins Brodie, a surgeon in St. George's Hospital, London, United Kingdom (Fig. 1). He amputated the leg of a man who had intractable pain for a number of years. Unfortunately, the patient died due to the complications of the amputation. After macroscopic examination of the amputated limb, Brodie described the condition in the tibia as "a cavity the size of a walnut filled with dark-colored pus. The bone immediately surrounding the cavity was whiter and harder than the surrounding bone. The inner surface of the cavity appeared to be highly vascular" (1).

Pathogenesis

A Brodie's abscess is a subtype of a subacute osteomyelitis. In a Brodie's abscess a situation develops where the bacteria and the host defenses are equally matched; the abscess is walled-off, minimizing the systemic response. An osseous infection can be caused by haematogenous spread of organisms to bone or by direct local invasion by bacteria. The organisms reach the bone from a disrupted site elsewhere in the body such as a skin pustule, furuncles, impetigo, infected blisters and burns, or secondary to an infection of another organ system (urogenital infections, enteritis, cholangitis or endocarditis).

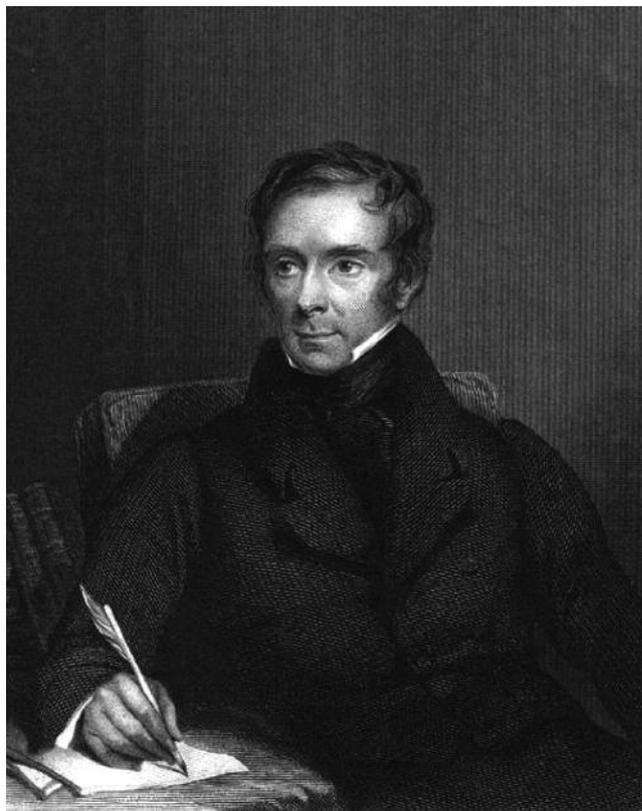


Fig. 1. — Sir Benjamin Collins Brodie (1783-1862), British physiologist and surgeon.

Infection has even been suggested to be the outcome of common events such as normally harmless daily teeth brushing. Often the infective focus is not identified. Direct spread to bone can occur from bac-

terial invasion, e.g. through penetrating wounds or postoperative infection. This route is most likely after contaminated soft tissue trauma, as well as in diabetic patients with plantar ulcers or in bedridden patients with decubitus ulcers (2).

The causative organism is usually coagulase-positive *Staphylococcus* (3). Other organisms encountered are *Streptococcus B*, in the newborn, *Pseudomonas*, which is more frequent in drug addicts than in the general population, and

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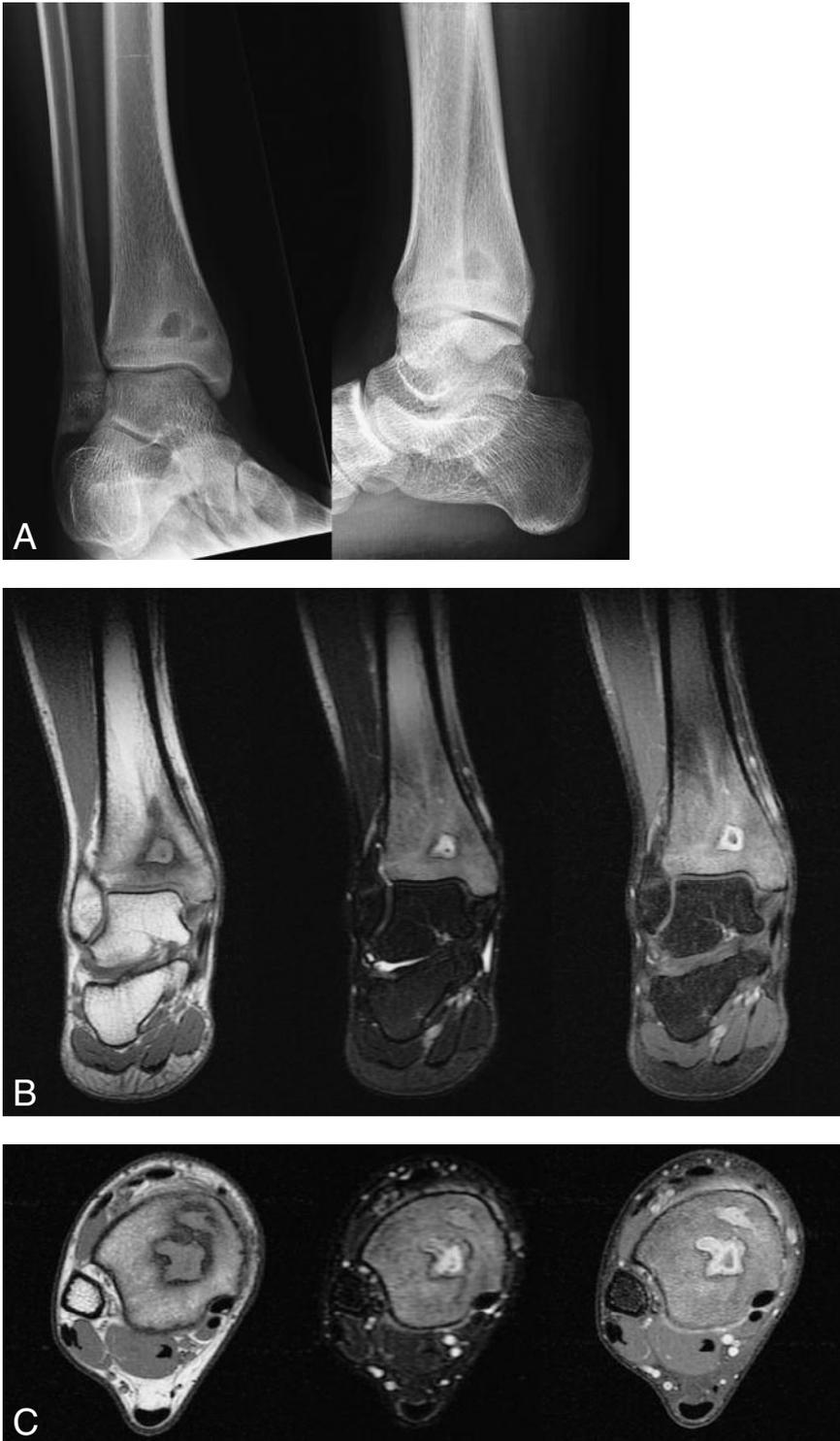


Fig. 2. — A. Conventional radiographs show a discrete predominantly osteolytic, geographic, ovoid lesion, with a sclerotic border in the metaphysis of the distal tibia.

B. From left to right: coronal T1-weighted, T2-weighted with fat suppression, and post gadolinium T1-weighted images with fat suppression. The images show a typical Brodie's abscess in the distal metaphysis of the tibia. It contains a small central area with low signal intensities on all sequences, compatible with a sequestrum. The penumbra sign is present, with a high signal intensity rim on the T1-weighted images, corresponding to granulation tissue. The reactive sclerotic border causes a low signal intensity rim on all sequences. Associated bone marrow edema is also present, low signal intensity changes on the T1-weighted images and high signal intensity on T2-weighted and post gadolinium images.

C. MR images of the distal tibia. From left to right: axial T1-weighted image, axial fat suppressed T2-weighted image, and fat suppressed T1-weighted post gadolinium image. On these axial images a "guirlande" shaped appearance of the Brodie's abscess is appreciated.

Salmonella, in patients with diabetes mellitus or sickle cell anemia. Haemophilus influenza, Kingella kingae, Mycobacterium tuberculosis, Spirochaetes, Fungi (Candida, Actinomyces), Viruses and Helminths (e.g. Echinococcus) are also described. However, in almost 50% of cases of a Brodie's abscess, no organism can be cultured.

A Brodie's abscess is most commonly seen in children and characterized by accumulation of the pathogenic organisms in the terminal arterioles and capillaries of the metaphysis. Metaphyseal locations are most common before closure of the growth plates. After closure, an epiphyseal / metaphyseal abscess is most frequent. Epiphyseal lesions may also occur in older adolescents as the growth plates are closed and vessels cross the closed growth plate, failing to provide a barrier to the epiphysis. Interconnecting infection of the epiphysis and metaphysis is explainable in infants younger than 18 months, when one considers that vascular communication between the epiphysis and metaphysis is present until the age of 18 months, as described by Trueta (4). Another interesting explanation for the localization of subacute osteomyelitis adjacent to the growth plate cartilage is the finding by Speers and Nade that *S. aureus* has a certain affinity for physeal cartilage (5). Infection develops as the organisms spread into the perivascular interstitial tissue, leading to a leucocytic infiltration that permeates the bone marrow. The dissemination progresses along Volkmann's canals and through the Haversian system. The infiltration leads to vascular compression and compromised nutrition of the bone marrow. Combined with the effect of the bacterial toxins, this ultimately causes osteonecrosis, leading to the formation of a Brodie's abscess (6).

Clinical Presentation

Pain is the most consistent complaint in most patients followed by minimal loss of function or limping. Because the symptoms of a Brodie's abscess are often vague, an accurate diagnosis is usually delayed, with an average duration of symptoms varying between 1 month and 2 years. A Brodie's abscess is slightly more common in boys with a 3 to 2 ratio and usually occurs in young patients with an average age of 19.5 years (7). White blood cell count, erythrocyte sedimentation rate, and C-reactive



Fig. 3. — Conventional radiograph of the ankle shows the typical metaphyseal location of a Brodie's abscess in the distal fibula (white arrow).

protein (CRP) are usually within normal limits or occasionally slightly elevated. Blood culture results are usually negative. The lower limb is affected much more often than the upper limb, and the tibia is affected relatively more often than is the femur. Other sites in which a Brodie's abscess is frequently reported are the pelvis, the vertebrae, the calcaneus, the clavicle, and the talus. When a Brodie's abscess occurs in tarsal bones, it usually occurs in the subchondral part or borders the apophysis of the calcaneus. Lesions in the spine occur more often in adults than in children. The patella is rarely involved. Multifocal subacute osteomyelitis is a rare form of subacute osteomyelitis that was reported by Season and Miller and by Rasool (8, 9). It is usually associated with a deficient immune system.



B. Coronal T2-weighted MR image with fat suppression of the knee. A Brodie's abscess is appreciated in the lateral aspect of the epiphysis and metaphysis of the distal femur. The abscess is elongated in a snakelike fashion, the "serpentine sign" (white arrowheads).

Imaging

Conventional radiographs should always be the first step in imaging of a Brodie's abscess. Typically, a well-demarcated radiolucent lesion with surrounding sclerosis is present within the metaphysis of a long bone (Fig. 2A and 3). A Brodie's abscess might be tethered to the growth plate, and the cavity progressively elongates, with growth extending from the epiphysis through the metaphysis and even into the diaphysis in a snakelike fashion, resulting in the so-called "serpentine sign" (10) (Fig. 4A, 4B, 5B, 5C). An area of sclerosis may be seen centrally in the lucent lesion, a sequestrum (Fig. 2). In the early stages of osteomyelitis the conventional radiographs are normal, as it takes from 10 to 21 days for an osseous lesion to become visible on conventional radiography, because a 30-50% reduction of bone mass must occur before radiographic change is apparent (11). Unfortunately, a Brodie's abscess sometimes has a less typical presen-



Fig. 4. — A. Conventional radiograph of the knee. A predominantly lucent lesion at the lateral aspect of the epiphysis and metaphysis of the distal femur. Over time a Brodie's abscess progressively elongates from epiphysis through metaphysis, the "serpentine sign" (white arrows).

tation on conventional radiographs showing extensive erosions of cortical bone or periosteal new bone formation. Radiography is also valuable as a primary imaging technique as it can exclude other diagnoses and to monitor therapy. The various radiologic techniques involved in the diagnosis of a Brodie's abscess are important and complementary, rather than competitive.

Bone scintigraphy is rarely indicated unless the diagnosis is unclear and a bone scan is performed as part of a tumor work-up. Also, bone scintigraphy might be helpful for the assessment of multifocal subacute osteomyelitis.

Computed tomography (CT) scanning is valuable in detecting lesions in difficult anatomic locations and to differentiate a Brodie's abscess from osteoid osteoma. CT scan is also superior to conventional radiography or MR imaging for the detection of a sequestrum.

Magnetic resonance (MR) imaging is the most sensitive technique to evaluate a Brodie's abscess



Fig. 5. — A. Conventional radiographs of the knee. A subtle round radiolucency in the medial site of the proximal tibia metaphysis was missed initially (white arrow).

B. Conventional radiographs of the knee, two years later. A radiolucency at the epiphysis and metaphysis of the medial proximal tibia, consistent with a Brodie's abscess. Note the elongated shape of the Brodie's abscess, the "serpentine sign".

C. Coronal T1 weighted image of the same patient. Similar to the conventional images, an elongated lesion is seen at the medial site of the proximal tibia epiphysis and metaphysis.

D. Axial MR images of the proximal tibia. From left to right: T1-weighted image, fat suppressed T2-weighted image, and post gadolinium fat suppressed T1-weighted image. The images show a Brodie's abscess with sequestrum formation (black arrow), cloaca (white arrows), sinus tracts (black arrowheads) and soft tissue spread (white arrowhead).

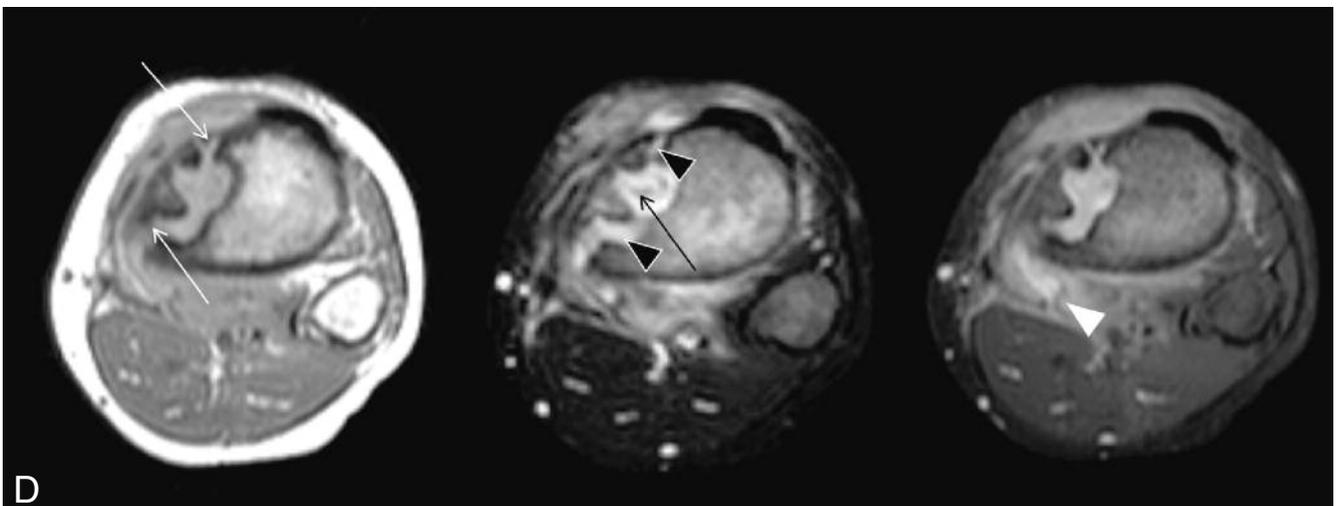




Fig. 6. — A. Conventional radiographs of the right proximal humerus show a Brodie's abscess in the proximal metaphysis of the right humerus. Note the lucency at the medial aspect of the proximal humerus metaphysis, consistent with a subperiosteal extension of the abscess (black arrow).

B. Coronal MR images of the right proximal humerus. The T1-weighted and fat suppressed T2-weighted image shows the subperiosteal extension of the Brodie's abscess (white arrows).

(Fig. 2B and 2C). Within the central part of the lesion, signal intensity is decreased on T1-weighted images and increased on T2-weighted images. A characteristic but not pathognomonic finding on MR that supports the diagnosis of a Brodie's abscess and helps to exclude the presence of a tumor is the penumbra sign (Fig. 2). The penumbra sign does not appear to occur with any great frequency in other osseous conditions (12). The penumbra sign

is characteristically seen on T1-weighted MR images as a discrete peripheral zone of marginally higher signal intensity, than the abscess cavity itself. The hyperintensity may be due to the high protein content of the highly vascularized granulation tissue surrounding the abscess cavity. This zone is surrounded by a second layer of low signal intensity rim on all sequences corresponding to sclerotic bone. Finally, there is bone marrow edema surrounding

the lesion showing lower signal intensity than the fatty bone marrow on T1-weighted images. A Brodie's abscess typically has a "guirlande" shaped appearance (Fig. 2C). A gadolinium-enhanced image depicts a well-circumscribed non-enhancing area with slight rim enhancement. Brodie's abscess generally appears as a defect without central contrast enhancement; however, the defect can enhance if the abscess cavity is filled with granulation tissue rather than pus. Lesions penetrating the cortex are characterized by signs of intramedullary inflammation as well as some degree of concomitant soft tissue inflammation. Soft tissue or subperiosteal abscesses are more common in children because of the loose periosteum in children (Fig. 6). Classically a Brodie's abscess can form sinus tracts, a cloaca, and a sequestrum (Fig. 5D).

Differential diagnosis

Osteomyelitis is a known mimic of various diseases, and a Brodie's abscess is no exception, having all of the presenting signs and symptoms of many bone tumors, both benign and malignant. The classic solitary lesion located in the metaphysis surrounded by reactive new bone presents little difficulty in diagnosis. However, extensive erosions of cortical bone or periosteal new bone formation may add a more ominous dimension.

When the lesion is diaphyseal it may be confused with bone infarction or Langerhans cell histiocytosis. When the lesion is located at the diaphysis and associated with an onionskin periosteal reaction, it may be confused with Ewing's sarcoma, osteosarcoma or lymphoma. An epiphyseal lesion may mimic a chondroblastoma, clear cell sarcoma, fungal osteomyelitis, tuberculous osteomyelitis, aneurysmal bone cyst, pigmented villonodular synovitis (PVNS), degenerative changes, degenerative erosions, intraosseous ganglion, giant cell tumor, or gout, depending upon the age of the patient. Metaphyseal eccentric lesions may have a similar imaging appearance of a nonossifying fibroma or chondromyxoid fibroma, metastatic neuroblastoma, or stress fractures. Brodie's abscesses, osteoid osteoma, intracortical hemangioma, stress fractures and a cortical desmoid should all be included in the differential diagnosis of an intracortical bone lesion.

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Röntgenlaboranten:

positionering (theorie-praktijk), artefacten, fysisch-technische controle, evaluatie meegebrachte mammografieën

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