*American Journal of Medical Case Reports, 2017, Vol. 5, No. 8, 199-201*
Available online at http://pubs.sciepub.com/ajmcr/5/8/1

DOI:10.12691/ajmcr-5-8-1

# The "Penumbra Sign" on Magnetic Resonance Images of Brodie's Abscess: A Case Report and Literature Review

**Farate A[1,*], Yunusa GH[2], Umar UH[1], Ahmadu MS[1], Mustapha Z[1], Ahidjo A[1]**

[1]Department of Radiology, University of Maiduguri Teaching Hospital, Maiduguri, Borno State, Nigeria
[2]Department of Radiology, Usmanu Danfodio University Teaching Hospital, Sokoto, Sokoto State, Nigeria
*Corresponding author: abu.farati@gmail.com

**Abstract** This report presents the "penumbra sign" of Brodie's abscess in a 17-year-old boy. The lesion was located in the proximal metaphysis of the left tibia. Histologic and microbiologic confirmation of the diagnosis was made. A "penumbra sign" on non-contrast enhanced T1-weighted magnetic resonance images is a helpful diagnostic sign of Brodie's abscess.

***Keywords:*** *Brodie's abscess, magnetic resonance imaging, penumbra sign*

**Cite This Article:** Farate A, Yunusa GH, Umar UH, Ahmadu MS, Mustapha Z, and Ahidjo A, "The "Penumbra Sign" on Magnetic Resonance Images of Brodie's Abscess: A Case Report and Literature Review." *American Journal of Medical Case Reports*, vol. 5, no. 8 (2017): 199-201. doi: 10.12691/ajmcr-5-8-1.

## 1. Introduction

Brodie's abscess is a primary subacute osteomyelitis that is characterized by localized intraosseous collection of abscess [1,2]. It is seen on plain radiograph as a radiolucent lesion with a well-defined marginal sclerosis, most often in the proximal metaphysis of tibia, usually in a young patient prior to epiphyseal closure [2,3]. Brodie's abscess may have a finger-like extension ('tunneling') toward the epiphyseal plate, which, when present, is pathognomonic of the disease [2]. Sometimes the clinical and radiographic features may be ambiguous making differentiation of Brodie's abscess from other benign and malignant bone tumors difficult [3]. The 'penumbra sign', which is a high signal intensity thin layer of granulation tissue that lines the abscess cavity on unenhanced T1-weighted magnetic resonance (MR) images, has been found to be helpful in the diagnosis of Brodie's osteomyelitis [4,5]. This report highlights the importance of a 'penumbra sign' in differentiating between Brodie's abscess and other bone tumors or lesions on MR imaging.

## 2. Case Presentation

The patient was a 17-year-old boy presented with swelling in proximal left leg for 10 years. It was initially painless but he started to experience occasional dull achy pains few months prior to presentation, which did not prevent him from performing his routine daily activities. He had no history of prior trauma or chronic cough. There were no constitutional symptoms of either acute or chronic illness at the time of presentation. The proximal part of the left leg was mildly enlarged with minimal soft tissue swelling overlying the anterior aspect of tibia. The lesion was slightly warm to touch but no undue tenderness. The range of movement at the adjacent knee joint was normal.

The relevant laboratory investigations such as erythrocyte sedimentation rate, C-reactive protein and leucocyte count were all within normal limits. Plain radiographs of the left knee showed an irregular radiolucent lesion with no significant marginal sclerosis in the proximal metaphysis of tibia [Figure 1]. There was marked increase in thickness of the cortices of the proximal one-third of tibia with associated mild overlying soft tissue swelling. MR imaging revealed an irregular hypointense intramedullary lesion in the proximal metaphysis of tibia on non-contrast enhanced T1-weighted images with a surrounding rim of high signal intensity ('penumbra sign') [Figure 2]. The lesion was hyperintense on T2-weighted images [Figure 3]. Minimal overlying soft tissue swelling was also evident.


**Figure 1.** Posteroanterior (a) and lateral (b) radiographs of the left knee: A well-defined radiolucent lesion in proximal metaphysis of tibia is noted. The lesion does not show the usual well-defined marginal sclerosis. Note also thickening of the cortices of tibia

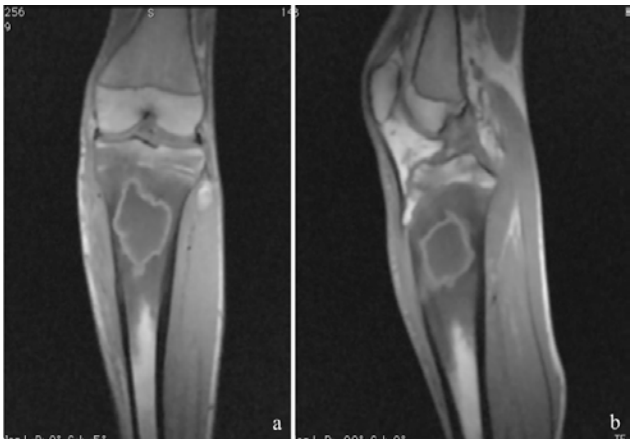


**Figure 2.** Non-enhanced T1-weighted MR images of the left proximal tibia in coronal (a) and sagittal (b) planes: They show a well-defined hypointense intramedullary lesion in the proximal metaphysis of the tibia with a surrounding rim of high signal intensity ('penumbra sign'). There is extensive surrounding hypointensity representing marrow edema

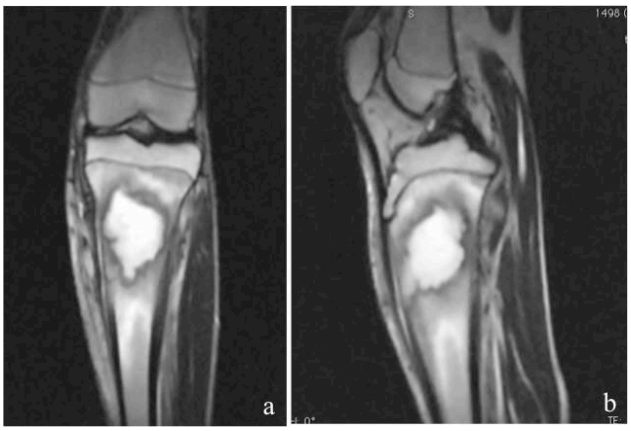


**Figure 3.** T2-weighted MR images of the left proximal tibia of the same patient in coronal (a) and sagittal (b) planes: They show a well-defined hyperintense lesion in the metaphysis of tibia with a surrounding rim of hypointensity. At the periphery is a surrounding zone of increased signal intensity representing marrow edema

The patient underwent surgical drainage and curettage of the abscess cavity and he was commenced on appropriate antibiotics according to the culture and sensitivity. Histopathologic and microbiologic examinations confirmed the diagnosis of Brodie's osteomyelitis. The patient remained in a stable condition with no sign of local recurrence or complications on subsequent follow-up visits.

## 3. Discussion

Sir Benjamin Collins Brodie, a surgeon in St. George's Hospital, London, United Kingdom, first described three cases of localized intraosseous collection of abscess in the proximal metaphysis of tibia in 1832 [1]. This would later become what is known as Brodie's abscess. The pathophysiologic explanation for the local abscess collection is thought to be due to balanced host and bacteria defenses—the abscess is walled-off, minimizing systemic response [3]. Differentiating Brodie's abscess from benign and malignant bone lesions can be challenging on the basis of clinical and laboratory features and even on conventional radiographs.

The clinical presentation of Brodie's osteomyelitis is elusive and so the diagnosis is often delayed [3,5]. Pain is the most common presenting symptom in most patients followed by minimal loss of function or limping [3]. The lesion is caused by organisms that reach the bone from a disrupted site elsewhere in the body, such as a skin pustule, furuncle, impetigo, or an infected blister or burn, or secondary to an infection of another organ system (genitourinary infections, enteritis, cholecystitis or endocarditis) [3]. The causative organism is usually Staphylococcus aureus [6]. Organisms such as Streptococcus B, in the newborn; Pseudomonas, in drug addicts; and Salmonella, in patients with sickle cell disease or diabetes mellitus are other organisms encountered. Other organisms reported are Haemophilus influenza, Mycobacterium tuberculosis, Spirochetes, fungi (Candida, Actinomyces), viruses and Helminths (e.g. Echinococcus) [3]. However, no organism can be cultured in almost half of cases [3].

The laboratory investigations such as inflammatory markers (white blood cell count, erythrocyte sedimentation rate and C-reactive protein) are usually normal or occasionally slightly elevated. Blood culture results are usually negative [3].

Conventional radiographs should always be the first step in imaging of a suspected Brodie's osteomyelitis. Typically, a well-defined radiolucent lesion with a surrounding rim of sclerosis is present within the metaphysis of the long bone. Unfortunately, Brodie's abscess sometimes has less typical presentation on conventional radiographs, showing extensive erosions of cortical bone. Occasionally, a Brodie's abscess can mimic other bone lesions such as osteoid osteoma [7,8].

Although bone scintigraphy is rarely requested and not readily available in some developing countries, it can help differentiate Brodie's abscess from osteoid osteoma. Brodie's abscess typically shows increased radiotracer accumulation on the delayed scan whereas osteoid osteoma show increased uptake on all three phases of bone scan (flow, blood pool and delayed scans) due to its central vascularity [2]. Whole body bone scintigraphy is also indicated if multifocal disease is suspected or is performed as part of a tumor work-up when the diagnosis is uncertain. The hybrid fused single photon emission computed tomography-computed tomography —SPECT-CT has the ability to provide both functional information and anatomic localization of the lesion and better definition of a lesion in an obscured location [9].

At computed tomography (CT) imaging, Brodie's abscess is seen as central hypodense cystic intramedullary lesion with thick reactive rim of sclerosis. CT can also help differentiate a Brodie's abscess from an osteoid osteoma. The nidus of osteoid osteoma is well defined round or oval with a central area of high attenuation, representing a mineralized osteoid [10]. CT is also superior to conventional radiograph and MR imaging for detection of a sequestrum [3].

Marti-Bonmati et al. [11] first described the target appearance of the Brodie's abscess on MR imaging. They defined four distinct layers: (a) the centre (pus) which is reduced in intensity on T1-weighted and increased intensity on T2-weighted images, (b) the internal ring (abscess wall) which is isointense to muscle on T1-weighted and increased intensity on T2-weighted images, (c) the external ring (zone of reactive sclerosis) which is reduced in intensity on T1-weighted and T2-weighted images and (d) the peripheral

halo (marrow edema) which is reduced in intensity on T1-weighted and increased on T2-weighted images.

Grey et al. [4] subsequently elucidated the importance of the 'penumbra sign' in the imaging diagnosis of subacute osteomyelitis. The 'penumbra sign' is a zone of transition with relatively high signal intensity on T1-weighted images between the abscess and reactive sclerosis. This zone of transition corresponds to the inner ring described by Marti-Bonmati et al [11]. Histologically, the 'penumbra sign' represents the vascularized granulation tissue wall surrounding the abscess cavity with a variable water content, which in turn determines the degree of hyperintensity on T1-weighted images [12]. The rich vascular supply of this layer accounts for its avid contrast enhancement.

The 'penumbra sign' is not pathognomonic but is an important characteristic MR imaging feature with reasonably high specificity, reported as greater than 90% [5] in the diagnosis of subacute osteomyelitis of Brodie. However, 'penumbra sign' has also been observed in other bone conditions such as Langerhans cell histiocytosis [13], chondrosarcoma [12] and lymphoma [14]. Despite this, the sign remains an important diagnostic pointer of Brodie's osteomyelitis.

## 4. Conclusion

There is ambiguity in differentiating subacute osteomyelitis of Brodie from other benign and malignant bone lesions (clinically and radiographically). The 'penumbra sign' on non-enhanced T1-weighetd MR imaging is a useful diagnostic sign of Brodie's abscess, especially when it occurs in a typical location—the proximal tibial metaphysis. The presence of 'penumbra sign' helps in narrowing the differential diagnosis and assists in excluding other benign and malignant bone lesions thereby facilitating the therapeutic decision.

## Acknowledgements

Nothing to disclose.

## Competing Interests

None declared.

## References

[1] Brodie BC. An account of some cases of chronic abscess of the tibia. *Medico-Chirug Trans.* 1832; 175: 239-249.

[2] Renton P. Periosteal reaction; bone and joint infection; sarcoid. In: Sutton D (Ed). A Textbook of Radiology and Imaging, 7th Ed. *Churchill Livingstone, Edinburgh*, 2007; Pp1153-1177.

[3] Kornaat PR, Camerlinck M, Vanhoenacker FM, De Praeter G, Kroon HM. Brodie's abscess revisited. *JBR-BTR*. 2010; 93 (2): 81-86.

[4] Grey AC, Davies AM, Mangham DC et al. The 'penumbra sign' on T1-weighted MR imaging in subacute osteomyelitis: frequency, cause and significance. *Clin Radiol*. 1998; 53:587-592.

[5] Afshar A, Mohammadi A. The "Penumbra Sign" on Magnetic Resonance Images of Brodie's Abscess: A Case Report. *Iran J Radiol*. 2011; 8(4): 245-248.

[6] Bohndort K. Infection of the appendicular skeleton. *Eur Radiol*. 2004; 14:E53-E63.

[7] Gulati Y, Maheshwari AV. Brodie's abscess of the femoral neck simulating osteoid osteoma. *Acta Orthop Belg*. 2007; 73(5): 648-652.

[8] Agrawal P, Sobti A. A Brodie's Abscess of Femoral Neck Mimicking Osteoid Osteoma: Diagnostic Approach and Management Strategy. *Ethiop J Health Sci*. 2016; 26 (1): 81-84.

[9] Al-Jafar H, Al-Shemmeri E, Al-Shemmeri J, Aytglu L, Afzal L, Al-Enizi S. Precision of SPECT/CT Allows the Diagnosis of Hidden Brodie's Abscess of the Talus in a Patient with Sickle Cell Disease. *Nuc Med Mol Imaging*. 2015; 49(2): 153-156.

[10] Chai JW, Hong SH, Choi JY et al. Radiologic diagnosis of osteoid osteoma: from simple to challenging findings. *Radiographics*. 2010; 30 (3): 737-749.

[11] Mart-Bonmati L, Aparisi F, Poyatos C et al. Brodie abscess: MR imaging appearance in 10 patients. *J Magn Reson* 1993; 3:543-546.

[12] Datir A, Lidder S, Pollock R, Tirabosco R, Saifuddin A. High-grade chondrosarcoma mimicking Brodie's abscess. *Clin Radiol*. 2009; 64:944-947.

[13] Chang WF, Hsu YC, Wu YD, Huang GS. Localized Langerhans cell histiocytosis masquerading as Brodie's abscess in a 2-year old child: a case report. *EXCLIJ*. 2016; 15:33-37.

[14] Park J, Lee S, Joo KB, Park CK. Primary Bone Lymphoma of the Distal Tibia Mimicking Brodie's Abscess. *J Korean Soc Radiol*. 2014; 70(1): 59-63.